YAŞAR UNIVERSITY

IX. INTERNATIONAL LOGISTICS & SUPPLY CHAIN CONGRESS

"INTERNATIONAL RETAIL LOGISTICS IN THE VALUE ERA"

27-29 OCTOBER 2011, ÇEŞME, İZMİR TURKEY

PROCEEDINGS

VOLUME 1

YAŞAR UNIVERSITY PUBLICATONS

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Publishing Date: August, 2012

ISBN: 978-975-6339

Printed in Izmir- Turkey.
Printed in 2012 Izmir / Turkey

Printed at Meta Basım, İzmir, Turkey

IX. INTERNATIONAL LOGISTICS & SUPPLY CHAIN CONGRESS
27-29 OCTOBER 2011

DEPARTMENT OF INTERNATIONAL LOGISTICS MANAGEMENT,YAŞAR UNIVERSITY

&

LOGISTICS ASSOCIATION (LODER)

In memory of Donald J.Bowersox[1]

[1] Don was professor of Dr.Omer Baybars TEK at MSU during in 1969-1971 and later Dr.Tek had the chance to teach with him under his deanship at Eli Broad in MSU 2002. The Congress Committee decided to dedicate this congress in memory of him, as a leading pioneer and legend of logistics. No doubt most of the members of the global logistics community are familiar with Prof. Don Bowersox, who was supposed to have been in this Congress, sadly he passed away a few months before the Congress date. A brief commemoration for him held at the outset of the opening ceremony. (Ömer Baybars TEK).

YAŞAR UNIVERSITY & LODER
IN COLLABORATION WITH OUR ESTEEMED PARTNERS

- Cranfield University
- Michigan State University
- University of Ljubljana
- University of Parma
- University of South Florida

PREFACE

As the department of International Logistics Management and LODER (together with our domestic and International partners) we had the honor of hosting 9th International Logistics and Supply Chain Congress between 27-29 October 2011 in Yaşar University Campus and Çeşme Altınyunus Resort Hotel.

These Proceedings are the outcome of the Congress. The proceedings comprised two volumes which contain papers which have been completely reviewed by our distinguished reviewers. We are thankful to the domestic and international reviewers and the authors of these papers. The committees involved, namely the organization committee, proceedings subcommittee and the international steering committee, did an excellent job in materializing the Congress and the Proceedings.

300 academics and experts in logistics participated in the Congress from more than 18 countries, including India, Brazil, North America, Europe and many others. About 120 presentations are given over 23 sessions. We had 6 distinguished Keynote Speakers, five of which are International, 16 Invited Speakers, some of which are International and 10 speakers from the Logistics Industry.

As listed in the subsequent opening speeches we owed may thanks to many people without whose support and self-sacrificing help neither this congress nor these proceedings could have come about.

PROF.DR.ÖMER BAYBARS TEK
CONGRESS CHAIR AND
HEAD OF THE DEPARTMENT OF INTERNATIONAL LOGISTICS MANAGEMEMENT

PROF.DR. MEHMET TANYAŞ
CHAIR OF LOGISTICS ASSOCIATION OF TURKEY
CONGRESS CO-CHAIR

"Logistics is making promise and keeping that promise." ***Ömer Baybars Tek***

"Logistics is the science of logical, systematical and targeted movement and placement of people, goods and services, information and vehicles." ***Ömer Baybars Tek***

"Logistics is an important philosophy and instrument that will create responsiveness and sensitivity in the management of time, place, movement, information and energy throughout all exchange relationships." ***Ömer Baybars Tek***

OPENING SPEECHES

TELECONFERENCE BY BİNALİ YILDIRIM

THE MINISTER OF TRANSPORT, MARITIME AFFAIRS AND COMMUNICATION OF REBUPLIC OF TURKEY.

Dear guests, dear academicians, dear students, I would have wished very much to be among you in this Congress organized by Yasar University. However, I could not be with you todays because of my National Assembly program work load. I already wish success and greet all participants with love and respect.

Wellcome to İzmir. I expect that this Congress, no doubt, will open up a new horizon to our Logistics industry and supply chain sector.

Throughout this International Congress started by you today in Yasar University İzmir and which will continue later in Çeşme, the significant issues of the sector, by many speakers and presenters from France, Belgium, America, Netherlands, Brazil, Czech Republic, Slovenia, Malezia, İran etc. will be discussed in depth. Certainly the outcome of this Congress will turn out to be important opportunities for all professionals and for our Government. Again I wish you all much success and fruitful work.

VIDEO CONFERENCE BY PROF. DR. MARTIN CHRISTOPHER

Hello,
I'm Martin Christopher. I like to welcome you all , to the Congress. It's an honor to be invited and to be recognized in this particular way. I'm only too sorry that I cannot actually be with you in person today. I hope the congress would rewarding experience for everybody. I'm particularly like to thank Prof. Dr. Omer Tek for his kind invitation and indeed the Rector of the university and all those responsible for making this successful event that I know it would be. Thank you very much and have a good conference.

AHMET YİĞİTBAŞI
PRESIDENT
BOARD OF TRUSTEES

Dear, Dear Ministry Of Transportation & Communications, Rector, Dean, Professors, Speakers and distinguished keynote and invited speakers, participants distinguished guests, Ladies and Gentlemen, Welcome.

We are all delighted to welcome you to the 9th International Logistics and Supply Chain Congress in a region which is the cradle of the logistics, intersecting Ephesus, Smyrna, Pergamon etc. and which has been the hub of transportation and logistics for over 5000 year .

It is my pleasure to officially open this 9th Logistics Congress at our University. I would like to welcome everybody and a special welcome to our keynote, invited speakers and all other domestic and international guests.

It is both timely and appropriate that this Congress be held here in İzmir. It is also appropriate that we are holding the opening session here in wonderful new Yaşar University Selçuk Yaşar Campus.

While celebrating the 10th year of YAŞAR UNIVERSITY this year, we today mark another important event among many others in our international university.

Today we, as Yaşar University, are witnessing and holding a significant international event, in collaboration with Turkish Logistic Association, and with the partnership of 5 international esteemed universities, namely Michigan State, Parma, Erasmus and Cranfield Universities and University of South Florida and University of Ljubljana. Our Turkish partners are Turkish Marketing Association, Turkish Chamber of Shipping, Turkish Association of Shopping Centers and Retailers (AMPD). All of these organizations share their dedication to education, science and humanist values.

A special welcome and gracious thanks to our distinguished Keynote Speakers, Dr. Mehmet AKTAS, CEO, Yaşar Holding Member of Board of Directors, James STOCK, University of South Florida, Brenda STERNQUIST Michigan State University, Rene De KOSTER, Rotterdam School of Management, Erasmus University, Antonio RIZZI, Parma University, Igor JAKOMIN, Ministry of Transportation State Secretary, Slovenia, Martin CHRISTOPHER, UK (through Video message) .

In this congress, we have approximately 40 participants and more than 300 hundred participants from Turkey and aboard including England, France, USA, Australia, Belgium, Netherlands, Germany, Brazil, Czech Republic, Poland, Iran, Greece, Slovenia and Malezia. I proudly welcome and thank to all our guests.

In this era of globalization, where there have been rapid changes in various walks of business life as a result of the global acceleration of information, communication, technology, transportation and logistics, we really need to be prepared to meet the challenges driven by the global demands. Therefore, worldwide theoretical and practical achievements and future challenges in logistics will be discussed in depth in this Congress. I believe that this Congress will contribute to find answers to these challenges

We know that it took almost two years of preparation to organize and achieve this excellent meeting. Under the leadership of Dr. Tek, an industrious, devoted and savvy core / lean team from the Department of International Logistics Management and Department of Business of the Faculty of Economics and Administrative science, a small student team, together with the support of all Yaşar

University experienced and devoted staff have made this Congress possible, taking extra miles, braving and overcoming all the difficulties that might come about along the way. Of course the Scientific Committee, Organizing Committee also greatly contributed to the success of this Congress. I cordially congratulate all of them .

We are proud of hosting many speakers, keynote and invited speakers, industry and sponsor speakers, and all other worldwide speakers and participants that made this Congress come true.

On behalf of the Board of Trustees, in addition to the keynote speakers I mentioned above I particularly thank to Invited, industry speakers and all contributors.

I wish you all and every success in your deliberations this week. I hope that by the end of the Congress every one of you will feel newly inspired and newly committed to the cause of different dimensions of Logistics.

On behalf of Yaşar University I would like to express my gratefulness and thanks to all participant especially those who came from different parts of the world by taking extra miles.

May I congratulate the Yaşar University's Department of Logistics Management Congress Committee for the success of conducting this international conference. As board of trustees we are grateful for your kind willingness to give your time and knowledge voluntarily.

I wish you all the best in your endeavours and hope that the scientific program today will be the first spark of a fruitful collaboration that will also put our university further on the map as a universal center of excellence in logistics research. I also believe that this Congress will help further promotion of our city in the way of becoming a destination center for all through the word -of -mouth of our friends who are coming from various countries.

I wish all the participants productive discussions throughout the conference and an enjoyable stay in our City and especially in excellent Altınyunus Resort Hotel facilities. Thank you.

Once again, it's a pleasure to greet everybody here contributing to the Congress with respect and I hope you have a successful congress

AHMET YİĞİTBAŞI
PRESIDENT
BOARD OF TRUSTEES

PROF.DR. MURAT BARKAN
RECTOR

Dear President of the Board of Trustees distinguished members of the Board of Trustees, Distinguished Rectors, Professors, Distinguished Keynote and Invited speakers, Business Speakers, President of Logistics Association, and all other participants and all distinguished guests, Ladies and Gentlemen, Welcome to the 9th International Logistics and supply Chain Congress to be held in our University.

We are very pleased and honored hosting you among us from all over the World. I am sure almost all participants in this Conference hall are aware of the purpose and meaning of this meeting. As a matter of fact in the opening speeches before me the purpose of the Congress made clear sufficiently. Therefore I do not want to elaborate and take the precious times of coming keynote speakers. All I want to say as Yaşar University we are well aware of the importance of Logistics for the World as well as Turkey. This is why we opened up the department of International logistics Management. I proudly know from the outset, the Department of International Logistics Management with a lean team spent a great deal of time and effort to make this excellent Congress come true. In addition a good many invaluable people whose names already cited through the opening remarks before me contributed for the success of this Conference. I congratulate the Department of International Logistics management, my University staff, the Organizing Committee, the Scientific Committee, the Executive Committee, Keynote Speakers, Invited Speakers, Business Speakers and all other people who will present papers during these three days. My special thanks goes to all our International Speakers who went extra miles to visit us here in Turkey.

I am sure this Conference will reach its achieve its purpose and be a great success. I wish a very fruitful and enjoyable Conference.

PROF. DR. MURAT BARKAN
RECTOR

PROF.DR. MEHMET TANYAŞ
CHAIR OF LOGISTICS ASSOCIATION OF TURKEY
CONGRESS CO-CHAIR

Dear, Dear Ministry of Transportation & Communications, Rector and Participants,

It is a great pleasure for us to host all of valuable yours, for the 9th International Logistics and Supply Chain Congress, in this beautiful city, Izmir. This Congress is the first and still the unique scientific lecture environment on logistics and supply chain regularly being held in Turkey. These Congresses had been arranged each, in cooperation with a Turkish University, an International University and also Logistics Association of Turkey (called LODER). Following, next year's congress will be organized within Kemerburgaz University, in Istanbul city, October 2012.

Initially, I would like to give some brief information about the Logistics Association of Turkey, called "LODER" that was founded in the year, 2001. LODER only consists of individual members; corporations are not allowed to register. We have now approximately 950 members. LODER carries out its own activities within the vision of being a leader for providing services for the adoption of supply chain management from all aspects.
LODER focuses on the professionally personal developments of it's members as well, and at the same time, organizes Logistics' Case Study Competitions for university students on every yearly base. LODER, publishes bi-monthly Logistics Journal containing technical and academical articles in Turkish Language and a Glossary of Logistics Terms on a regular basis accordingly. Finally, LODER is a representative of International Associate of APICS in Turkey.
Competition has become tougher and more challengeable, even not only among the companies but also among the countries and on global supply chains. In order to realize the competitive advantage via "right good, at right place, on right time within reasonable cost" strategy, nevertheless, related a common logistics' policy and a master plan should be established for better result. Scientific congresses are very helpful and useful for providing references for establishing this kind of policies. This congress provides one of the milestones on this basis with presentations, discussions and proceedings.
I would like to thank Yaşar University and all foreign universities for their appreciative efforts in organizing this congress. I would like to extend my thanks to our congress sponsors for their contributions. Our special thanks go to Professor Ömer Baybars Tek and his assistants who succeeded lots of the organizational works.
In closing, I wish to express my gratitude to all participants who have contributed and cooperated for making this congress a reality and a success.

Thank you

PROF.DR. MEHMET TANYAŞ
CHAIR OF LOGISTICS ASSOCIATION OF TURKEY
CONGRESS CO-CHAIR

PROF.DR.NURİ YILDIRIM, PH.D.
DEAN OF THE FACULTY OF ECONOMICS AND ADMINISTRATIVE SCIENCES OF YAŞAR UNIVERSITY

Dear Ministry of Transportation & Communications, The Honorable Members of The Board of Trustees of Yaşar University, The Rector of Yaşar University, Keynote Speakers, Invited Speakers, Industry Speakers, Partners, The Distinguished Guests and Participants, Academics, Colleagues, Press Members, Our Students and Ladies and Gentlemen,
It is a great pleasure and honor for me to welcome you all today to the 9th International Logistics & Supply Chain Congress organized by my Faculty, The Faculty of Economics and Administrative Sciences of Yaşar University in collaboration with LODER, Turkey. I sincerely hope that our 3-day comprehensive conference which consists of seven keynote speeches, 23 discussion sessions and more than 220 paper representations will be fruitful, interesting and enjoyable for all participants and researchers.
I am sure that the wide spectrum of topics elaborated in the submitted papers to the Conference will be a source of inspiration and ideas, and the interdisciplinary nature of the conference will provide a good platform for knowledge exchange and dissemination of opinions among participants coming from different branches of research.
It is our great pleasure and privilege to have this year seven distinguished guests as keynote speakers: Doctor AKTAŞ, CEO, Yaşar Holding Member of Board of Directors; Professor STOCK, University of South Florida; Professor STERNQUIST, Michigan State University; Professor RIZZI, Parma University; Professor KOSTER, Erasmus University; Doctor JAKOMIN, Ministry of Transportation State Secretary, SLOVENIA; Professor CHRISTOPHER, Cranfield University. I would like to express my sincere thanks and gratitude to all people and institutions who have contributed in various ways to the realization of this Conference. First of all, allow me to express my heartfelt thanks to The Members of Board of Trustees of Yaşar University, Dear Rector Professor Murat Barkan, Partners and Keynote Speakers, for their invaluable supports and contributions.
I wish also to extend my sincere thanks to the Congress Chair Dear Professor Ömer Baybars Tek, Dear Co-Chair of Congress Professor Mehmet Tanyaş, Dear Members of Scientific Committee, Advisory Board, and the Congress Organization Committee for all the hard work they did to realize this successful Congress. I would also like to thank our sponsors, ARKAS, BORUSAN, BP, Bumerang Logistics, Çelik Motor, DTO İzmir, Mars Logistics, NAKLOG, OMSAN, LODER, Mazhar İzmirlioğlu, AS Yakıt, NETSİS, İnci Lojistik, ÜÇGE, GRAS SAVOYE, PEGASUS, SOFRA GRUP, Altın Yunus, Milliyet, Retail News, Pepsi Co., Kristal Fikirler and BİNTUR for their sponsorships and supports.

With all my respects,
Thank You.

PROFESSOR NURI YILDIRIM, PH.D.
DEAN OF THE FACULTY OF ECONOMICS AND ADMINISTRATIVE SCIENCES OF YAŞAR UNIVERSITY

PROF.DR.ÖMER BAYBARS TEK'S FOREWORD
CONGRESS CHAIR AND
HEAD OF THE DEPARTMENT OF INTERNATIONAL LOGISTICS MANAGEMENT

Dear Ministry of Transportation & Communications, The Honorable Members of The Board of Trustees of Yaşar University, The Rector of Yaşar University, Keynote Speakers, Invited Speakers, Industry Speakers, Partners, The Distinguished Guests and Participants, Academics, Colleagues, Press Members, Our Students and Ladies and Gentlemen, it is my great pleasure and honor to welcome you to the 9th International Logistics and Supply Chain Congress, the theme of which is **International Retail Logistics in the Value Age.** We thank you all for honoring our Congress.

A special welcome to all our Distinguished Keynote, Invited and Industry Speakers. Late Dr. Bowersox; Dr. Mehmet AKTAŞ, CEO, Yaşar Holding Member of Board of Directors; James STOCK, University of South Florida; Brenda STERNQUIST Michigan State University; Rene De KOSTER Erasmus University; Antonio RIZZI, Parma University; Igor JAKOMIN, Ministry of Transportation State Secretary, SLOVENIA; Martin CHRISTOPHER UK (through Video message) .

This congress, which has been organized for the last eight years, has already established itself as a key event in which the most influential logistic leaders from all over the world come together to exchange insights on worldwide logistic issues. The value of this Congress lies in the opportunity it provides for an in-depth dialogue among scientists and professionals.
We now have the pleasure of hosting you to share in this global knowledge and friendship within our university.

The preparations for this Congress started in 2009, when I was first appointed to the chair of the Department Of International Logistics Management. I am sure the audience here today fully appreciates the toil and sweat that is involved in pursuit of such an endeavor. Therefore I won't go into the details of the process. However enough to say that it was a challenging, but yet enjoyable, work for all of us. As in the words of Paulo Coelho's Alchemist, we set out in organising this Congress, without seeing or knowing the visible and invisible obstacles that might appear in front of us, notwithstanding them and all the world helped us in making it happen.

It started as a dream… I started with a belief in my long standing Turkish, American and European friends and colleagues, and also in my two research assistants, namely Research Assistant Pervin Ersoy and Research Assistant Gülmüş Börühan, who were at the core of the team, and who willingly sacrificed their time - the same time that they should have been allocating to their doctoral studies. They never disappointed me with their incredible work. Later on in the preparations, we also benefitted from the experienced and devoted works of dear Research Assistant Senem Yılmaz and dear Instructor Ceren Altuntaş. And in September 2011, Assoc. Prof. Dr. Yücel Öztürkoglu and Assoc. Prof. Dr. Özge Naillat also joined the core team. Thanks to all of them.
Of course such a Congress could not have materialized with merely six people. There is more... The rest of the team has turned out to be an army of valuable people whose names I shall list for you shortly. However first I would like to mention some important figures, whom I trust and who were always supporting us. First and foremost a special thanks goes to Ahmet Yiğitbaşı, our Rector Prof. Dr. Murat Barkan and particularly my valued and esteemed friend, the CEO of Yaşar Holding Dr. Mehmet Aktaş. If it had not been for them, this Congress would not have happened. We also made use of the valuable experiences and guidance of Prof. Dr.Mehmet Tanyaş, the president of the Logistics Association.

In this introduction, I would like to take the opportunity to briefly comment on the term **'logistics'** with a few words as I understand it.

Logistic can be defined **as the science and art of commanding movement, time, energy and place.** It is an art of **living and survival that includes strategy as well as many tactical instruments**. It is a globally linked phenomenon, with many prestigious Turkish logistics companies, most of which became our sponsors , thriving in global competitive arena, having successfully captured the universal momentum of logistics over the years, some better than their global competitors.

Logistics is recognized as the **sine qua non** of **marketing** and constitutes a substantial part of it. **Marketing** is a **Value Offer** or **promise** which is given to customer and it is the logistics that provides the fulfilling route to deliver or keep that promise.

Likewise, I made a **promise** to Ahmet Yiğitbaşı, our Rector Prof. Murat Barkan, Dr. Mehmet Aktaş and also to Prof. Dr. Tanyaş, that we would hold /deliver this Congress and today I am happy that I kept my promise.

And so today, we are **delivering this 'Value Offer'** with the help and support of innumerable people, who have demonstrated their appreciation of knowledge and science, and their commitment towards supporting **the future of young students**.
We organized this Congress with the valued collaborations of 5 international universities shown below as partners;

- Michigan State University,
- Parma University,
- Cranfield University,
- University of South Florida and
- University of Ljubljana.

In addition four esteemed Turkish Organizations, Logistics Association (LODER) Turkish Marketing Association, Turkish Chamber of Shipping and Turkish Association of Shopping Centers and Retailers (AMPD) are also joined to the partnership. 300 academics and experts in logistics will be participated in the Congress from more than 18 countries, including India, Brazil, North America, Europe and many others. About 120 presentations are expected to be given over 23 sessions. We had 6 distinguished Keynote Speakers, five of which are International, 16 Invited Speakers, some of which are International and 10 speakers from the Logistics Industry.
And perhaps most importantly, some 240 volunteer students, including 32 Erasmus students, were with us as listeners during the congress, because we paid special attention to the participation of students in this event. Students have had the chance to meet with our sponsors and the other participating firms at their promotional stands.

We owe many thanks to many people. First of all Binali YILDIRIM, the Minister of Transport, Maritime Affairs and Communications joined the Opening ceremony through video conference. We do thank him for his invaluable contribution. I should like to name the wider team, without whose support and self-sacrificing help this congress could not have happened. Foremost I would like to extend my gratitude and thanks to our partners, namely MSU, Parma, Cranfield, Southern California, University of Ljubljana.

My other thanks goes to;

- Prof. Mehmet Tanyaş (President of Logistics Association)
- To our keynote speakers (Dr.Mehmet Aktaş, Profs. Brenda Sternquist, *Donald Bowersox*, James Stock, Antonio Rizzi, Igor Jakomin, Rene de Koster, Martin Christopher)

- All our partners I mentioned above.
- Our dean Prof.Nuri Yıldırım and former Dean Prof. Orhan İçöz
- Our Local Committee
- The Scientific Committee and our referees
- All the Yaşar University Administrative Staff (*Dilek Sezer, Hale Duymaz, Yiğit Ocak, Betül Ertürk, the IT Unit, Mesut Yılmaz, Emin Mengüarslan, Onur Erbaş, Neslihan Takmaz, Çağdaş Saraç, Patricia Türkmenoğlu, Turgut Onarır , IT personnel and other personel)*
- All participants and participating students and paper presenters
- All the research assistants who participated in sessions.
- **Invited speakers, Academics and Professionals,** (Yaşar Büyükçetin, Turgut Sarıoğlu, Murat Ihlamur, Geza Dolough, Berna Kumaş, Deniz Sipahi, Dilek Gappi, Paul Barret, John N.Gaskins, Murat Ihlamur, Reha Haznedaroğlu, Mehmet Nane, Tunç Erem, Okan Tuna, Alptekin Erkollar, Servet Topaloğlu, Tunçdan Baltacıoğlu, Muhammed Bamyacı, Kemal İzmirden, Okan Aras, Yılmaz Attila, Emrah Gezgin, Kemal Izmirden, Aydan Bilgel, Burak Alat, Sinan Cem Savcı, Devrim Erişkon, Türkan Gürsac, Duygu Tekin, Özgür Arı).
- Our “backstreets student team” (Especially Anıl Tanrıverdi and Mehmet Serdar Erdoğan)

- I also thank to the hundreds of **inconspicuous** e-mail correspondents and secretaries whose names only we know and with whom we communicated several times over two years.

- **We owe many many and foremost special thanks and appreciation to following sponsors** that generously supported this Congress to be an outstanding success. Namely, Schenker Arkas, British Petrol, Borusan Lojistik, Çelik Motor, Omsan Lojistik, Netsis, Sofra Group, Mars Lojistik, Naklog, Boomerang, ÜÇGE, Dr.Mazhar İzmiroğlu, As Yakıt, İnci Lojistik, Pegasus, Altınyunus, Gras Savoye, Pepsico, Milliyet, Kristal Fikirler Web Design, Yaşar University Computing Center, Retail News, AMPD, Bintur Travel Agency, Turkish Shipping Organization İzmir,

I once again thank to the invaluable contributions of all of these valued organizations and people. *Nothing could have been accomplished if it were not for them.*

Last but not least, we hoped that ILC 2011 will be beneficial and enlightening for all participants and we did every effort to see to it that the Congress be a success and it did turn out to be a real success indeed.

Thank you.

PROF.DR.ÖMER BAYBARS TEK’S FOREWORD
CONGRESS CHAIR AND
HEAD OF THE DEPARTMENT OF INTERNATIONAL LOGISTICS MANAGEMENT

LETTERS OF APPRECIATION FOR OUTSTANDING ACHIEVEMENT

PROF.DR. ANTONIO RIZZI

Dear Gentlemen ,
I've been impressed by the outstanding event you organized and by your hospitality and kindness. The award you gave me honored myself and my University . I hope this could be the first step of a fruitful and long lasting collaboration between us and our University. Thank you again.
Best regards,
Prof.Dr. Antonio Rizzi,
Industrial Logistics & Supply Chain Management
University of Parma

WİFE OF LATE PROF. DR. DONALD J.BOWERSOX (MSU)

Thank you so much for this email. I am very late in replying. It has been a difficult time. I do want to also thank you for sending the award that was awarded to Don at your meeting in October. He was very honored to be getting this award and we were looking forward to our trip to Turkey. I am sure your meeting was a success. Thank you.
Terry Bowersox

PROF.DR. JAMES STOCK

Dear Mr. Ahmet Yigitbası
President of The Board of Trustees
It was a great pleasure to meet you in Turkey at the IX. International Logistics & Supply Chain Congress. I enjoyed your remarks during the opening speeches as well as all of the session presentations which I attended over the course of the Congress. Overall, the event was well conceived, developed and carried out. Congratulations to those involved in the planning and implementation of the Congress. I must say that I very much enjoyed all aspects of my stay in Turkey, not just the Congress, but also my one-day visit to Ephesus on the Sunday following the Congress. Thank you for the great hospitality during my visit. I hope to again visit Turkey at some point in the future, perhaps as a participant in a future Congress or other event.

My best wishes are extended to you for a successful year at Yaşar University. All the best.

Sincerely yours,

James Stock
Frank Harvey Endowed Professor of Marketing

DR.IGOR JAKOMIN

Dear Prof.Dr.Barkan,
Let me thank you for inviting me at IX. International Logistics and Supply Chain Congress. By my opinion, the congress was really excellent organized and prepared, with a top-quality program. Being a keynote speaker was an honour to me and I would like to express all my gratitude for the hospitality and pleasurable time during my stay in Turkey. I really looking forward to meeting you again. Yours sincerely
Dr.Igor Jakomin

Prof. PAUL BARRETT, DEAN

Dear Omer:
The Congress was one of the very best conferences I have attended anywhere. It was a pleasure to meet you and attend this year's Congress. I will be sending special notes to Mr. Yigitbasi and Professor Barkan very soon on how well constructed and executed the Congress was. It will be our continued pleasure to make every attempt to attend next year's Congress as well.

Best regards,
Paul Barrett, Dean
College of Business and Economics
Longwood University

PROF.DR.JAMES STOCK

Prof. Dr. Barkan
Thank you for your hospitality and support of the IX. International Logistics & Supply Chain Congress held in Cesme and Izmir, Turkey. I enjoyed meeting you and many others involved in the conference. It was a wonderful conference in terms of its content and attendance. I very much appreciated being able to participate as a speaker and session chair. The individuals who developed the conference agenda and coordinated the logistics of the event (venue, location, timing, etc.) are to be congratulated. I have attended many conferences over the years and this one was one of the best. Everything ran smoothly and the content was both varied and informative.

I wish you the best and hope that it might work out for me to participate again in the future. Thanks again for a great experience. By the way, on Sunday after the conference ended, I rented a car and visited Ephesus. It was a memorable experience and one that made a perfect ending to an overall great trip to Turkey.

Sincerely yours,

James Stock
Frank Harvey Endowed Professor of Marketing
College of Business, University of South Florida
USA

PROF.DR. BRENDA STERNQUIST

Mr.Ahmet Yigitbası
President of the Board of Trustees of the Yasar University

Dear Mr.Ahmet Yigitbası,

What a delightful time I had at the conference in Izmir. The opening ceremony was very well attended and it was insightful to hear from local/national dignitaries.
I was very pleased to see that the excellent attendance continued even when we moved to the resort. Often times you find that the sun temps people too much, but this didn't happen. Thank you for your gracious sponsoring of the conference. I made some lifetime friends.
Brenda Sternquist

ASSIST. PROF. DR KRZYSZTOF WITKOWSKI

Dear Mr. President of the Board of Trustees of the Yasar University, Mr. Ahmet Yigitbası,
I would like to thank you for giving me the opportunity to attend the IX. International Logistics and Supply Chain Congress' 2011. I have to emphasize that the Executive Committee has worked very hard and the Congress was organized, prepared and accomplished excellent. People were very helpful, kind and friendly. Ever I asked Professor Omer Tek or Pervin, or Gülmüş, or anyone else for anything I got the information and help immediately. Students club was hard-working and their help was noticeable. I had an intellectually and in every other aspects pleasurable time and saw a splendid hospitality. I am very glad to be there. Congratulations!
I had also the opportunity to see the Yaşar University in Izmir. This is stately facility. It was good to see such a beautiful place.
Congratulations once again for the IX International Logistics and Supply Chain Congress' 2011 in Izmir!

Yours Sincerely,

Assist. Prof. Dr. Krzysztof WITKOWSKI
Vice-dean
Faculty of Economics and Management
University of Zielona Gora, Poland

ASSIST. PROF. DR KRZYSZTOF WITKOWSKI

Dear Profesor Omer TEK,
There is another email I sent to the President of the Board of Trustees of the Yasar University, Mr. Ahmet Yigitbası.
Thank you once again for invitation to the Congress and giving me the opportunity to chair the session. I hope we will fix a date of my Erasmus lectures for your students. I have also discussed the problem with Ceren Altuntas and Pervin Ersoy. Maybe during the International Erasmus Week I could give some lectures or even sooner. I do not know when do you start the summer term?
It was nice to see you and to visit Yasar University.

Very kind regards,
Krzysztof Witkowski

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DAY 1 - 27 OCTOBER 2011 – THURSDAY, WELCOME & OPENING REMARKS	
08:30-09:00	**Coffe & Snacks**
09:00-09:15	**Mini Concert**
09:15-10:15	**OPENING SPEECHES** Prof. Dr. Ömer Baybars TEK, Congress Chair, Yasar University Prof. Dr. Mehmet TANYAS, President, LODER-Turkish Association of Logistics, Congress Co-Chair Prof. Dr. Nuri YILDIRIM, Dean, Yasar University Prof. Dr. Murat BARKAN, Rector, Yasar University Ahmet YIGITBASI, Yasar University Head of the Board of Trustees Binali YILDIRIM, Minister of Transportation (Upon confirmation)
10:15-10:30	**Coffee Break** **(COMMEMORATION) Professor Donald J. BOWERSOX, Ph.D., Michigan State University, U.S.A.**
10:30-12:30	**KEYNOTE SPEAKERS** Mehmet AKTAS, Ph.D., CEO, Yasar Holding Member of Board of Directors, TURKEY *“Logistics and Supply Chain Management, An Industrial Perspective”* Professor James STOCK, Ph.D., University of South Florida, USA *“Trends in Logistics and Supply Chain Management”* Professor Brenda STERNQUIST, Ph.D., Michigan State University, USA *“Retailer’s Strategic International Expansion”* Professor Antonio RIZZI, Ph.D., Parma University, ITALY *“RFID Fashion Pilot Project”* Professor Rene De KOSTER, Ph.D., Rotterdam School of Management Erasmus University, NETHERLANDS *“Time Windows as a Tool to Manage City Sustainability”* Igor JAKOMIN, Ph.D., Ministry of Transportation State Secretary, SLOVENIA *”The Gateway for Your Logistics Solutions”* Professor Martin CHRISTOPHER, Ph.D., Cranfield University, UK (VTR)
12:30-13:30	**Lunch**
13:45-14:00	**Mini Concert**
14:00-15:45	**INVITED SESSION I** **Chair: Professor Ömer Baybars TEK, Ph.D.** Professor Mehmet TANYAS, Ph.D., *President, LODER-Turkish Association of Logistics, TURKEY* Assoc. Prof. Paul BARRETT, Ph.D., *Dean of Longwood University, USA* Assoc. Prof. John N. GASKINS, Ph.D., *Longwood University, USA* Servet TOPALOGLU, *Yasar Holding, Member of Board of Directors, TURKEY* Yasar BÜYÜKÇETIN, *CEO, Sofra Grup, TURKEY* Murat IHLAMUR, *Netsis General Manager, TURKEY* Mehmet NANE, *President, Council of Shopping Centers and Retailers (AMPD), TURKEY*
15:45-16:00	**Coffee Break**

16:00-17:45	**INVITED SESSION II** **Chair: Professor Mehmet TANYAS, Ph.D.** Emrah GEZGIN General Manager, Inci Logistics, TURKEY Professor Tunç EREM, Ph.D., President, Turkish Marketing Association, TURKEY Professor Okan TUNA, Ph.D., Dokuz Eylül University, TURKEY Professor Alptekin ERKOLLAR, Ph.D., University of Kalgenfurt, AUSTRIA Professor Tunçdan BALTACIOGLU, Ph.D., Izmir University of Economics, TURKEY Assist. Prof. Muhammed BAMYACI, Ph.D., Maltepe University, TURKEY Emre AKAL, Akzo Nobel Boya A.S., Purchasing Manager, TURKEY
18:00	**SHUTTLE TO ÇESME ALTIN YUNUS HOTEL**

DAY 2 - 28 OCTOBER 2011 – FRIDAY

INDUSTRY- SPONSORS PRESENTATIONS OKYANUS
09:30 – 11:00

Session Chair: Mehmet Tanyaş, Maltepe University, Turkey
Okan Aras, Üçge Drs Depolama Sistemleri,Turkey
“Lojistikte Verimliliğin Anahtarı : Depo Raf Sistemleri”
Yılmaz Attila, Yılmaz Attila Danışmanlık, Turkey
“Dağıtım Deposu ile Mağaza Formatları Arasında Yaşanan Sorunlar”
Emrah Gezgin, Yeşil Lojistik, Turkey
“İntermodal Denizotobanı Taşımacılığı”
Kemal İzmirden, Food Group,Yasar Holding A.Ş, Turkey
“Lojistikte Performans Yönetimi”
Aydan Bilgel, Mars Logistics Group,Turkey
“Lojistik Sektöründe Standardizasyon”
Burak Alat, Omsan, Turkey
“Perakende Lojistiği”
Sinan Cem Savcı, Borusan Logistics, Turkey
“Müşteri Lokasyonunda Lojistik”
Devrim Erişkon, Gras Savoye, Turkey
“Stratejik Risk Yönetimi Kapsaminda Tedarik Zinciri Yonetiminin Yeri ve Siyasal İstikrari Düşük Ülkelerde Lojistik Riskleri”
Türkan Gürsaç, Schenker Arkas, Turkey
“Hızla Büyüyen Lojistik Sektöründe İnsan Kaynakları Uygulamaları ve Artan Önemi”
Haluk R. Cezyirlioğlu,Orkide Danışmanlık,Turkey
“Lojistik Köy Concepti ve Yeni Girisimler”

SESSION 1 DENİZKIZI 1
09:30 – 10:45
FACILITY LOCATION-1

Session Chair: Brenda Sternquist, Michigan State University, USA
Muhittin H. Demir , İzmir University of Economics, Turkey
Ladin H. Yıldıran, İzmir Metropolitan Municipality, Turkey
“Optimal Location of Waste Landfill Site And GIS Implementation For İzmir”
Funda Samanlıoğlu, Kadir Has University, Turkey
Zeki Ayağ, Kadir Has University, Turkey
Ahmet Yücekaya, Kadir Has University, Turkey
Duygu Elibol, Kadir Has University, Turkey
İlke Depe, Kadir Has University, Turkey
Gökçe Özdemir, Kadir Has University, Turkey
Cemal Ersin Davarcı, Kadir Has University, Turkey
“A Location - Routing Model For Regional Blood Banks”
Atilla Yıldıztekin, Logistics Consultant, Turkey
Ercan Şenyiğit, Erciyes University, Turkey

Ayşe Merve Can, Erciyes University, Turkey
"The Location Selection of Freight Village in Samsun"
Turhan Bilgili, Beykoz Vocational School of Logistics, Turkey
"Retail Location Methodologies Comparison Through Decision Making Processes"
Volkan Yavaş, Dokuz Eylül University, Turkey
Gül Denktaş Şakar, Dokuz Eylül University, Turkey
"Evaluation of Freight Villages Concept in Turkey: A Case Study for Aliağa Region"

SESSION 2 DENİZKIZI 1
11.00-12.15
WAREHOUSING

Session Chair: Antonio Rizzi, Parma University, Italy
Gülsüm Aydın, İstanbul University, Turkey
Sibel Bayar Çağlak, İstanbul University, Turkey
Güler Bilen Alkan, İstanbul University, Turkey
"Development of Warehousing Management System in Turkey"
İsmail Karakış, İstanbul Technical University, Turkey
Murat Başkak, İstanbul Technical University, Turkey
Mehmet Tanyaş, Maltepe University, Turkey
"Warehouse Design: A Comprehensive Literature Review"
Hüseyin Selçuk Kılıç, Marmara University, Turkey
M. Bülent Durmuşoğlu, İstanbul Technical University, Turkey
"In-Plant Logistics: Literature Review"
Mesut Kumru, Doğuş University, Turkey
"Measuring The Internal Performance of Logistics: A Case Study"
Ömer Öztürkoğlu, Yaşar University, Turkey
Kevin R. Gue, Auburn University, USA
Russell D. Meller, University of Arkansas, USA
"The Effects of New Aisle Designs On Travel Distance in Unit-Load Warehouses"

SESSION 3 DENİZKIZI 1
14.00-15.15
LOGISTIC CENTERS & E-COMMERCE I

Session Chair: Gülçin Büyüközkan, Galatasaray University, Turkey
A. Güldem Cerit, Dokuz Eylül University, Turkey
Gözde Nihat, Dokuz Eylül University, Turkey
"Developments in Transporter Centers: A Logistics Oriented Approach For İzmir"
Ceren Altuntaş, Yaşar University, Turkey
Okan Tuna, Dokuz Eylül University, Turkey
"Conceptualization of Logistics Centers From an Industrial Buying Approach"
Mehmet Tanyaş,Maltepe University, Turkey
Umut Rıfat Tuzkaya, Yıldız Technical University, Turkey
Özge Nalan Alp, Yıldız Technical University, Turkey
Nurgül Demirtaş, Yıldız Technical University, Turkey
Ela Sibel Bayrak Meydanoğlu, Marmara University, Turkey
"Distribution Center Layout Design Selection by Using Axiomatic Design: A Specific Case For Fruits And Vegetables Wholesale Market Hall"
Ela Sibel Bayrak Meydanoğlu, Marmara University, Turkey
"Soa-Based E-Supply Chains"
Elizabeth Mariotz, Philadelphia University, USA
Alexander Von Lingen, Equipeuropa, Belgium
"Business Competitiveness and Consumer Protection in E-commerce Trends in Multi-Channel and Cross-Border Retailing Via Internet The European Union And The Unıted States Compared"

SESSION 4 DENİZKIZI 1
15.30-16.45
LOGISTIC CENTERS & E-COMMERCE II

Session Chair: Antonio Rizzi, Parma University, Italy
Banu Atrek, Dokuz Eylül University, Turkey
Ceren Altuntaş, Yaşar University,Turkey
"Web Base Private Shopping Companies: To What Extent Do They Have E-Supply Chains?"
Besoa Rabenasolo, Ecole Nationale Superieure Des Arts Et Industries Textile, Ensait Roubaix, France
Fatma Kalaoğlu, İstanbul Technical University,Turkey
Selin Hanife Eryürük, İstanbul Technical University,Turkey
ALEV Bilge, İstanbul Technical University,Turkey
MURAT Başkak, İstanbul Technical University,Turkey
"Analysis of Logistics Center Activities in Europe"
İpek Eker, Fatih University,Turkey
Şakir Esnaf, İstanbul University,Turkey
M. Fatih Taşgetiren,Yaşar University,Turkey
"A Differential Evolution Algorithm For The Median Cycle Problem"
Selin Hanife Eryürük, İstanbul Technical University,Turkey
Fatma Kalaoğlu, İstanbul Technical University,Turkey
Besao Rabenasolo,Universite Lille Nord De France,France
Murat Baskak, İstanbul Technical University,Turkey
Emmanuel Castelain, Universite Lille Nord De France, France
Feridun Akpınar,Universite Lille Nord De France, France
"How to Create a Strong Collaborative Logistics For Turkish Clothing Industry in Order to Satisfy Local And European Retailers"
Okan Aksoy, Gazi University,Turkey
Bahar Özyörük,Gazi University,Turkey
"The Importance of Freight Villages:The Aplication in TCDD"

SESSION 5 GERENCE 1
09.30-10.45
REVERSE LOGISTICS-I

Session Chair: Paul Barrett, Dean of Longwood University, Usa
Kamyar Raoufi,Iran University of Science and Technology, Iran
Mohammad Mahdavi Mazdeh, Iran University of Science and Technology, Iran
"An Optimization Model for Forward/Reverse Logistics in a Supply Chain Master Planning"
Krzysztof Witkowski,University of Zielonagora,Poland
Sebastian Saniuk, University of Zielonagora,Poland
"Reverse Logistics Processes in City Logistics System"
Kenan Dinç,Beykoz Vocational School of Logistics,Turkey
"The Importance and Effects of Reverse Logistics Activities for The Retail Companies"
Gül T. Temur, İstanbul Technical University,Turkey
Bersam Bolat, İstanbul Technical University,Turkey
"A Methodological Framework For Reverse Logistics Network Design Combining Intelligent System and Optimization Model"
Hans-Christian Pfohl,Technische Universität Darmstadt,Germany
Ha Van Thi Nguyen, Technische Universität Darmstadt,Germany
"Reverse Logistics in Vietnam: The Case of Electronics Industry"

SESSION 6 GERENCE 1
11.00-12.15
REVERSE LOGISTICS-II

Session Chair: Igor Jakomin, Ministry of Transportation State Secretary, Slovenia
Kemal Subulan, Dokuz Eylül University,Turkey
A. Serdar Taşan, Dokuz Eylül University,Turkey
"Reverse Logistics Network Design Model For Recycling And Retreading Process of Used Tires"
Paraskevi Kapetanopoulou, Aristotle University, Greece
George Tagaras, Aristotle University, Greece
"Practices, Policies and Perceptions of Value Recovery From Used Products: A Comparion Between Smes and Large Enterprises"
Alena Klapalová,Masaryk University,Czech Republic
"Outsourcing Reverse Logistics in Contex"
Radoslav Škapa, Masaryk University,Czech Republic
"The Fraudulent Returns: The Additional Cost For Reverse Logistics"
Gülçin Büyüközkan,Galatasaray University,Turkey
Leyla Arsan,TAGES, Turkey
Mehmet Tanyaş, Maltepe University,Turkey
Aslıhan Kağnıcı, TAGES, Turkey
"Creating Value-Added Services in Logistics Domain Through Enterprise Interoperability and Collaboration Technologies: A European Project Case"

SESSION 7 GERENCE 1
14.00-15.15
GREEN RECYLING AND WASTE

Session Chair: John N. Gaskins, Longwood University, USA

14.00-15.15

GREEN RECYLING AND WASTE

Session Chair: John N. Gaskins, Longwood University, USA
Fatma Yaşlı, Anadolu University, Turkey
Demet Bayraktar,İstanbul Technical University,Turkey
"Mathematical Programming Approach For Hazardous Waste Management in an Organized Industrial Zone"
Samet Güner,Sakarya University, Turkey
Erman Coşkun, Sakarya University, Turkey
Esin Çevrioğlu, Sakarya University, Turkey
"Information Systems: As a Facilitator For Green Initiatives"
Dorsaf Zouari,Grenoble University,France
"Inter-Organizational Issues Toward A Greener Supply Chain"
Ayşe Bayrak,Tübitak,Turkey
Bahar Özyörük,Gazi University,Turkey
"A Metaheuristic Approach for Logistics Management of Drug Collection, Disposal and Recycling"
M. Yaman Öztek,Galatasaray University,Turkey
Özgür Çengel,İstanbul Commerce University,Turkey
"The Formation of Green Buying Strategy on The Scope of Consumer Decision Making Behavior"

SESSION 8 GERENCE 1
15.30-16.45
OUTSOURCING AND 3PLs

Session Chair: Nuri Yıldırım, Yaşar University, Turkey
Berrin Agaran, Doğuş University,Turkey
Füsun Ülengin, Doğuş University,Turkey
Şule Onsel, Doğuş University,Turkey
Emel Aktaş,Brunel University,UK
"What Turkey Expects From Logistics Outsourcing?"
Özlem Kaya,Hitit University,Turkey
Serdar Kılıçkaplan, Gazi University,Turkey
"Using Outsourcıng in The Textile Sector: A Notional Analysis"
Vahit Kaplanoğlu, Gaziantep University,Turkey
Adil Baykaşoğlu,Dokuz Eylül University, Turkey
"An Agent-Based Order Dispatching Model For Third Party Logistics Service Providers"
Nikitas Nikitakos,University of The Aegean,Greece
Vassilios Pirkatis, University of The Aegean,Greece
"A Decision Model For Third Party Logistics Provider Selection Using The Analytic Hierarchy Process"
Mohd Rızaimy Shaharudin,Universiti Teknologi Malaysia,Malaysia
Ferry Jie,Rmit University,Austrialia
"Determinants of Tasks Towards Value Creation of Third Party Logistics (3PLS) in Closed Loop Supply Chains (CLSCS)"
Ramazan Erturgut, Air NCO Higher Vocational School,Turkey
Harun Alanur,Air Supply And Administration School,Turkey
"Freight Forwarding in Military Logistics as a Strategic Outsourching Form: The Survey on Military Freight Forwarding Firms in USA"

SESSION 9 GERENCE 1
09.30-10.45
INVENTORY

Session Chair: Rene De KOSTER, Rotterdam School of Management Erasmus University, Netherlands
Tolga Temuçin,Turkish Naval Academy, Turkey
A. Özgür Toy, Turkish Naval Academy, Turkey
"Performances of Lot Sizing Rules Under Variable Cost Structures"
Cengiz Sevinç, İstanbul University,Turkey
Ali Özdemir, İstanbul University,Turkey
"Optimizing The Amount of Material Which Have to Be Placed in Multi-Item Multi-Echelon Supply Chain Depots By Dynamic Programming"
Murat Düzgün,Okan University,Turkey
Mehmet Tanyaş, Maltepe University,Turkey
"Integration of Stock Keeping Areas and Inventory Planning"
Halim Yurdakul,Beykoz Vocational School of Logistics,Turkey
İbrahim Zeki Akyurt,İstanbul University, Turkey
"Designing Supply Contract With Quantity Commitments: A Conceptual Model"
Çağatay İris, İstanbul Technical University,Turkey
M. Mutlu Yenisey, İstanbul Technical University,Turkey
"Metaheuristics and Hybrid Heuristics Used in Capacitated Lot Sizing Problem: A Review of Applications"

SESSION 10 GERENCE 1
11.00-12.15
TRANSPORTATION I

Session Chair: Engin Özgül, Longwood University, USA &Dokuz Eylül University,Turkey
Gonca Tuncel,Dokuz Eylül University,Turkey
Engin Bıçak, Dokuz Eylül University,Turkey
Esra D. Durmaz, Dokuz Eylül University,Turkey
"An Application of Fleet Assigment Model For A Sample of The Inter-City Bus Schedule"
Maciej Szymczak, Poznari University of Economics,Poland
"Is Carpooling Likely to be a Well-Received Solution to Traffic Congestion in Poland? An Investigation into How to Bring Carpooling Successfully to the Local Community"
Alperen Ayman, Dokuz Eylül University,Turkey
Gül Denktaş Şakar, Dokuz Eylül University,Turkey
"City Logistics Applications, Strategies and Challenges:A Case Study for İzmir"
Hassan Zoghi, Islamic Azad University,Karaj Branch
Morteza Tolouei, Islamic Azad University,Karaj Branch
Kianoush Siamardi, Islamic Azad University,Karaj Branch
Mohammad Ramezani Afjadi,Obermeyer Mıddle East Gmbh,Adu Dhabı
"Application of Intervehicle Communication (IVC) in The Autonom Detection and Forecast of The Jam Fronts"
Ali Özgür Karagülle, İstanbul University, Turkey
Didem Büyükarslan, , İstanbul University, Turkey
"Transport Safety and The Implications of Turkish Transportation Industry"

SESSION 11 GERENCE 1
14.00-15.15
TRANSPORTATION II

Session Chair: Engin Özgül, Longwood University, USA &Dokuz Eylül University,Turkey
Francisco Gildemir Ferreira Da Silva, Ceara Federal University, Brazil
Marcelo Vinaud Prado, Inland Transport Federal Agency, Brazil
Luis Claudio Santana Montenegro,
Ports Special Secretary,Brazil
Anna Paola Alleone Luksevicius,
Inland Transport Agency,Brazil
"Impact Analysis At Ports By The Interventions Analysis Technique"
Sibel Bayar Çağlak, İstanbul University,Turkey
Gülsüm Aydın, İstanbul University,Turkey
Güler Bilgen Alkan, İstanbul University,Turkey
"Leagile Supply Chains on Seaports"
Osman Kulak, Pamukkale University, Turkey
Mustafa Egemen Taner, Pamukkale University, Turkey
Olcay Polat, Pamukkale University, Turkey
Mehmet Ulaş Koyuncuoğlu, Pamukkale University, Turkey
"AGV Applications For Short Sea Container Terminals"
Maja Kiba-Janiak, Higher School of Business,Poland
Katarzyna Cheba, Zachodniopomorski Uiwersytet Technologiczny W. Szczecinie, Poland
"City Logistics Solutions in a Medium Sized Town"

SESSION 12 GERENCE 1
28 OCTOBER 2011 15.30-16.45
TRANSPORTATION III

Session Chair: Nikitas Nikitakos, University of The Aegean, Greece
Mehmet Tanyaş, Maltepe University, Turkey
Birsen Konuk, İstanbul Technical University, Turkey
"Distribution Logistics Performance Measures"
Ferhan Kuyucak, Anadolu University, Turkey
Yusuf Şengur, Anadolu University, Turkey
"Consolidation and Cooperation of Air Cargo Carriers in a Global Era: A Review of Current Status and Future Prospects"
Timur Özer,Dokuz, Eylül University, İzmir
İsmail Bilge Çetin, Eylül University, İzmir
"A Market Research on the Charter Type Choice of Turkish General Cargo And Drybulk Shipowners"
Serhat Burmaoğlu, Turkish Naval Academy, Turkey
Yiğit Kazançoğlu, İzmir University of Economics, Turkey
"Logistics Innovation Profile of Turkish Transportation Firms"
Güldem Elmas, İstanbul University, Turkey
"Future Trends in Finished Vehicle Logistics"
Erdal Arlı, Turkey
"Analysis of Land Transportation and Cabotage Transportation Systems in Terms of Fuel Consumption and Costs in Physical Distribution"

SESSION 13 GERENCE 2
28 OCTOBER 2011 09.30-10.45
SUPPLIER SELECTION I

Session Chair: Wojciech Piotrowicz, University of Oxford, UK
Esin Sayın, Adnan Menderes University, Turkey
Ali Eleren, Afyon Kocatepe University, Turkey
"Selection of Suppliers By Fuzzy Topsis Model: A Sample Study of Leather Sector From Turkey"
Erdal Nebol, Yeditepe University, Turkey
Erkut Akkartal, Yeditepe University, Turkey
"Comparling Deterministic and Stochastic Models Used in Logistics Modelling Case : Supplier Selection"
Gülçin Büyüközkan, Galatasaray University, Turkey
Çiğdem Berkol, Galatasaray University, Turkey
Mehmet Şakir Ersoy, Galatasaray University, Turkey
"Supplier Selection With Sustainability Perspective Using An Integrated Fuzzy MCDM Approach"
Turan Paksoy, Selçuk University, Turkey
Eren Özceylan, Selçuk University, Turkey
Nimet Yapıcı Pehlivan, Selçuk University, Turkey
Fuzzy Inference System Based Comparison of Particle Swarm Optimization and Artificial Neural Network in Supplier Selection"
İmran Aslan, Erzincan University, Turkey
"Multi Stage Contracting Options"

SESSION 14 GERENCE 2
28 OCTOBER 2011 11.00-12.15
SUPPLIER SELECTION II

Session Chair: James Stock, University of South Florida, USA

Danuta Kisperska-Moron,University of Economics in Katowiceul,France
"The Impact of Relations With Strategic Innovative Suppliers on Performance of Manufacturing Companies"
Yeliz Kocaman, Yaşar University, Turkey
İkbal Ece Dizbay, Yaşar University, Turkey
Ali Özdemir, Dokuz Eylül University, Turkey
"The Effect of Supplier Selection Criteria to Delivery Performance: Application of Logistic Regression Analysis"
Feyzan Arıkan, Gazi University, Turkey
"An Augmented Max-Min Model For Multiple Objective Supplier Selection"
Esra Tekez, Sakarya University, Turkey
Fatih Kar, Sakarya University, Turkey
Nilay Koyuncu Yemenici, Sakarya University, Turkey
Nursel Gürkan Sakarya University, Turkey
"An Expert System Approach For Supplier Evaluation: A Case Study"
Güldem Elmas, İstanbul University, Turkey
Fevzi Erdoğmuş, İstanbul University, Turkey
"Components of The Maritime Transport Costs"

SESSION 15 GERENCE 2
14.00-15.15
PRODUCTION MANAGEMENT I

Session Chair: Danuta Kisperska-Moron, University of Economics in Katowiceul
Çağrı Sel, Dokuz Eylül University, Turkey
Bilge Bilgen, Dokuz Eylül University, Turkey
"Application of Fix & Optimize Heuristic to The Production Allocation"
Galiya Klinkova, Neu-Ulm University, Germany
Micheal Grabinski, Neu-Ulm University, Germany
"Learning Curves With Two Frequencies For Analyzing All Kinds of Operation"
Zohre Moattar Husseini, Amir Kabir University of Technology, Iran
Behrooz Karimi, Amir Kabir University of Technology, Iran
Seyed Mohammad Moattar Husseini, Amir Kabir University of Technology, Iran
Seyed Hassan Ghodsypour, Amir Kabir University of Technology, Iran
Mohammad Moattar Husseini, Amir Kabir University of Technology, Iran
"Multi-Objective Production Planning Concerning Manufacturing Partners: Using NSGA Based Solution"
Hüseyin Selçuk Kılıç,Marmara University, Turkey
M. Bülent Durmuşoğlu, İstanbul Technical University, Turkey
"A Mathematical Model For Kitting in Lean Production Systems"
Levent Atahan, İstanbul Technical University, Turkey
Çağatay İris, İstanbul Technical University, Turkey
Mehmet Tanyaş, Maltepe University, Turkey
"Modelling and Forecasting of Energy Consumption and CO2 Emission of Turkish Logistics Sector By Artificial Neural Networks"

SESSION 16 GERENCE 2
15.30-16.45
PRODUCTION MANAGEMENT II

Session Chair: Orhan İçöz, Yaşar University, Turkey
Halim Yurdakul, Beykoz Vocational School of Logistics, Turkey
Derya Saatcioğlu, İstanbul University, Turkey
İbrahim Zeki Akyurt, İstanbul University, Turkey
"Multi-Criteria Inventory Classification Using Analytic Hierarchy Process (AHP): A Case Study For An Automotive Weather-Stripping Company"
A. Ghafarimoghadam, Iran University of Science and Technology, Iran
A. Karimi, Iran University of Science and Technology, Iran
"An Integrated Remanufacturing Closed-Loop Model With One Way Substitution: An Interval Based Robust Optimization Approach"
Mustafa Güller, University of Duisburg-Essen, Germany
Emre Koç, University of Duisburg-Essen, Germany
Yakup Kalkan, University of Duisburg-Essen, Germany
Bernd Noche, University of Duisburg-Essen, Germany
"Multi-Objective Particle Swarm Optimization For A Serial Supply Chain Under Continuous Review Policy"
Azizollah Jafari, University of Science and Culture,Iran
Nima Yazdan Shenas, University of Science and Culture,Iran
Fereshteh Abdi, University of Science and Culture,Iran
"A Robust Optimization Model to Closed Loop Logistic Network Design For Third Party Provider Under Uncertain Environment"
Hakan Yıldız, Michigan State University,USA
R. Ravi, Carnegie Mellon University,USA
Wayne Fairey, Robert Bosch LLC, USA
"Integrated Optimization of Customer and Supplier Logistics At Robert Bosch LLC"

DAY 3 - 29 OCTOBER 2011 – SATURDAY

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SOCIAL ASPECTS-I

Chair: Krzysztof Witkowski, University of Zielonagora, Poland
Ramazan Erturgut, Air Force NCO Higher Vocational School, Turkey
"The Therotical Background of Customer-Centric Organization"
Füsun Bulutlar, Yeditepe University, Turkey
Ezgi Uzel, Yeditepe University, Turkey
Tanyeri Uslu, Yeditepe University, Turkey
"The Role of Trust in the Knowledge Sharing among Supply Chain Partners"
Caner Dinçer, Galatasaray University, Turkey
Belgin Kaygan, Galatasaray University, Turkey
"The Development of Corporate Social Responsibility in the Logistics Sector"
Emel Kurşunluoğlu, Yaşar University, Turkey
"The Model for Improving Customer Satisfaction and Customer Loyalty for Cargo Firms"
Bengü Sevil Oflaç, İzmir University of Economics, Turkey
"Customer Service Complaints of Online Retailers"

SESSION 18 DENİZKIZI 1
11:00 – 12:15
SOCIAL ASPECTS-II

Chair: Elizabeth Mariotz, Philadelphia University, USA
Ali Özgür Karagülle, İstanbul University, Turkey
Meltem Yıldırımlı, İstanbul University, Turkey
"The Role of Air Traffic Controllers in the Aviation Industry: A Comperative Study Between Turkey and European Union from Human Resources Management Perspective"
Sinem Derindere, İstanbul University, Turkey
Fatma Sezer, İstanbul University, Turkey
"Is Baltic Dry Index a Good Economic Indicator for Monitoring the Progress of Global Economy?"
Serra Demiral, İstanbul Technical University, Turkey
Selin Hanife Eryürük, İstanbul Technical University, Turkey
Fatma Kaloğlu, İstanbul Technical University, Turkey
"The Evaluation of Business Model and Core Components of Zara's Success"
Ahmet Murat Köseoğlu, Ulaştırma Okulu, Turkey
"The Lifeblood of Disaster Management: Logistics"
Sema Türkkantos, Gebze Institute of Technology, Turkey
Y. Zafer Acar, Okan University, Turkey
Bülent Sezen, Gebze Institute of Technology, Turkey
"An Outlook for Physical Distrubition System in Durable Goods Retail: A Comparative Case Study"

SESSION 19 GERENCE 1
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INFORMATION SYSTEM AND TECHNOLOGY

Chair: Alptekin Erkollar, Haliç University, Turkey
Göknur Arzu Akyüz, Atılım University, Turkey
Güner Gürsoy, Kemerburgaz University, Turkey
"Role and Importance of Information Technology in Supply Chain Collaboration"
Alptekin Erkollar, Haliç University, Turkey
Berk Küçükaltan, Marmara University, Turkey
Birgit Oberer, Kadir Has University, Turkey
"Comparative Analysis of Logistics Information System in Turkey"
İbrahim Sarper Karakadılar, Yeditepe University, Turkey
Nurgün Komşuoğlu Yılmaz, Yeditepe University, Turkey
"Using Information Technologies for Productivity Impact on Logistics Interfaces"
Kenan Dinç, Beykoz Vocational School of Logistics, Turkey
"Bottlenecks of RFID Technology and its Utilizations in Retail Logistics"
Çağatay İris, İstanbul Technical University, Turkey
Murat Başkak, İstanbul Technical University, Turkey
"A Decision Support System to Pre-Evalutation, Selection and Performance Evaluation for Business Service Providers"

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Chair: Tuncay Kocamaz, Yeditepe University, Turkey
Onur Dikmenli, İstanbul University, Turkey
"A New Competitive Advantage for Turkish Logistic Firms in The European Union Membership Process Talent"
Pervin Ersoy, Yaşar University, Turkey
Ömer Baybars Tek, Yaşar University, Turkey
Şaban Çelik, Yaşar University, Turkey
"The Impact of Strategic Logistics Planning on Value Creation: An Empirical Investigation on Firms Listed in İstanbul Stock Exchange"
Yaman Öztek, Galatasaray University, Turkey
Özgür Çengel, İstanbul Commerce University, Turkey
"Consumer Oriented Online Retail Delivery Strategies"
Derya Eren Akyol, Dokuz Eylül University, Turkey
Rene B. M. De Koster, RMS Erasmus University, Netherlands
"Aligning City Municipality and Retailer Objectives Using Time Access Windows"
M. Mahmoudi-Meymand, Payamnoor University, Iran
M. Zare, SAIPA Automotive Group, Iran
"Operational Planning, Practical Tool to Achieve Strategic Objectives in the Areas of Supply Chain Managment"

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Chair: Maja Kiba-Janiak, Higher School of Business, Poland
Işık Özge Yumurtacı, İzmir University of Economics, Turkey
Gülmüş Börühan, Yaşar University, Turkey
"The Interfaces between Retailing Research and Supply Chain Management"
Wojciech Piotrowicz, University of Oxford, UK
Richard Cuthbertson, University of Oxford, UK
"The State of Performance Measurement in Supply Chains: Results of the Exploratory Survey and Directions for Further"
Artur Swierczek, University of Economics In Katowice, Poland
"The Effects of Integration in a Supply Chain on the Level of Risks: An Empirical Study"
Erdal Nebol, Yeditepe University, Turkey
Tanyeri Uslu, Yeditepe University, Turkey
"Dilemma in Supply Chain Integration"
Mehmet Sıtkı Saygılı, İstanbul University, Turkey
Elif Bayram, İstanbul University, Turkey
"Logistics Services for Textile Products"

SESSION 22 DENİZKIZI 2
11:00 – 12:15
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Chair: Mehmet Şakir Ersoy, Ministry of Transportation State Secretary, Slovenia
A. Emre Varol, Turkish Naval Academy, Turkey
A. Özgür Toy, Turkish Naval Academy, Turkey
“Optimization via Simulation of the Number of Shopping Carts for a Retailer Store”
Aydın Sipahioğlu, Eskişehir Osmangazi University, Turkey
Fehmi Burçin Özsoydan, Eskişehir Osmangazi University, Turkey
“A New Discrete Particle Swarm Optimization Design for the Multi Depot Open Vehicle Routing Problem”
Şeyda Topaloğlu, Dokuz Eylül University, Turkey
Alper Hamzadayı, Dokuz Eylül University, Turkey
Simge Yelkenci Köse, Dokuz Eylül University, Turkey
“Nested Simulated Annealing Approach to the Multi-Period Vehicle Routing Problem of a Retail Distribution System”
İlkay KARADUMAN, TSK SAĞLIK KOMUTANLIĞI, Turkey
“A Comparative Study to Propose a Supply Chain Performance Management Tool for SME’s in Turkey”

SESSION 23 GERENCE 2
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VEHICLE ROUTING II

Chair: Micheal Grabinski,Neu-Ulm University, Germany
Gülnar Eren, Yaşar University, Turkey
M.Fatih Taşgetiren, Yaşar University, Turkey
Şakir Esnaf, İstanbul University, Turkey
“A Populated and Variable Iterated Greedy Algorithm for the Generalized Traveling Salesman Problem”
Özgür AKSOY, Osmangazi University, Turkey
Muzaffer Kapanoğlu, Osmangazi University, Turkey
“Multi Depot, Heterogenous Vehicle Pick Up and Delivery Problem for Air Transportation in the Turkish Air Force”
Alireza Mohamadi-Shad, Buali Sina University, Iran
Seyed-Ali Ghasemi-Nezhad, University of Kurdistan, Iran
Parviz Fattahi, Buali Sina University, Iran
“A Hybrid Simulated Annealing and Variable Neighborhood Algorithm for the Capacitated Vehicle Routing”
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REVERSE LOGISTICS II

Chair: Igor Jakomin, Ministry of Transportation State Secretary, Slovenia

GREEN RECYLING AND WASTE

Chair: John N. Gaskins, Longwood University, USA

OUTSOURCING AND 3PLs

Chair: Nuri Yıldırım, Yaşar University, Turkey

INVENTORY

Chair: Rene De KOSTER, Rotterdam School of Management Erasmus University, Netherlands

TRANSPORTATION I

Chair: Engin Özgül, Longwood University, USA &Dokuz Eylül University,Turkey

TRANSPORTATION II

Session Chair: ***Engin Özgül, Longwood University, USA &Dokuz Eylül University,Turkey***

TRANSPORTATION III

Session Chair: Nikitas Nikitakos, University of The Aegean, Greece

A LOCATION-ROUTING MODEL FOR REGIONAL BLOOD BANKS

Funda Samanlioglu[1], Zeki Ayag[2], Ahmet Yucekaya[3], Duygu Elibol[4], İlke Depe[5], Gokce Ozdemir[6], Cemal Ersin Davarcı[7]

Abstract *– Blood banks are facilities which procure, store, process, and dispense blood. Blood service operations of the Turkish Red Crescent Society are a significant part of the national health care system. Therefore, the blood banking system, specifically the location of the blood banks, and routing of blood carrying vehicles need to be effectively planned taking into consideration the hospital blood demands, capacities of vehicles, and the perishable characteristic of blood. In this study, based on these aspects, a location-routing model is formulated, and applied in a pilot area in Istanbul, Turkey. In the model, the total cost of establishing new blood banks, and transportation cost is minimized, while making sure that blood is delivered to hospitals on time before it perishes. The mathematical model is solved optimally with LINGO 7.0 solver, and the results are reported to the specialists.*

Keywords – blood banks, location-routing problem, perishable products, routing

INTRODUCTION

The goals of the blood banks are to procure, store, process, and dispense blood in a timely manner. While dispensing blood, time matters since blood is perishable. In this paper, a location-routing mathematical model is developed for locating blood banks, assigning blood banks to hospitals, and routing special vehicles that carry blood from the blood banks to the hospitals and back to blood banks while taking into consideration hospital blood demands, blood bank capacities, vehicle capacities and time since blood is perishable.

Location-routing can be defined as ‘‘location planning with tour planning aspects taken into account” [6]. In the literature, there are many papers related to location-routing problems [1, 2, 3, 5, 7, 8, 11]. Readers can also refer to Nagy and Salhi’s survey [6] for issues, models and methods related to location-routing. The closest mathematical model in the literature so far is the Tuzun and Burke’s [10] research. Tuzun and Burke [10] presented a three-index mixed integer programming formulation of the location-routing problem, and solved it with a two-phase tabu search algorithm. In terms of the constraints on the vehicle routes, they adopted a common one: the total demand of the customers on a given route should not exceed the vehicle capacity. The mathematical model presented here is also a three-index location-routing problem with vehicle capacity constraint however, there are several constraint differences. In the presented mathematical model, there is a constraint that limits the time length of the tours, since blood is perishable. Also, there is a capacity constraint that ensures that if a blood bank is established, the demands of hospitals which are satisfied with that blood bank do not exceed the capacity of the blood bank. In the next section, details of the mathematical model are given.

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MATHEMATICAL MODEL DEVELOPMENT

In this paper, an integer location-routing model is developed. The notations, parameters, decision variables, and the mathematical model are given below.

Parameters:

$A = \{ r \mid r = 1, ..., R \}$	is the set of R feasible sites of potential blood banks;
$B = \{ i \mid i = R+1, ..., R+N \}$	is the set of N hospital to be served
$C = \{A\} \cup \{B\}$	is the set of all potential blood bank sites and hospitals (also referred to as all nodes)
$V = \{k \mid k = 1, ..., K\}$	is the set of K vehicles available for routing from the blood banks
$COST_{ij}$	average daily cost of travelling from node i to node j, $j, i \in C$
FXD_k	average daily cost of using vehicle k, $k \in V$
BS_r	average daily cost of establishing a blood bank at site r, $r \in A$
$DEMAND_j$	average number of units of blood demanded by hospital j, $j \in B$
Q_k	capacity of vehicle k, $k \in V$
RV_i	are continuous variables used in the subtour elimination constraints.

Decision variables:

X_{ijk}	Binary variable that equals to 1 if vehicle k goes from node i to node j where $i \in C, j \in C, k \in V, i \neq j$; and 0 otherwise
Z_r	Binary variable that equals to 1 if a blood bank is established at site r $r \in A$; and 0 otherwise
ATA_{rj}	Binary variable that equals to 1 if blood bank r serves to hospital j $r \in A, j \in B$; and 0 otherwise

Mathematical Model:

$$\min \sum_{i \in C} \sum_{j \in C} \sum_{k \in V} COST_{ij} \, X_{ijk} + \sum_{k \in V} FXD_k \sum_{r \in A} \sum_{j \in B} X_{rjk} + \sum_{r \in A} BS_r \, Z_r \tag{1}$$

The objective function (1) is the total cost of establishing blood banks and servicing the hospitals. The objective function minimizes the sum of the delivery cost; dispatching cost for the vehicles assigned, and fixed blood bank establishing costs.

Subject to:

$$\sum_{i \in C} \sum_{k \in V} X_{ijk} = 1 \qquad \forall \, j \in B \qquad i \neq j \tag{2}$$

$$\sum_{j \in B} \sum_{i \in C} DEMAND_j \, X_{ijk} \leq Q_k \qquad \forall \, k \in V \tag{3}$$

$$\sum_{r \in A} \sum_{j \in B} X_{rjk} \leq 1 \qquad \forall \, k \in V \tag{4}$$

$$\sum_{i\in C} X_{ipk} - \sum_{j\in C} X_{pjk} = 0 \qquad \forall\, k\in V\,,\, p\in C \tag{5}$$

$$RV_i - RV_j + (R+N)\sum_{k\in V} X_{ijk} \le (R+N) - 1 \qquad \forall\ i\,, j\in B\ ,\ i\ne j \tag{6}$$

$$\sum_{i\in C}\ \sum_{j\in B} X_{ijk}\ TIME_{ij} \le T_k \qquad \forall\ k\ \in\ V \tag{7}$$

$$\sum_{j\in B} DEMAND_j\ ATA_{rj} - Cap_r\ Z_r\ \le\ 0 \qquad \forall\, r\in A \tag{8}$$

$$-ATA_{rj} + \sum_{u\in C}(\, X_{ruk} + X_{ujk}\,) \le 1 \qquad \forall\, r\in A\,, j\in B\,, k\in V \tag{9}$$

$$\sum_{r\in A} ATA_{rj} \le 1 \qquad \forall\, j\in B \tag{10}$$

$$Z_r >= 1 \qquad r = 1 \tag{11}$$

$$\sum_{k\in V} X_{rmk} + Z_r + Z_m \le 2 \qquad \forall\, m\in A\,, r\in A \quad m\ne r \tag{12}$$

$$\sum_{k\in V}\sum_{j\in B} X_{rjk} \le Z_r \qquad \forall\, r\in A \tag{13}$$

$$X_{ijk} \in \{0,1\} \quad \forall i\in C,\, j\in C,\, k\in V,\, i\ne j \tag{14}$$

$$Z_r \in \{0,1\} \quad \forall r\in A$$

$$ATA_{rj} \in \{0,1\} \quad \forall j\in C,\, r\in A$$

First constraint (2) requires that every hospital receives a shipment by one blood bank and served by only one vehicle. Second constraint (3) ensures that vehicle capacity is not exceeded. Third constraint (4) ensures that each route is served at most once. Fourth constraint (5) is the conservation of flow constraint and it implies that a vehicle departs from a point if and only if it enters there. Fifth constraint (6) is for subtour elimination. Sixth constraint (7) is the time limit constraint since blood is perishable. Seventh constraint (8) is the capacity constraint of blood banks. If a blood bank is established, the demands of hospitals which will be satisfied by that blood bank should not exceed the capacity of the blood bank. Eight constraint (9) ensures that a blood bank is assigned to a hospital only if there is a route from that blood bank going through that hospital. Ninth constraint (10) guarantees that each hospital is served by at most one blood bank. Tenth constraint (11) represents the already existing Çapa Kızılay Blood Bank. Eleventh constraint (12) ensures that there are no links between any blood banks. Twelfth constraint (13) means that a vehicle is routed from a blood bank if and only if that blood bank is established. Thirteenth constraint (14) represents the binary decision variables. In the next section, the application of the model in Istanbul is presented.

APPLICATION IN ISTANBUL

The data of several hospitals at Şişli, Fatih and Eminönü regions of Istanbul in Turkey is obtained and the mathematical model is solved optimally with LINGO 7.0 solver. The fixed setup costs of establishing blood banks with different blood storage capacities are approximately calculated with the data obtained from Çapa Kızılay Blood Bank. The set up cost of Çapa Kızılay Blood Bank is approximately 53000 USD≈81231TL with a daily storage capacity of 445 units of blood. 4 hospitals, including the existing Çapa Kızılay blood bank, are selected to serve as potential blood banks based on the opinions of the experts and based on previous data that shows that these places have high number of blood donations. The setup costs of the potential blood banks are calculated proportionally based on their potential (planned) blood storage capacities as seen in Table 1. Daily blood demands and data of hospitals are obtained from the Çapa Kızılay Blood Bank. Based on the opinions of the experts at Çapa Kızılay Blood Bank, the blood should be distributed by the vehicles in at most 3 hours since it is perishable.

TABLE 1
Setup Costs of Blood Banks and Daily Blood Storage Capacities

(Potential) Blood Banks	Çapa Kızılay Blood Bank (H1)	Özel Kadıoğlu Hospital (H2)	Business Esnaf Hospital (H3)	Huzur Hospital (H4)
Daily blood storage capacity (units)	445	133	266	140
Setup cost (TL)	0	24278	48557	25555

Based on the data obtained from Çapa Kızılay Blood Bank, it is assumed that there are a total of 4 vehicles, and 160 units of blood can fit into every vehicle per day (trip). Hospitals which have daily demands less than 10 units per day are ignored, so out of 36 hospitals that are at Şişli, Fatih and Eminönü region of Istanbul, 8 hospitals are selected. Based on the data received from Çapa Kızılay, average daily blood demands of these hospitals are calculated from the annual demands of the hospitals. These hospitals, which are numbered from H5 to H12 and their daily blood demands are shown in Table 2.

TABLE 2
Hospitals and Daily Blood Demands

Hospitals	Daily Blood Demands (units)
Şişli Etfal Hospital (H5)	58
Okmeydanı Eğitim ve Araştırma Hospital (H6)	90
Vehbi Koç Vakfı Amerikan Hospital (H7)	18
İstanbul Üniversitesi Çapa Tıp Fakültesi Hospital (H8)	156
İstanbul Üniversitesi Cerrahpaşa Tıp Fakültesi Hospital (H9)	73
İstanbul Haseki Eğitim ve Araştırma Hospital (H10)	36
İstanbul Eğitim ve Araştırma Hospital (H11)	28
Vakıf Gureba (SSK) Hospital (H12)	15

The distance (km) and travel time (minutes) between hospitals and blood banks are calculated by using Google maps [4] and Republic of Turkey General Directorate of Highways website [9] as seen in Tables 3 and 4. The average daily cost of travelling is calculated based on the distance times the fixed cost of a vehicle to run on gas for 1km which is calculated with recent daily values as 0.2 TL/km. Also, average daily cost of using a vehicle is taken as 50 TL based on the opinions of experts.

When the mathematical model is solved with the presented data, the optimal total cost objective is found as 24481.58TL. Also, the optimal solution is found as:

In addition to the existing Çapa Kızılay Blood Bank (H1), Özel Kadıoğlu Hospital (H2) will also serve as a blood bank. Çapa Kızılay Blood Bank (H1) will use three vehicles.

Tour of Vehicle #1: Çapa Kızılay Blood Bank (H1)- Vehbi Koç Vakfı Amerikan Hospital (H7)- Okmeydanı Eğitim ve Araştırma Hospital (H6)- Çapa Kızılay Blood Bank (H1).

Tour of Vehicle #3: Çapa Kızılay Blood Bank (H1)- İstanbul Eğitim ve Araştırma Hospital (H11)- İstanbul Üniversitesi Cerrahpaşa Tıp Fakültesi Hospital (H9)- İstanbul Haseki Eğitim ve Araştırma Hospital (H10)- Vakıf Gureba (SSK) Hospital (H12)- Çapa Kızılay Blood Bank (H1).

Tour of Vehicle #4: Çapa Kızılay Blood Bank (H1)- İstanbul Üniversitesi Çapa Tıp Fakültesi Hospital (H8)- Çapa Kızılay Blood Bank (H1).

Özel Kadıoğlu Hospital (H2) will use one vehicle.

Vehicle #2: Özel Kadıoğlu Hospital (H2)- Şişli Etfal Hospital (H5)-Özel Kadıoğlu Hospital (H2).

TABLE 3
Distance Matrix (km)

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12
H1	0	7.2	2.4	1	6.6	6.3	5.4	0.3	1	1	1.3	0.5
H2	7.2	0	6.1	7.2	0.6	1.8	2	7.2	7.9	7.2	8.2	6.9
H3	2.4	6.1	0	1.5	5.5	5.8	4.7	2.4	1.9	1.5	2.4	1.1
H4	1	7.2	1.5	0	6.6	6.7	5.6	1.3	0.6	0.05	1	0.3
H5	6.6	0.6	5.5	6.6	0	1.7	1.5	6.5	7.2	6.6	7.6	6.3
H6	6.3	1.8	5.8	6.7	1.7	0	1.2	6.3	7.2	6.7	7.6	6.5
H7	5.4	2	4.7	5.6	1.5	1.2	0	5.3	6.1	5.6	6.6	5.4
H8	0.3	7.2	2.4	1.3	6.5	6.3	5.3	0	1.3	1.2	1.6	1.5
H9	1	7.9	1.9	0.6	7.2	7.2	6.1	1.3	0	0.6	0.4	0.9
H10	1	7.2	1.5	0.05	6.6	6.7	5.6	1.2	0.6	0	1	0.4
H11	1.3	8.2	2.4	1	7.6	7.6	6.6	1.6	0.4	1	0	1.3
H12	0.5	6.9	1.1	0.3	6.3	6.5	5.4	1.5	0.9	0.4	1.3	0

TABLE 4
Time Matrix (minutes)

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12
H1	0	8	14	6	21	15	26	3	7	5	6	4
H2	8	0	26	23	6	9	11	18	26	22	24	20
H3	14	26	0	9	26	24	21	12	11	8	14	10
H4	6	23	9	0	25	20	20	5	4	1	6	1
H5	21	6	26	25	0	13	12	25	29	25	27	22
H6	15	9	24	20	13	0	10	15	22	19	21	17
H7	26	11	21	20	12	10	0	19	23	20	24	20
H8	3	18	12	5	25	15	19	0	8	5	11	5
H9	7	26	11	4	29	22	23	8	0	4	1	5
H10	5	22	8	1	25	19	20	5	4	0	5	1
H11	6	24	14	6	27	21	24	11	1	5	0	7
H12	4	20	10	1	22	17	20	5	5	1	7	0

CONCLUSIONS

Blood banks are a significant part of the national healthcare system. In this paper, a mathematical model is developed for decisions related to location of blood banks, assignment of blood banks to hospitals, and routing of blood carrying vehicles. The model is implemented with the data of selected hospitals in Istanbul, and the results are reported to the specialists. For future research, the application area of the study can be extended, and the model can be applied to all the hospitals in the area. However, in that case, a heuristic method might be needed to obtain (approximately) optimal solutions since the problem is NP-hard. Also, in the mathematical model, the criterion considered is the minimization of total cost, however, for future research; the model can be extended to take into account the service levels, population densities, risky routes, route conditions, accident probabilities, and traffic.

REFERENCES

[1] Barreto, S.,Ferreira, C., Paixao, J., Santos, B. S., 2007, "Using clustering analysis in a capacitated location-routing problem",European Journal of Operational Research, Vol. 179, pp. 968-977

[2] Cappanera, P., Gallo, G., Maffioli, F., 2004, "Discrete facility location and routing of obnoxious activities", Discrete Applied Mathematics, Vol. 133, pp. 3-28

[3] Chan, Y., Carter, W. B., Burnes, M.D., 2001, "A multiple-depot, multiple-vehicle, location-routing problem with stochastically processed demands", Computers & Operations Research, Vol. 28, pp. 803-826

[4] Google maps. URL: http://maps.google.com/.

[5] Laporte, G., Nobert, Y., Taillefer, S., 1988, "Solving a Family of Multi-Depot Vehicle Routing and Location-Routing Problems", Transportation Science, Vol. 22, No. 3, 161-172

[6] Nagy, G., Salhi, S., 2007, "Location-routing: Issues, models and methods", European Journal of Operational Research, Vol. 177, pp. 649-672

[7] Or,İ. ,Pierskalla,W.,P. ,"A transportation Location-Allocation Model for Regional Blood Banking" ,AIIE Transactions,Vol.11,No.2, February 1979.

[8] Prins, C., Prodhon, C., Ruiz, A., Soriano, P., Calvo, R.W., 2007, "Solving the Capacitated Location-Routing Problem by a Cooperative Lagrangean Relaxation-Granular Tabu Search Heuristic", Transportation Science Vol. 41, No. 4, pp. 470-483

[9] Republic of Turkey General Directorate of Highways website. URL: http://www.kgm.gov.tr.

[10] Tüzün, D., Burke, L., 1998, "A two-phase tabu search approach to the location routing problem", European Journal of Operational Research, Vol. 116, pp. 87-99

[11] Wu, T., Low, C., Bai, J., 2002, "Heuristic solutions to multi-depot location-routing problems", Computers & Operations Research, Vol. 29, pp. 1393-1415

THE LOCATION SELECTION OF FREIGHT VILLAGE IN SAMSUN

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Abstract — *The logistics in supply of raw materials and sold product delivery to the customer appears as a business function which importance increase day by day. The business that resolves logistics processes as effective, efficient and cost-effective, are able to deliver competitive advantage against their competitors. Freight villages can help business that provides the advantage against competitors. Freight villages are defined as special centres where all the activities relating to transport, logistics and distribution for both the national and international transportation. In this study, the problem of the selection location of the freight village, planning to build in Samsun, are discussed. Site selection criteria of freight village are identified and the most appropriate place is determined using AHP method among candidate destinations. The results of the study are presented.*

Keywords — AHP, freight village, location selection problem, multi-criteria decision-making.

INTRODUCTION

A freight village is the hub of a specific area where all the activities relating to transport, logistics and goods distribution. Freight villages evolve alliances among the entities responsible for the transport, storage and distribution services, which can generate significant reduction in the number of trucks vehicle-kilometres. In addition, a freight village located in the vicinity of a large city may provide an efficient solution to urban freight transport problems including traffic congestion, regional competitiveness, and quality of life [1]. Because of realize logistics activities in all, speedy and saving, freight villages are made. If the location of freight village isn't select in suitable place, the project can be inactive. For this reason, master plans of freight villages are realized carefully. When the selection of location for freight village is made, all of factors that are diagnostic must go into carefully. Because of this aim, multi-criteria decision making can be preferred in decision making process. In this study, the problem of freight village location selection, planning to build in Samsun was discussed and found the result using AHP method and the result was instructed in the last section. Early location theory focused mainly on the production of raw materials and selling to markets in order to determine a factory's optimal position by minimizing transportation costs.

AHP METHOD

Saaty developed the following steps for applying the AHP:

1. Define the problem and determine its goal.
2. Structure the hierarchy from the top through the intermediate levels to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.
4. There are n (n-1)/judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.

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6. Having made all the pair-wise comparisons, the consistency is determined by using the eigenvalue, λ_{max}, to calculate the consistency index, CI as follows:

$$CI= (\lambda_{max} – n)/(n-1) \qquad (1)$$

Where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 2. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.
7. Steps 3-6 are performed for all levels in the hierarchy [2].

TABLE 1
Pair-wise Comparison Scale for AHP Preferences

Numerical rating	Verbal judgments of preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

TABLE 2
Average Random Consistency (RI)

Size of matrix	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

FREIGHT VILLAGE LOCATION SELECTION CRITERIA

Ballis and Mavrotas have picked up a freight village project, which is carried out in Greece. PROMETHEE method was used in the study that is multi-criteria decision making methods, and three alternatives design of freight village location were compared. Multi-criteria analysis result was showed that preference order of alternatives designs [1]. Afandizadeh and Moayedfar discussed the suitability of establishing a freight village in Iran, Hormazgan which is in offered study. The current situation in the region was introduced and sensitivity analysis was performed by applying the proposed model for the region. In conclusion, analysis results and interpretation of different results were presented [3]. Information about candidate locations was searched for practice. Simultaneously important factors were found for selection. These factors are:

I. Distance of candidate location by “km” category to the nearest master highway (C1).
II. Distance of candidate location by “km” category to the nearest seaport (C2).
III. Distance of candidate location by “km” category to the nearest railroad station (C3).
IV. Distance of candidate location by “km” category to the nearest airport (C4).
V. Average construction cost of candidate location (TL/m^2) (only subtraction cost as road, water, electricity, location arrangement security) (C5).
VI. Distance of candidate location by “km” category to the nearest industry region and road cost if highway was built (C6).
VII. Distance of candidate location by “km” category to the nearest city centre (C7).
VIII. Appropriateness of candidate location for expands (C8).

IX. Appropriateness of candidate location about geographical, topographical, floor construction (C9).
X. Height difference between candidate location and the nearest railroad (C10).
XI. Average square foot cost of each candidate location (C11).

Candidate locations data are indicated in Table-3.The pair-wise comparison matrices and priority vectors for the all criteria can be found as shown in Tables 4-21.

TABLE 3
Candidate Locations Data

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Can-1	3	14	0	10	250	7	16	3	3	2	20-50
Can-2	1	12	4	8	250	7	16	2	3	2	0
Can-3	2	20	5	2	250	12	13	2	3	2	15-20
Can-4	0	9	1	12	250	4	20	1	3	2	120
Can-5	2	17	20	35	250	24	15	3	1	1	70-200

TABLE 4
Pair-wise Comparison Matrix for C1

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1/4	1/2	1/6	1/2
Can-2	4	1	2	½	2
Can-3	2	1/2	1	¼	1
Can-4	6	2	4	1	4
Can-5	2	1/2	1	¼	1

TABLE 5
Synthesized Matrix for C1

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.067	0.059	0.059	0.077	0.059	0.064
Can-2	0.267	0.235	0.235	0.230	0.235	0.240
Can-3	0.134	0.117	0.117	0.115	0.117	0.120
Can-4	0.400	0.470	0.470	0.461	0.470	0.454
Can-5	0.134	0.117	0.117	0.115	0.117	0.120

λ_{max} 5.01, CI 0.0025, CR 0.0022 < 0.1 OK.

TABLE 6
Pair-wise Comparison Matrix for C2

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1/2	5	1/3	2
Can-2	2	1	7	½	3
Can-3	1/5	1/7	1	1/9	1/2
Can-4	3	2	9	1	7
Can-5	½	1/3	2	1/7	1

TABLE 7

Synthesized Matrix for C2

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.150	0.130	0.210	0.158	0.148	0.159
Can-2	0.300	0.250	0.290	0.240	0.223	0.261
Can-3	0.030	0.036	0.042	0.053	0.037	0.040
Can-4	0.450	0.513	0.375	0.476	0.518	0.466
Can-5	0.075	0.085	0.084	0.070	0.074	0.078

λ_{max} 5.043, CI 0.0107, CR 0.0095 < 0.1 OK.

TABLE 8

Pair-wise Comparison Matrix for C3

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	5	6	2	9
Can-2	1/5	1	3	1/3	7
Can-3	1/6	1/3	1	1/7	3
Can-4	½	3	7	1	8
Can-5	1/9	1/7	1/3	1/8	1

TABLE 9

Synthesized Matrix for C3

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.510	0.530	0.350	0.550	0.320	0.450
Can-2	0.101	0.100	0.170	0.090	0.250	0.142
Can-3	0.085	0.035	0.060	0.040	0.107	0.065
Can-4	0.250	0.320	0.400	0.270	0.280	0.304
Can-5	0.056	0.015	0.020	0.035	0.035	0.030

λ_{max} 5.254, CI 0.0635, CR 0.0567 < 0.1 OK.

TABLE 10

Pair-wise Comparison Matrix for C4

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1/2	1/5	2	4
Can-2	2	1	1/4	3	5
Can-3	5	4	1	6	9
Can-4	1/2	1/4	1/6	1	3
Can-5	1/4	1/5	1/9	1/3	1

TABLE 11
Synthesized Matrix for C4

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.114	0.084	0.115	0.162	0.182	0.131
Can-2	0.228	0.168	0.145	0.243	0.230	0.203
Can-3	0.571	0.672	0.580	0.486	0.410	0.544
Can-4	0.057	0.042	0.096	0.081	0.136	0.082
Can-5	0.029	0.034	0.064	0.027	0.045	0.040

λ_{max} 5.1059, CI 0.0265, CR 0.0169 $<$ 0.1 OK.

TABLE 12
Pair-wise Comparison Matrix for C5, C9 and C10

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1	1	1	9
Can-2	1	1	1	1	9
Can-3	1	1	1	1	9
Can-4	1	1	1	1	9
Can-5	1/9	1/9	1/9	1/9	1

TABLE 13
Synthesized Matrix for C5, C9 and C10

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.243	0.243	0.243	0.243	0.243	0.243
Can-2	0.243	0.243	0.243	0.243	0.243	0.243
Can-3	0.243	0.243	0.243	0.243	0.243	0.243
Can-4	0.243	0.243	0.243	0.243	0.243	0.243
Can-5	0.027	0.027	0.027	0.027	0.027	0.027

λ_{max} 5.207, CI 0.05, CR 0.0323 $<$ 0.1 OK.

TABLE 14
Pair-wise Comparison Matrix for C6

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1	3	½	6
Can-2	1	1	3	½	6
Can-3	1/3	1/3	1	¼	5
Can-4	2	2	4	1	9
Can-5	1/6	1/6	1/5	1/9	1

TABLE 15
Synthesized Matrix for C6

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.223	0.223	0.268	0.212	0.223	0.230
Can-2	0.223	0.223	0.268	0.212	0.223	0.230
Can-3	0.074	0.074	0.089	0.106	0.185	0.106
Can-4	0.445	0.445	0.357	0.424	0.334	0.401
Can-5	0.037	0.037	0.018	0.047	0.037	0.035

λ_{max} 5.1142, CI 0.0286, CR 0.0255 < 0.1 OK.

TABLE 16
Pair-wise Comparison Matrix for C7

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1	1/4	5	1/2
Can-2	1	1	1/4	5	1/2
Can-3	4	4	1	8	3
Can-4	1/5	1/5	1/8	1	1/6
Can-5	2	2	1/3	6	1

TABLE 17
Synthesized Matrix for C7

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.122	0.122	0.128	0.200	0.096	0.134
Can-2	0.122	0.122	0.128	0.200	0.096	0.134
Can-3	0.488	0.488	0.511	0.320	0.580	0.477
Can-4	0.024	0.024	0.064	0.040	0.032	0.037
Can-5	0.244	0.244	0.170	0.240	0.193	0.218

λ_{max} 5.131, CI 0.0327, CR 0.029 < 0.1 OK.

TABLE 18
Pair-wise Comparison Matrix for C8

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	2	2	3	1
Can-2	1/2	1	1	2	1
Can-3	1/2	1	1	2	1
Can-4	1/3	1/2	1/2	1	1/3
Can-5	1	1	1	3	1

TABLE 19
Synthesized Matrix for C8

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.300	0.360	0.360	0.250	0.230	0.300
Can-2	0.150	0.180	0.180	0.167	0.230	0.180
Can-3	0.150	0.180	0.180	0.167	0.230	0.180
Can-4	0.100	0.090	0.090	0.083	0.077	0.088
Can-5	0.300	0.180	0.180	0.250	0.230	0.228

λ_{max} 5.059, CI 0.0147, CR 0.0131 < 0.1 OK.

TABLE 20
Pair-wise comparison matrix for C11

	Can-1	Can-2	Can-3	Can-4	Can-5
Can-1	1	1/4	3	6	4
Can-2	4	1	2	9	7
Can-3	1/3	1/2	1	8	6
Can-4	1/6	1/9	1/8	1	1/2
Can-5	1/4	1/7	1/6	2	1

TABLE 21
Synthesized Matrix for C11

	Can-1	Can-2	Can-3	Can-4	Can-5	Priority vector
Can-1	0.175	0.125	0.476	0.230	0.216	0.240
Can-2	0.700	0.490	0.317	0.350	0.380	0.480
Can-3	0.060	0.250	0.160	0.300	0.324	0.220
Can-4	0.030	0.055	0.020	0.038	0.027	0.034
Can-5	0.035	0.071	0.026	0.077	0.054	0.053

λ_{max} 5.365, CI 0.0912, CR 0.0814 < 0.1 OK.

In addition to the pair-wise comparison for the decision alternatives, we also use the same pair-wise comparison procedure to set priorities for all eleven criteria in terms of importance of each in contributing to the overall goal. Table 22 shows the pair-wise comparison matrix and priority vector for the eleven criteria. We manually combine the criterion priorities and the priorities of each decision alternative relative to each criterion in order to develop an overall priority ranking of the decision alternative which is termed as the priority matrix by Table 23.

CONCLUSIONS

The current work presents an overall view of the freight village location selection problem and its formulation as a multi-criteria decision making problem. In order to set up the problem in a multi-criteria analysis framework, the alterative locations are determined (5 candidate locations) and the major characteristics of the problem are translated into a set of 11 measurable criteria. For prequalification purposes, the locations are now ranked according to their overall priorities, as follows: Location-2, Location-4, Location-1, Location-3, and Location-5, indicating that Location-2 is the best qualified location to build freight village.

TABLE 22
Pair-wise Comparison Matrix for the eleven criteria

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Priority vector
C1	1	1	2	6	2	3	3	4	1/4	1/3	1/2	0.091
C2	1	1	2	6	2	3	3	4	1/4	1/3	1/2	0.091
C3	1/2	1/2	1	5	1	2	2	3	1/5	1/4	1/3	0.060
C4	1/6	1/6	1/5	1	1/5	1/4	1/4	1/3	1/9	1/8	1/7	0.034
C5	1/2	1/2	1	5	1	2	2	3	1/5	1/4	1/3	0.060
C6	1/3	1/3	1/2	4	1/2	1	1	2	1/6	1/5	1/4	0.040
C7	1/3	1/3	1/2	4	1/2	1	1	2	1/6	1/5	1/4	0.040
C8	1/4	1/4	1/3	3	1/3	1/2	1/2	1	1/7	1/6	1/5	0.027
C9	4	4	5	9	5	6	6	7	1	2	3	0.280
C10	3	3	4	8	4	5	5	6	1/2	1	2	0.200
C11	2	2	3	7	3	4	4	5	1/3	1/2	1	0.137

λ_{max} 12.153, CI 1.115, CR 0.076 $<$ 0.1 OK.

TABLE 23
Priority Matrix for Location Prequalification

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Overall
	0.091	**0.091**	**0.060**	**0.034**	**0.060**	**0.040**	**0.040**	**0.027**	**0.280**	**0.200**	**0.137**	
Location-1	0.064	0.159	0.450	0.131	0.243	0.223	0.134	0.300	0.243	0.243	0.240	0.229
Location-2	0.2404	0.2606	0.142	0.2028	0.243	0.2298	0.1336	0.18	0.243	0.243	0.48	**0.343**
Location-3	0.12	0.0396	0.065	0.5438	0.243	0.1056	0.4774	0.18	0.243	0.243	0.22	0.127
Location-4	0.4542	0.4664	0.304	0.0824	0.243	0.401	0.0368	0.088	0.243	0.243	0.034	0.251
Location-5	0.12	0.0776	0.03	0.04	0.027	0.0352	0.2182	0.228	0.027	0.027	0.0526	0.050

ACKNOWLEDGMENT

This study originated from the project supported by The Scientific Research Unit of Erciyes University (SRU project number is FBY-11-3636).

REFERENCES

[1] Ballis A. and Mavrotas G., 2007, “Freight village design using the multicriteria method PROMETHEE”, Operational Research. An International Journal, 7, 2, 213-232

[2] Al-Subhi Al-Harbi K.M., 2001, “Application of the AHP in project management”, International Journal of Project Management, 19, 19-27

[3] Afandizadeh S. and Moayedfar R., 2008, “The feasibility study on creation freight village in Hormozgan province”, Transport, 23, 2, 167-171

RETAIL LOCATION METHODOLOGIES' COMPARISON THROUGH DECISION-MAKING PROCESSES

Turhan BİLGİLİ[1]

Abstract *– Decisions pertaining to retail location have always been an evolving dilemma since spatial characteristics of retailing would have dictated contradictions on threshold; owners, customers and products/services to be delivered. Although, the optimization of the criteria for site selection decisions requires careful attention to the inherent trade-offs among land costs, facility costs, inventory costs, transportation costs, total revenues and customer responsiveness, the paradox is, however, not easy to explain decisions as part of a contributed disciplines – economics, geography, sociology, psychology, marketing and logistics which always play vital role in elaborated work (location strategies) while maintaining cost and efficiency at reasonable levels. This paper presents a heuristics approach that provides an integrated view while criticizing current theories and methods, and provides efficiency and effectiveness through contemporary decision-making tools.*

Keywords – Decision-Making Processes, Location, Logistics, Retailing.

INTRODUCTION

Contemporary logistics focuses on attaining advantage in a competitive environment since the challenge to business today is to manage and alleviate that risk through creating more flexible supply chains [1]. For many businesses, business location is an essential component in its eventual success or failure. Site selection is pivotal in all sorts of businesses, including retail, service, wholesale, and manufacturing efforts.

It is the retailing which comes second last before the customer in any supply chain and it is the location to attract the target market in any retailing mix. There is no doubt that the retail industry is incessantly changing as the global and regional economies are both metamorphosing and transforming worldwide. Retail location selection is not a stand-alone decision but an integral factor reached after a series of methodologies in decision-making processes. Since well-designed retail location strategies will keep enterprises to start ahead of the game, the more proper location in retailing is designed the most important factor of retail mix triggers the future market growth [2]. Of these, retail location is perhaps determinant of success, economic performance and boosting factor of social development [3]. That is why retail site selection must belong to careful and long-term studies and elaborates on great investments which cannot be underestimated easily. A retail location should not be regarded as a local position to serve the customers only but a geographic region which is more than a specific site providing potential benefits, effectiveness, and adding value to the land cost. Certainly, the choice of a retail location has a profound effect on the entire business activities of retailing operations as well as contributing to shopping patterns of consumers.

The context of the location decision may turn to be dilemma if the firms are reluctant to handle it as it is. Location decisions are key strategic decision which has to be considered into new businesses start with broadening thoughts (i) proximity to potential customers, (ii) relocation of existing business, as the present location may not have extra space, (iii) expansion of existing business, (iv) relocation of clients, and (v) supply chain problems [4]. It is the critical side of channel strategy where site selection (if a sound decision comes with proper places) gives chance to easy transportation, magnetizes customers and dispatches customers shopping and buying concepts. Among the retail stores providing identical services and goods, location is key to yield a big portion on market share and profitability.

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On the other hand, firms are relying increasingly on strategic planning to endow with long run viability and profits. In the decisions which site selection problems are complex in nature and expected to resolve in optimum results, retail chain is the key element to be put into both theory and practice where the competiveness has no mercy. Although the driving force behind the retailing is logistics, well-formulated decision-making processes applied to retail site selection are crucial for the quick return of investment (ROI).

One of the most important decisions a retailer can make is where to locate a retail outlet. The optimization of the criteria for site selection decisions requires careful attention to the inherent trade-offs among land costs, facility costs, inventory costs, transportation costs, total revenues and customer responsiveness, the paradox is, however, not easy to explain decisions as part of a contributed disciplines – economics, geography, sociology, psychology, marketing and logistics which always play vital role in elaborated work (location strategies) while maintaining cost and efficiency at reasonable levels. To this end, accessibility, convenience to the retailer and other utilities and customer services add to location constrains. Because convenience is so important to today's consumers, a retail store can prosper or fail solely based on its location and prior to that accurate or erroneous decisions. Recently, a shifting paradigm of retail environment is augmenting the location importance as retail formations develop multi-outlet chains of small stores.

The study of retail location contained in many books ranges widely over academic and applied sciences and the theory is a challenging issue mostly causes random locational decisions in practice. In addition contributions to location methodologies come from a variety of other disciplines apart from logistics – geography, economics, sociology, finance, management, psychology and marketing [5].

It is for sure that both a firm may have multiple sites which will make possible to be a single source for an item or service into each site thus gaining some of the advantages of single sourcing without the downside risk and also if a manufacturing firm makes a range of products it may be possible to be a sole source by supplying products thus keeping an alternative source of retail goods available.

LITERATURE SURVEY

In today's global market arena, it is essential to stay informed about the most recent investment opportunities. Pioneering new markets, maximizing supply chain networks, evaluating your location portfolio, these are all very significant, yet complex matters. As dictated earlier, investment in manufacturing facilities and the options of their locations will consequently be a managerial activity strategically both at the present and in the future. Practitioners and academics studied the problem that firms highlight certain factors in the location decisions more likely to locate in one centre versus another ultimately. Former literature on retail location problems and the methodologies adopted can be categorized into multiple approaches. There has been a classification approach categorizing two models as (i) cost-based plant location models which elaborate exclusively on the cost aspects of the decision and (ii) qualitative variables in plant location which have a broader spectrum starting up with weighted checklist to the Analytic Hierarchy Process and GIS in contemporary studies [6].

Another research including prior models to determine the transaction associated with the plant location decisions fall into two distinct categories. The first set of models primarily focuses on quantitative analyses based on assumed costs of land, labor and transport, scale economies, and other cost-based variables (as stated above). In such a modeling key qualitative factors such as availability of skilled workforce, efficient business services and infrastructure, and stability of government policies are ignored, since these are critical for creating and supporting competitive advantage. The latter category of models on plant location incorporates both quantitative as well as qualitative variables submitted to above [7]. More recent developments incorporating meta-heuristics such as genetic algorithms for the global problem of the multi-outlet chain configuration, the use of contemporary tools like Voronoi diagrams in store trade area delimitation or heuristic approaches like Ardalan Heuristic [8], and finally set, the Information Systems' role on the decision support process are also found eligible to be compared [9].

As a matter of fact, the literature regarding to location decision processes have been widely ranged from simple paper-based approaches to the most advanced, data-driven, knowledge –based techniques or in some sense highly complicated computer-based modeling. The common characteristics of mostly preferred methods anchor in site surveys, evaluation, site selection, although there may be some variation emerging from methodologies adapted [10].

DESIGN/METHODOLOGY/APPROACH

The facility location decision involves organizations seeking to establish, relocate or expand their operations for finding the lowest expenditure for distributing stocks of goods or supplies from multiple origins to multiple destinations that demand the merchandises. The facility location decision process encompasses the classification, analysis, assessment and selection among alternatives [11] and [12].

As sited above, location decision is the process of choosing region and specific location to accomplish the business strategy. In order to make location decisions right, each method follows a rationale based on decision on the criteria which will then be followed by identification of the important factors and the development of location alternatives. Evaluation and making a selection is a final step right after the alternatives are clear since evaluating the alternatives is a threshold process to identify common region, identify a number of community alternatives and identify site alternatives.

The variables that form conceptual models in current retail location methodologies are not more than a dozen although; facility location problems involve choosing the best location for one or more facilities from a set of possible locations. To overwhelm the problem, first, relevant segments of literature are reviewed, encompassing models that incorporate both quantitative and qualitative factors in the plant location decision. This is followed by a discussion of the research framework, hypotheses, and research methodology. Next, analysis of results and findings are presented. Finally, concluding comments and future research directions are outlined. Ultimately, this paper presents a heuristics approach that provides an integrated view while criticizing current theories and methods, and provides efficiency and effectiveness through contemporary decision-making tools.

Per contra, a heuristic approach (or heuristics; Greek: "Εὑρίσκω", "find" or "discover") adapted in this paper refers to experience-based techniques for problem solving, learning, and discovery. Heuristic methods are used to speed up the process of finding a good enough solution, where an exhaustive search is impractical. Examples of this method include using a "rule of thumb", an educated guess, an intuitive judgment, or common sense [13].

In spite of the fact that the design of the study does not comprise micro and macro level evaluations as caveats, the site selection process which is accepted to be a sustainable approach must take into account relevant environmental, planning, engineering (‘building conditions’ and ‘operability’), property (including cost), social and economic aspects to enable selection of the most suitable combination of sites along with the managerial decisions which also necessitates a relationship between the processes for site selection, engineering design and project options. The location design processes for the retailing proceed in tandem with the site selection process even though there it is no iterative relationship among the methods (except the relation between Reilly’s Law and Huff’s Model) adapted in this paper.

As an approach and in addition to the latest demographics, contemporary models are also revitalized including substantial social, housing, and income data, along with easy-to-use analysis tools that will allow anyone to better understand the relationships between demand, supply, and competitor locations.

Many lectures on academic environment introduce factor rating, cost-volume analysis, center of gravity (CoG) method and transportation model but those are the basics to solve any problem in a degree level. For instance, CoG is known as "Reilly's Law of Retail Gravity" which assumes that the populations of the communities in which the centers are based and the distance between the two centers are key factors in this relationship.

Given the above research goals and design, the nature of the study capitulates both explorative and explicative assessment of location methods are tuned within a historical hierarchy as dictated on Table 1. There, the evaluation and nomination of potential location methods has been involved an interdisciplinary approach. The approach involved a wide range of specialist studies as well as research papers which examined the feasibility of the sites in terms of various different variables/issues.

Secondly, the models are scrutinized matching with the location methods where spatial and software enabled models are preeminent to those formerly employed. The synchronization of models has foremost importance accrued to a rationale comparison.

Third, the last step in the methodology focuses on brief dissertations implying the comments forasmuch as the models seem not overlapping but treating as asymmetric clusters giving way to cannibalization. Short explanations are scanned out of model nomenclatures and laundering the study to comprehend a full vision to researchers. There has not been required any broad paraphrasing since the experience to weigh the pros and cons of each model associated with the breadth of experience gained through site selection processes across the methods adapted from surveys and case studies conducted so far.

TABLE 1
Comparison of Location Methods

Location Methods	Models	Comments
Checklist	**Lists or control diagrams**	Early model used to reduce failure by compensating for potential limits of human memory and attention ensuring that analysts are on track with contributing factors (population, retail outlets, costs, infrastructure, etc.)
Analogue	**Applebaume's Analytical Method**	Seeks most proper site provided by appropriate comparison of analogue locations
Financial	**RSI (Retail Saturation Index)**	Predicts the potential demand of a given trade zone, based on a breakeven point with specified level of competition and financial gains, i.e. comparing the potential return
Regression	**Statistical Models**	Undertakes key factors (population size, accessibility, personal income, space, etc.) that affect demand and the equation linking them together to predict store turnover
	MNL (Multinominal Logit)	Envisages the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables including individual shopper choice measured
Spatial Interaction	**Reilly's Law**	Early model based on physical laws of gravity with geographic positioning, states that larger cities will have larger spheres of influence than smaller ones, meaning people travel farther to reach a larger city
	Huff's Law	Sets a development of Reilly's Law based on customer utility
	Rule of Compatibility	Furnishes a relationship amongst generative, shared and suscipient business
	Lakshmanan-Hansen/MU's Law	Further development of Reilly's Law based on index of specific store types
	MCI (Multiplicative Competitive Interaction)	Development of Huff's Law to include competitive factors
	Ardalan Heuristic	Elicits multi-site locations criteria which utilizes the concept of "equivalent cost" as incurred by the population in terms of "travel"
Software	**GIS (Geographical Information Systems)**	Enables retailers analyzing appropriate places and shows the results on screen maps, and also designed to capture, store, manipulate, analyze, manage and present all types of geographically referenced data
	Web Applications	Endows powerful combination of site mapping software and geographic data analysis that is needed to make informed decisions simply and effectively over the web
	Analytic Hierarchy Process	A powerful tool for comparing alternative design concepts which enables a systematic method for comparing a list of objectives or alternatives
	Simulation	Attempts to simulate an abstract model of a particular system becoming a useful part of mathematical modeling of many natural systems to explore and gain new insights and to estimate the performance of systems too complex for analytical solutions

CONCLUSION

In our globalized world, retail location assessment has gained more and more significance. The perpendicular dimensions of competition have led the firms to move one step ahead of their rivals and act more thoroughly in retail location consideration. The complexity of the interactions amongst the retail location methodologies are not driven by the adversity of decision-making processes only but also the logistics environment and the strategies to be seized. Nevertheless, site selection process and strategies which are most likely to succeed are those which fit future organizational goals within core capabilities. Accordingly, retail site selection methodologies can be assessed and compared on a spectrum of suitability, interoperability, feasibility and acceptability. It is for sure that each method has both surpluses over and above shortages due to the consequences arrived at the end. For example, center of gravity minimizes average distance for one facility only whereas Ardalan minimizes weighted distances for more than one facility.

In this context, it is examined in practice that the optimization of the criteria for site selection decisions which requires careful attention to the inherent trade-offs among land costs, facility costs, inventory costs, transportation costs, total revenues and customer responsiveness is crucial for the proper selection of the location. While maintaining cost and efficiency at reasonable levels, current theories and methods together with competence and effectiveness through contemporary decision-making tools are contributed to location strategies.

I am confident that this study, introducing a heuristics approach that provides an integrated view while criticizing those early tools, concedes useful insights both for researchers and practitioners; for researchers, since it highlights an interesting retail business segment where many of the consolidated supply chain management models seem to fail or be adequate, therefore claiming for further exploration; for practitioners, since it underscores the relationship between site location models and retail strategies and practices, targeting complementary management actions and guidelines with respect to well-acknowledged efforts in marketing, sales and design. This can be of great help for those firms in the retail segment that are now facing the challenge of an increasingly fierce rivalry, on a global playground.

REFERENCES

[1] Christopher, Martin and Denis Towill, 2002. “Developing Market Specific Supply Chain Strategies”, International Journal of Logistics Management, Vol. 13, No. 1, pp. 1-13

[2] Lamb, Charles W., Joseph F. Hair, Jr. and Carl McDaniel, 2011. “Marketing”, South-Western, USA, pp. 238-239

[3] Ghosh, Avijit and C. Samuel Craig, Summer 1983. “Formulating Retail Location Strategy in a Changing Environment”, Journal of Marketing, Vol. 47, pp. 56

[4] Cengiz Haksever, Barry Render, Roberta S. Russell, Robert G. Murdick, 2000. “Service Management and Operations”, 2/E, Prentice Hall, USA, pp. 256-260

[5] John A. Dawson, 1980. “Retail Geography”, ch. 2; The Study of Retail Location edited by P.T. Kivell and G. Shaw, john Wiley & Sons, Inc., USA, pp. 95-96

[6] , [7] Bhatnagar, Rohit., Bhatnagar, Jayanth Jayaram and Yue Cheng Phua, 2003. “Relative Importance of Plant Location Factors: Across National Comparison between Singapore and Malaysia”, Journal of Business Logistics, Vol. 24, No.1, pp. 147-149

[8] Alireza Ardalan, 1984. “An Efficient Heuristic for Service Facility Location”, Proceedings, Northeast Decision Sciences Institute Conference, pp.181-182

[9] A. B. Mendesa and I. H. Themidob, 2004. “Multi-outlet retail site location assessment”, International Transactions in Operational Research, Vol. 11, pp. 1-18

[10] Sullivan, Malcolm and Dennis Adcock, 2002. “Retail Marketing”, Thomson Learning, UK, pp. 97

[11] Verma, Ajar Kumar, Rakesh Verma and N.C. Mahanti, 2010. “Facility Location Selection: An Interval Valued Intuitionistic Fuzzy TOPSIS Approach”, Journal of Modern Mathematics and Statistics 4 (2), pp. 68

[12] Yang, J. and L. Huei, 1997. “An AHP Decision Model for Facility Location Selection”, J. Facil., 15, pp. 241-254

[13] Pearl, Judea, 1983. “Heuristics: Intelligent Search Strategies for Computer Problem Solving”, Addison-Wesley, New York, pp. vii.

EVALUATION OF FREIGHT VILLAGES' CONCEPT IN TURKEY: A CASE STUDY FOR ALİAĞA REGION

Volkan Yavaş[1], Gül Denktaş Şakar[2]

Abstract —*Together with the increasing use of intermodal transport activities and integration of logistics functions, the role of interchange points in the logistics channels has gained considerable importance. As one of interchange points in the logistics channel, freight villages are considered specific locations where many logistics activities take place by bringing various operators together. This study provides an evaluation of the freight villages' concept and their roles in the logistics chain. The aim of this study is to investigate the existing situation of freight villages in terms of their operations, potential markets and to provide an evaluation of a potential freight village in the Aliağa region. Semi-structured interviews are conducted with various parties who understand the operations of such freight villages. By integrating the views of relevant actors, the outcomes in this study are expected to provide a detailed understanding of the potential for a freight village in the Aliağa region.*

Key Words — *Aliağa, Distribution Center, Freight Villages, Intermodal Transportation*

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1. INTRODUCTION

With the economic growth in the world trade, globalization influences all production operations worldwide. Business organizations give great importance to the management of transportation, storage and distribution operations due to the time factor regarding the flow of goods from producers to consumers. Thus, freight villages are seen as the heart of the modern transportation. By integrating all transportation modes, freight villages have become important centers for efficient logistics operations.

As a country at the introductory stage of integrated transport systems, such as intermodal services, Turkey aims to introduce the freight village concept to improve freight transport operations as well as for developing value-added services. Freight villages have started to become local centers of global logistics operations. Furthermore, they create an opportunity for a sustainable level of economic development. In the light of these, this study seeks to provide an overall understanding of the freight villages in Turkey by considering the views of the relevant experts and to present an evaluation of freight village proposal of Aliağa in Izmir.

2. LITERATURE REVIEW

2.1 Freight Village Concept

Freight villages, being collection centers for logistics movements, rationalize trade flows, provide an integrated service and create value-added logistics services. Although these centers have been developed in USA, many freight villages have been constructed in Europe as well. France was the first example for this development, Germany and Italy also built very early examples of freight villages by 1970s [4]. The historical development of the freight village concept focused on seaports and airports where the main usage areas of start-up phase of a logistics base. Due to globalization, integration process of seaports and airports leads to emerge of transportation center, distribution center and freight village respectively as shown like in Figure 1 [11].

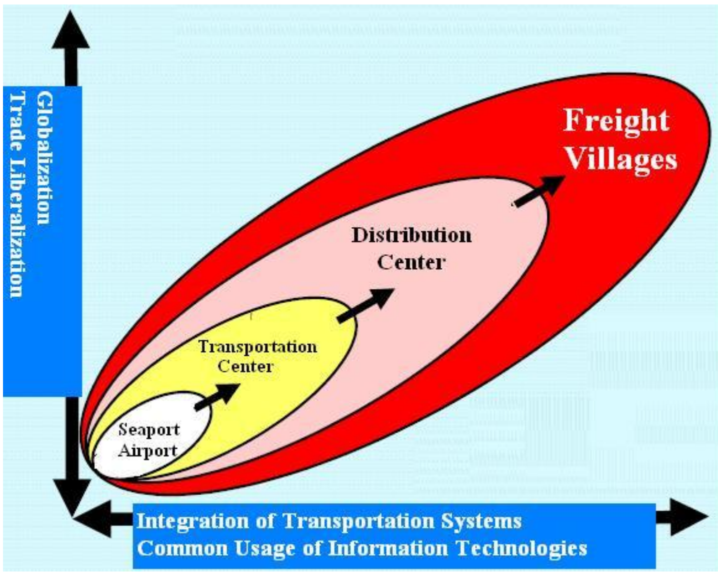

FIGURE 1
Freight Villages Development Process
Source: [11]

Freight villages have different names according to the regions they are located such as 'Freight Villages' (United Kingdom), 'Plate Forme Logistique' (France), 'Güterverkehrszentrum' (Germany), 'Interporto' (Italy), 'Transport Centre' (Denmark, USA) and also 'Dry Port' concepts are used [20]. As seen in Table 1, various definitions of freight villages, dry ports and logistics centers are compared with the views of different sources.

TABLE 1
Definitions

FREIGHT VILLAGE	Afandizadeh and Moayedfar [1]	*A Freight village is created to concentrate the cargo transportation tasks in a vast space and area, also to prevent the excessive spread of storage houses, transshipment centers and preparatory bases of companies users.*
	Turkish State Railways [31]	*A freight village is a place for warehouse activities, maintenance services, handling, loading-unloading, consolidation, packaging and so on, taking place in government organization related to freight and transportation companies, having active link to any types of transportation.*
	Tsamboulas and Kapros [25]	*A Freight village is mainly an intermodal terminal, which is the principal component of the intermodal transport chain, constituting the node where the transshipment of goods from one mode to the other takes place.*
LOGISTICS CENTRES [20]	Krzyzanowski	*Logistics centre is a multimodal terminal, the activity of which deals with cargo transportation, processing, sorting, storage, etc.*
	Prokofveja	*Logistics centre is a contact point of various transportation types where the distribution of cargo streams is concentrated and performed.*
	Palsaitis	*Logistics centre is a place of logistics services provision or logistics activities concentration place, through which large companies realize business service tasks of their customers.*
DRY PORT	Adolf and Gujar [2]	*A dry port can be understood as an inland location where the consolidation and distribution of cargoes takes place, with functions similar to those of seaports, including the handling of cargoes, the provision of intermodal transport connectivity, information exchange and other ancillary services, such as customs inspections, storage, the maintenance and repair of empty containers, and tax payments.*
	Notteboom and Rodrigue [21]	*Dry port is a customs clearance depot located inland away from seaport(s).*
	Roso, Woxenius and Lumsden [24]	*A dry port is an inland intermodal terminal directly connected to seaport(s) with high capacity transport means, where customers can leave/pick up their standardized units as if directly to a seaport.*

(Source: Compiled by the authors)

As seen in Table 1, there are different views and definitions for the logistics operation terminals but the common understanding among the all different views is that these centers are the terminals of the intermodal transportation of logistics operations. Therefore, in this study, the 'freight village' definition is used, according to Europlatforms; '*A Freight village is a specific area where all the activities relating to transport, logistics and goods distribution –both for national and international transit –are carried out by various operators*' [13].

In the direction of the European Association of Freight Villages' (Europlatforms) evaluations, the freight village concept should be based on three important elements according to economical effects and transportation standardization, which are territorial planning alongside infrastructure rationalization, transport quality and intermodal transport development. Dedicating a specific area to transport, logistics and goods distribution automatically implies planning the territory and rationalizing infrastructures in order to optimize area utilization, to safeguard the environment and to build the infrastructures following specific criteria based on operator necessities. The main objective of a freight village is to assure a high quality level, generating the transport system effects such as optimization of the logistics chain, lorry utilization, warehouse utilization and manpower organization, decrease in the total transport costs, total industrial costs and personnel costs, an increase in the transport operators' total turnover. Moreover, the most important goals of freight villages are to bring together the flow of the freight transport managed by the transport and logistics operators; and to offer very convenient transport and synergic solutions [13].

In addition to these elements, there are three principal reasons for the establishment of freight village around the world as: the need to improve the efficiency of domestic transport, the ever-growing congestion in the land areas around major ports and the transformation of shipping from a ‘port-to-port’ activity to an integral component of the broader logistics operations [14]. Establishment of freight village process constitutes technical, commercial and managerial aspects. For instance, investment cost is a key step among technical and commercial aspects and freight villages require both technological and physical infrastructures which require considerable investment. Hence, many of these freight villages have mostly been formed with public private partnership in Europe [5]. Two main categories of private financing of public infrastructure projects are identified shortly: ‘***Joint Venture*** *refers to a joint commitment by the public and private parties involved in a project and* ***concession*** *provides a better allocation of risk and less cultural friction between the public and private sectors’* [25].

Freight village’s administrators or investors have to make a choice about freight village types on the construction phase where after the financial facilities and resources are concluded. As an illustration, there are five basic types of freight villages [21]:

- **Traditional seaport-based:** This type is associated with the pre-container area in seaports.
- **Container oriented:** It includes a number of large warehouses close to the container terminal locations and intermodal terminal facilities.
- **Specialized seaport-based:** It may focus on the storage of liquid bulk, chemicals etc.,
- **Peripheral seaport-based:** It is located just outside the port area which typically offers advantages with respect to congestion, costs of land and labor.
- **Virtual port-based:** It is located outside the greater seaport area, sometimes at a distance of more than hundred kilometers from the seaport itself, but have a clear orientation to one or more seaports with respect to the origins of the (containerized cargo).

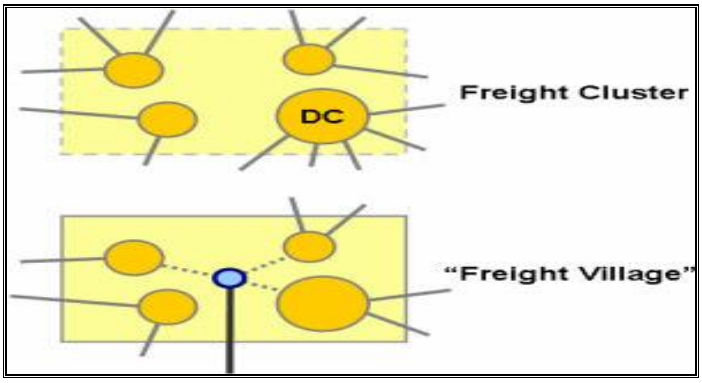

FIGURE 2
Freight Village’s Administration
Source: [19]

As seen in Figure 2, freight village provides safe and planned freight transportation operations and collects the clustered distribution centers under a single management [19]. According to Europlatforms, freight village’s administrators are responsible for all the procedures regarding the leasing or selling activities and they should realize six main activities that are defining infrastructure necessities (road, rail and port connections); defining the freight village (post/bank/insurance services, offices, warehouses, etc.); business plan (investment and development plan); creating the general infrastructures, the warehouses and the integrated services ; land leasing to transport operators / warehouse and office leasing / sale of warehouses and offices and; administrative, financial, commercial and operations management of the freight village [13].

2.2 Operations and Services of Freight Village

Freight villages are important since they are significant centers for realizing efficient logistics, transport and distribution services. To ensure effective freight village operations, there are two general objectives: '*Consolidation of maritime goods in intermodal short and long distance transport flows and collecting and distribution of local, regional and international transports. To achieve these two objectives, it is necessary for the terminal to carry out the following functions: hinterland warehousing; management of container flows to different ports based on consolidation of individual container flows; offering special- and extra services; reduction of transport costs; increase in the firms of ship owners and the port influence to ensure the intensification of the transport chains effectiveness' [15].*

Freight villages were usually built on land which has transportation mode connections, to provide efficient transportation flows. It acts as an intermediary between seaport/airport (export point) and regional hinterland; because of this their assets are very important for a country's international trade operations, as shown in Figure 3.

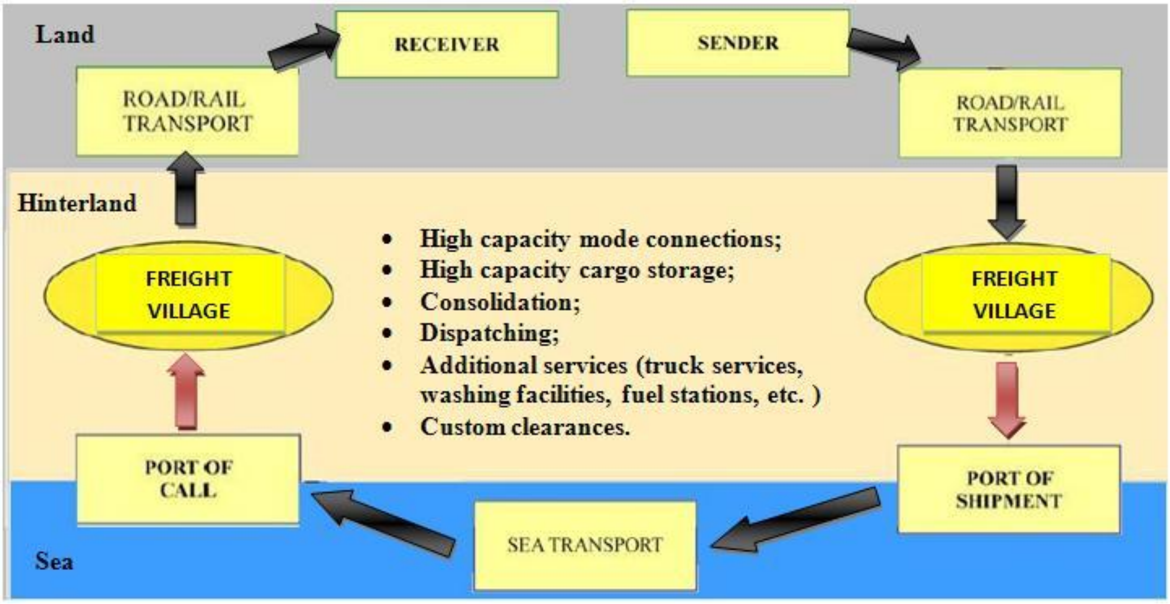

FIGURE 3
Freight Village's Operations Scheme
Source: [15]

Freight villages must have some specific services to rejoin all challenge and complicated operation efficiently. To meet the requirements of the freight villages, it should have well organized infrastructure systems [5]. On the contrary, to approach 'freight village concept' from a different standpoint, freight villages provide benefits to all parties so-called stakeholders as shippers, transport operators, intermediaries and authorities as shown in Table 2 [22].

TABLE 2

Benefits for Stakeholders of the Freight Villages

STAKEHOLDERS	EXPECTED BENEFITS
Shipping Companies	Development of a new product and entering in new markets (earnings & employment)
Existing Shippers	Lower transport costs, more transport opportunities / alternatives, greater reliability and safety.
Potential Shippers	Better access to market, opening of new markets, more transport opportunities / alternatives, lower logistics costs.
Railways	Potential growth of market and segments where competition with road transport can be succeeded.
Road Haulage Companies	Improved economies, greater flexibility for drivers operations (within constraints of prevailing driving and resting regulations).
Forwarding Industry	Greater range of transport opportunities / alternatives, lower costs (earnings & employment).
Intermodal Transport Operators	Improver economics, more transport alternatives, lower costs (earnings & employment).
Authorities, Policy Makers (the society at large)	Additional business opportunities / alternatives, enabling limitation / control of traffic congestion and dangers, emission of hazardous materials and energy use. Increased competition, offering cost effectiveness (and accelerated introduction of market principles).

Source**:** [22]

As seen in Table 2, freight village is the junction point for all stakeholders and they get the main benefits in terms of sustainable and efficient logistics activities. The concept of the freight village varies from country to country, but the common consensus is that one should contribute to intermodal transport, promote regional economic activity, and improve land use and local goods distribution [23]. In Europe, freight villages are located between the seaport and airport - which are known as the center of the trade, production and consumption - and the intersection points as rail, road and sea transportation nodes and most of them are Europlatforms (The European Association of Freight Villages) members as shown in Figure 4 [13].

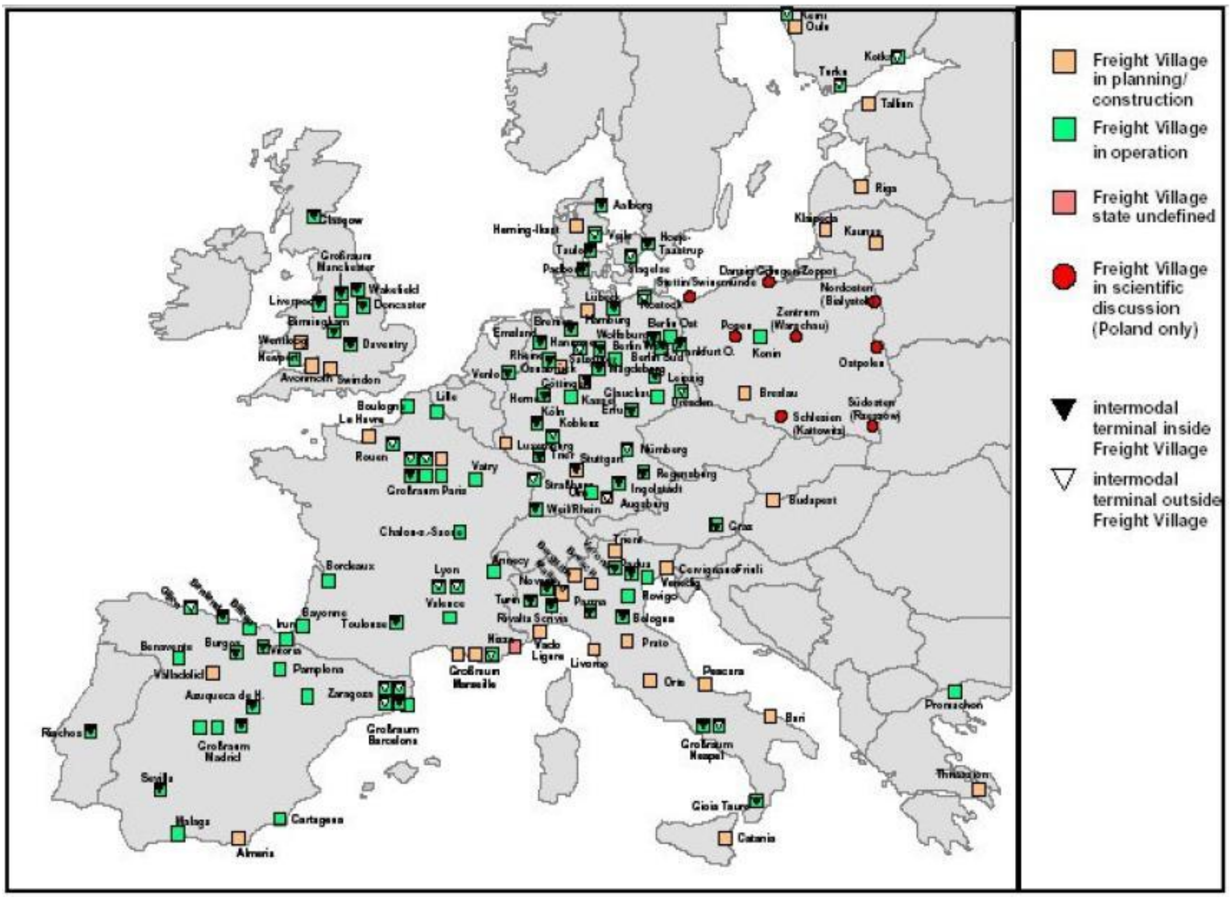

FIGURE 4
Europlatforms Members
Source: [4]

The Europlatform members are Denmark, France, Greek, Germany, Hungary, Italy, Luxembourg, Portugal, Spain, and Ukraine, including some 60 companies that have set up and manage freight villages all over Europe, in which over 1.200 transport and logistics companies operate [13]. *Europlatforms' main purpose is to promote and expand the concept of logistics platform in Europe and worldwide and create and develop relations among existing platforms in Europe and with similar groupings internationally* [30].

2.3 Freight Villages in Turkey

Turkey has a strategic advantage with its geopolitical position for making a logistics base in comparison to the contiguous countries in the world logistics sector. Turkey’s outlook on freight village concept may be summarized with the definitions of Turkish State Railways; ‘*A freight village is a place where activities of warehouse, maintenance services, handling, loading-unloading, consolidation, packaging and so on are performed, taking place in government organization related to freight and transportation companies, having active link to any types of transportation’*. For Turkey, freight village is brand new concept in the logistics and transportation operations so to meet the global competition needs and to accommodate the world logistics trend, under the leadership of Ministry of Transportation, Turkish State Railways have started to prepare some freight village projects to establish in eleven regions as shown Figure 5 [31].

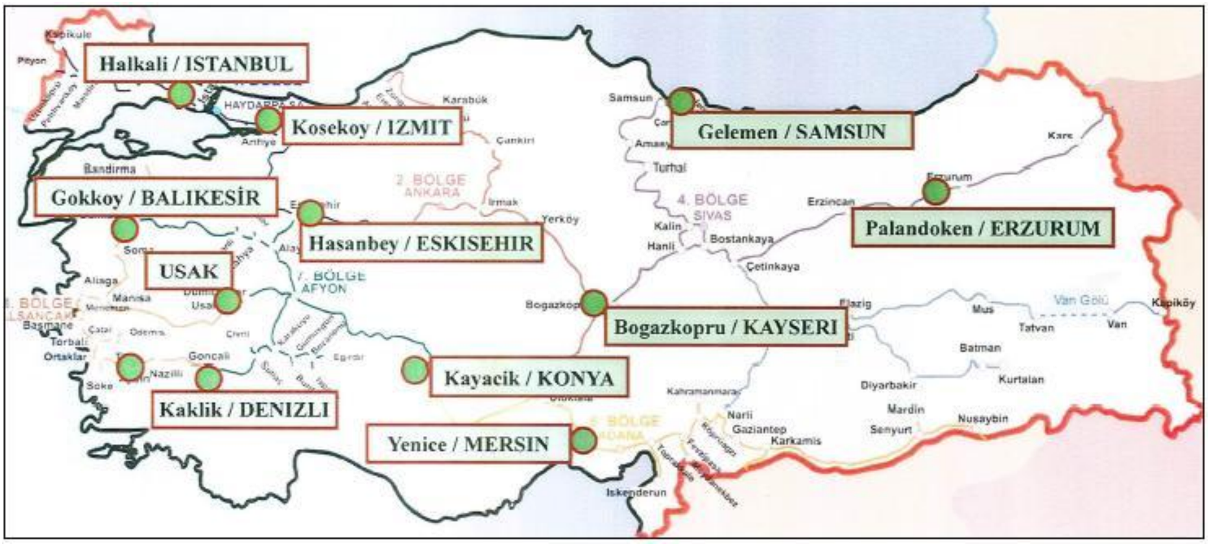

FIGURE 5
TCDD’s Freight Villages
Source: [31]

As seen in Figure 5, freight villages are mainly planned to be established in the Anatolian region of Turkey. Factors of freight villages’ location in Anatolia are mentioned by Denktas Sakar [9] as follows: ‘*Especially the Anatolian region is quite open for development in this respect due to emerging logistics centers in the region, increasing export volumes and service providers’ increasing interest in this region in terms of opening new branches, trying to increase customer satisfaction and investing in logistics centers*’. In addition to Turkish State Railway’s projects, Istanbul Metropolitan Municipality is planning to establish freight villages in Hadımköy and Tuzla. Moreover, public-private partnerships have two other freight villages’ projects in Manisa / Mosbar and Tekirdağ / Çorlu [4]. Besides all of these projects, in this study, Izmir’s logistics potential and the requirements of freight villages are discussed. In the way of Izmir, Izmir Chamber of Commerce’s freight village idea was brought to agenda. The logistics development rates and reaching world standard levels are very important for Turkey’s economic development. Also, world logistics values are expected to reach about 10 – 12 trillion dollars and Turkey’s values are expected to be around 150 billion dollars. On the other hand, Izmir’s foreign trade volume reaches 40 billion dollars, that rate is about Turkey’s 14% and an export rate is 17.7 (Turkey’s %16.5), import rate is 21.1 billion dollars (Turkey’s %12.4)[29]. Izmir’s logistics potential is very important for Turkey’s sustainable and economic development to meet world’s competitive logistics requirements. In addition, freight village location selection has vital importance for Izmir and Aliağa steps forward with their industry and the ports. Moreover, Izmir’s hinterland is the second place after Istanbul as an industrial situation and realizes 25% of Turkey’s total export and Aliağa is able to reach Aegean Region and Turkey via in Izmir’s hinterland like shown in Figure 6 [8].

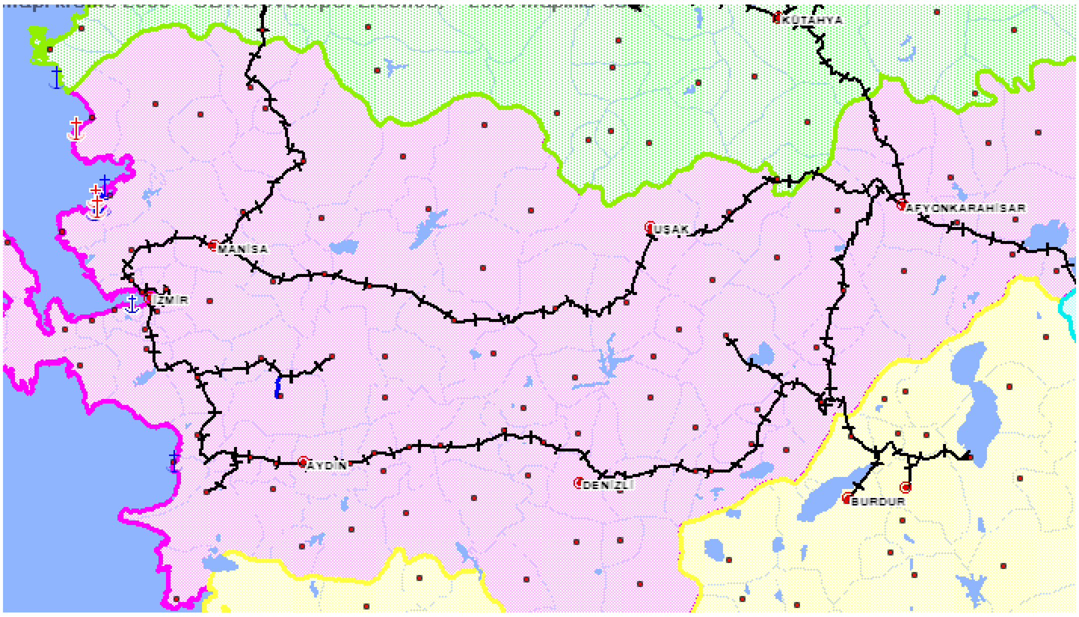

FIGURE 6
Potential Hinterland and Railway Networks of Izmir
Source: [8]

Aliağa has significant potential role for the Izmir with its industrial zones, ports and transportation connections. It has efficient railway, roadway and seaway infrastructures and connections with its hinterland and also it is located at the middle of Balıkesir and Izmir airports. Moreover, Aliağa has one of the most important industrial zones of Izmir and in other words, it is the industrial center of Izmir with Aliağa Organized Industrial Zone (Alosbi). Besides these, Aliağa has 7 ports in Nemrut Bay and they serve about 3500 – 4000 ship in a year and these figures are expected to grow in the years ahead. Also, Aliağa ports realize the 22% of total exports of Aegean Region and they usually use roadways to provide connections with the hinterland [27].

3. METHODOLOGY

In this study, semi-structured interviews are used to collect the data. This type of interview is more flexible and controllable by the researcher and it also gives opportunities to discuss the reactions, opinions and behaviors on a particular issue with the respondents. Semi-structured interviews form is formed with 2 main questions and 15 sub-questions about Aliağa's infrastructure and evaluation of a freight village in this region. The interviews were conducted face to face and each interview lasted about 15 minutes. A sample of the questionnaire is given in Appendix 1.

The sample of the study involved participants from Aliağa's port governances, chamber of commerce, organized industrial zone, freight forwarding companies, logistics firms, and railway operators. Because of the difficulty in reaching institutions and prominent actors, convenience sampling is used to conduct this study. The questionnaire form was sent to 30 institutions and the prominent actors, with feedback received from 14 respondent. The participants in the study have an average age of 37 (ranging from 24 to 66) and also they have around 7 years experience in the sector, with 78% of respondents having earned a bachelor's degree and the others having a master's degree.

4. FINDINGS

This section presents the overall findings from the semi-structured interviews. The interviews were conducted in order to make a preliminary study and to reach some findings on the proposal of the Aliağa freight village. Some common points mentioned by participants in the interviews will be given in this section.

The findings will be shown under main headings as the general information on Aliağa's infrastructure services, probable advantages of freight village and promotion of freight village concept in Aliağa.

4.1 Freight Village Infrastructure of Aliağa

In the first part of each interview, participants were asked about Aliağa's general infrastructural condition. First, the Aliağa port's transportation infrastructure was evaluated and in the view of majority of participants, it has not sufficient road and railway infrastructure. All of the participants agreed that it should be developed in the medium and long term. In addition, when the port's logistics services areas and services were evaluated, according to 70% of participants, it is sufficient in short term but it must be developed in the long term because, new areas and services will be needed.

Secondly, Aliağa railway station and their infrastructural possibilities were evaluated briefly. All of the participants reached a consensus that railway infrastructure is sufficient in the short term but it should be developed with new rail lines that provide connections to the ports. Furthermore, ports need new warehouses and services to improve freight capacity in the medium term. In the short term, roadways infrastructure may be sufficient, but common view is that, hinterland connections should be developed in the medium term and inner city roadways, ports and station connections should be renewed with landscaping activities. Also air freight requirement was considered by the participants and they mentioned that Aliağa certainly needs air freight operations.

Finally, in the view of all participants, Aliağa has sufficient areas to build a freight village and Izmir has sufficient workforces to this organization. Nevertheless, in a common view, freight village professionalizes the logistics activities so that they need qualified employees. Because of this requirement, a vocational school must be established in Aliağa. Proposal of Aliağa freight village aims to provide efficient and productive connections among the Aliağa ports and its hinterland shown as Figure 7.

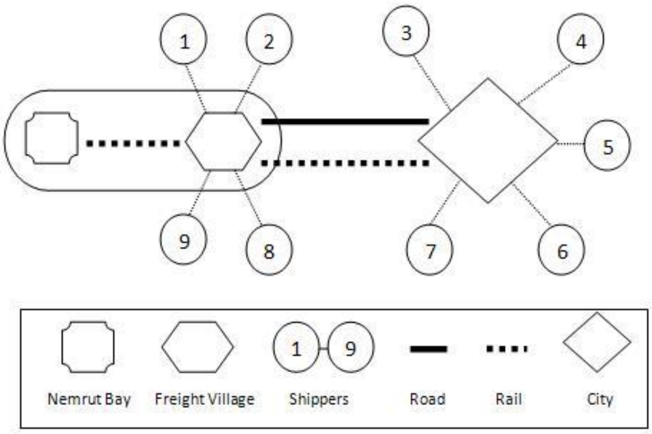

FIGURE 7
Proposal of Aliağa Freight Village Concept
(Source: Author)

As seen in Figure 7, proposal of Aliağa freight village concept should be organized from the perspective of railway usage. According to participants, new rail lines should be constructed between the ports and the freight villages and railways should be used mostly at the freight village operations.

4.2 Advantages of Freight Village

In the second part of interview, Aliağa freight village proposal's proceeds were evaluated in general. Firstly, Aliağa freight village's proposal and its potential positive accelerations to ports were discussed. All of participants agreed that if the ports provide added value and centralized administration, freight village will lead to positive growth for the ports. However, it does not depend on freight village but also on developing ports: developing their own services and organizations to be present at freight village operations.

In addition, intermodal activities and workforces were evaluated with the prominent that in general, because of the nature of freight village concept; intermodal activities are developed as a parallel and Aegean Region employment volume may increase. As a consequence, freight village provides economic efficiency for Izmir in particular, and also Aliağa freight village proposal may succeed to be important logistics centers in Aegean Region and Turkey.

4.3 Promotion of Freight Villages

The proposal for the Aliağa freight village has the support from all the interview participants, all agreeing that if Izmir needs a freight village, Aliağa is the most appropriate region. Furthermore, Aliağa freight village proposal is promoted by all participants and 60% of them agreed that it should be established around the Biçerova Railway Station area with its geographical positions, transportation and field facilities as shown Figure 8. It should also allow infrastructural investments among the ports, railway stations and organized industrial zone.

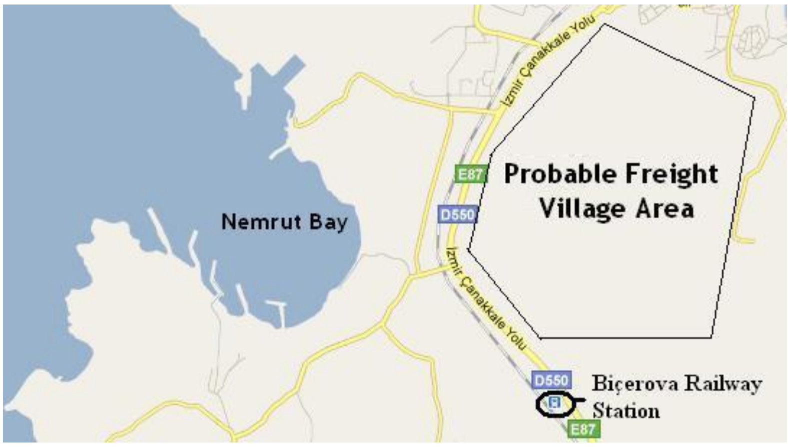

FIGURE 8
Probable Area of Aliağa Freight Village
(Source: Author)

As seen in Figure 8, according to the participants there is a huge area available to establish a freight village, but in the planning stage, experts should do a feasibility study for further consideration. Also, social and economic facilities should be included at all the bases of freight villages.

5. CONCLUSION

The main aim of this research was to understand the freight village concept generally and Turkey's freight villages specifically. Freight village is an important center for the logistic activities and it is also seen as the center of intermodal transportation. Logistics activities are expanding day by day in Turkey and the prominent decision makers are noticing the trends. Because of global competition in the global markets, Turkey meets the requirements of world's trade and logistics activities, including those for a freight village. There are some freight village projects under the Turkish State Railways in some municipalities, excluding Izmir.

In this study, Aliağa freight village proposal propounds logistics activity centers in Izmir because of their port capabilities, intermodal activities and qualified industrial zone. Aliağa's transportation infrastructure is well organized in a short term and its ports and industrial zone activities are still growing. In addition, Izmir's logistics prominent decision makers are leaning toward the Aliağa freight village proposal, but all agree that imaginative infrastructural investments should be implemented over the long term. According to these findings Aliağa is at suitable area for becoming Izmir's logistics centers.

In addition our study, further research should be based on studying the relationship among freight villages and the effects on competition or the evaluation of factors influencing the implementation of freight villages.

REFERENCES

[1] Afandizadeh S. and Moayedfar R., 2008. "The Feasibility Study on Creation of Freight Village in Hormozgan Provinence", Transport Vol. 23 No.2, 167-171.

[2] Adolf K.Y. and Gujar G., 2009. "The spatial characteristics of dry ports in India", Transport and Communications Bulletin for Asia and the Pacific, No. 78 Development of Dry Ports, 147-160.

[3] Alev A. and Sargın B., 2009. "World's Freight Village", Izmir chamber of commerce (İZTO).

[4] Aydın G.T. and Öğüt K.S., 2008. "Freight Villages In Europe And Turkey?", II. International Railway Symposium, Istanbul, Vol. 2, 1439 – 1448.

[5] Aydın G.T. and Öğüt K.S., 2008. "What is Freight Village?", II. International Railway Symposium, Istanbul, Vol. 2, 1471 – 1481.

[6] Ceran M. B., 2010. "Freight Villages Granting Competitive Excellence in Global Competition Environment: Proposal of Konya Freight Village", Selçuk University, Social Sciences Institute, Master Thesis.

[7] City Consultation Office 2009. "Izmir Logistics Center", Izmir chamber of commerce (İZTO).

[8] Demirlioğlu H., 2008. "Improvement of Seaborne Container Transportation of Turkey with Combined Transport", Istanbul Technical University, Institute of Science, Master Thesis.

[9] Denktas Sakar, G., 2010. "Transport Mode Choice Decisions and Multimodal Transport: A Triangulated Approach", Publication of Dokuz Eylul University, Izmir

[10] Economical and Social Commission for Asia and The Pacific (Unescap), "Development of Dry Ports", Transport and Communications Bulletin for Asia and the Pacific, No. 78.

[11] Erdal M., 2010. "The concept of Logistic Base and Analysis of Turkey", www.utikad.org.tr/pdf/Lojistikuskavrami.pdf, Accessed 2010.

[12] Erdumlu M., 2006. "City Logistics and Freight Village Application", Istanbul Technical University, Institute of Science, Postgraduate Thesis.

[13] Europlatforms, 2004. "Logistics Centers: Direction for Use", www.europlatforms.eu, Accessed 2010.

[14] Garnwa P., Beresford A. and Pettit S., 2009. "Dry ports: a comparative study of the United Kingdom and Nigeria", Transport and Communications Bulletin for Asia and the Pacific, No. 78 Development of Dry Ports, 58 – 81.

[15] Jaržemskis A. and Vasiliauskas A. V., 2007. "Research on Dry Port Concept As Intermodal Node", Transport Vol XXII No.3, 207-213.

[16] İzmir Economy University, 2009. "Analysis of Current Situation and Development Potential of Logistics Sector in Izmir", Project of Izmir Development Agency.

[17] Kara M., Tayfur L. and Basık H., 2009. "The Importance of Logistics Centers in Global Trade and Turkey", Mustafa Kemal University Journal of Social Sciences Institute, Vol. 6, No. 11, 69-84.

[18] Karakuyu M., 2010. "Hadımkoy as a Logistic Center and Its Problems", Marmara Geography Journal,Vol. 21, 269-286.

[19] Kaynak M and Zeybek H., 2007. "Logistics Centers And Distriparcs Within The Development Process Of Intermodal Terminals: Challenges for Turkey", Gazi University, Journal of Economics and Administrative Science, Vol.9 No.2, pp.39-58.

[20] Meidute, I., 2005. "Comparative Analysis of the Definitions of Logistics Centres", Transport, Vol. XX, No 3, pp.106–110.

[21] Notteboom T. and Rodrigue J., 2009. “Inland Terminals within North American and European Supply Chains”, Transport and Communications Bulletin for Asia and the Pacific, No. 78 Development of Dry Ports, 1 - 57.

[22] Palsaitis R. and Bazaras D., 2004. “Analysis of the Prospective Intermodal of Transport and Logistics Centres in Lithuania”, Transport, Vol.XIX No.3, pp. 119-123.

[23] Roso V., 2008. “Factors Influencing Implementation of A Dry Port”, International Journal of Physical Distribution & Logistics Management, Vol. 38 No. 10, 782-798.

[24] Roso V, Woxenius J. and Lumsden K., 2009. “The Dry Port Concept: Connecting Container Seaports with the Hinterland”, Journal of Transport Geography 17, 338–345.

[25] Tsamboulas A. D. and Kapros S., 2003. “Freight Village Evaluation Under Uncertainty with Public and Private Financing”, Transport Policy 10, 141–156

[26] Yıldıztekin A., 2010. “Supply Chain and Logistics Management: Freight Villages”, Istanbul University, Transportation and Logistics High School, VI. Logistics Summit.

[27] http://www.aliaga.bel.tr/index.php, 2011.

[28] http://www.atillayildiztekin.com, 2011.

[29] http://www.denizhaber.com.tr/deniz-turizmi/34993/izto-deniz-ticaret-haber.html, 2011.

[30] http://www.freight-village.com/index.php, 2011.

[31] http://www.tcdd.gov.tr/Upload/Files/ContentFiles/2010/yurticibilgi/lojistikkoy.pdf, 2011.

APPENDIX 1

1. Does Aliağa have the adequate substructure as a logistical center?

a. Is Aliağa sufficient in the terms of the substructure of port transportation?

b. Do the ports of Aliağa have the necessary logistical service spheres?

c. Does the Aliağa Railroad Station have the sufficient substructure in terms of load capacity and storage fields?

d. Does the Aliağa – Menemen Railroad line have the sufficient base for load transportation?

e. Does Aliağa have adequate highway connections?

f. Are the roads which provide Aliağa highway connections with transportation to the ports and stations in a good situation?

g. If a logistical village is founded in Aliağa, do you think that cargo transportation may be needed?

h. Do you think that there is an adequate and appropriate field in Aliağa for a logistical village to be constructed?

i. If a logistical village is founded in Aliağa, may a possibility of workforce at the level of international and national service be provided?

2. What would be the advantage of a logistical village for the area and Turkey?

a. Do you think that a possible logistical village to be constructed in Aliağa would affect the ports of the area in a positive way?

b. Do you think that a possible logistical village to be constructed in Aliağa would increase the railroad transportation activity in the area?

c. Can a possible logistical village to be constructed in Aliağa contribute to the development of intermodel transportation activity in the area?

d. Can a logistical village in Aliağa create a new area of employment?

e. Can a logistical village to be constructed in Aliağa give accelaration to particularly Izmir and then the Aegean Region and Turkey in the economical field?

f. Can a logistical village in Aliağa accomplish to be one of Turkey's best logistical centers?

3. Do you support the idea of a logistical village in Aliağa to be constructed?

a. If you do, do you have any area suggestions for the construction?

b. If you do not, would you share the reason why?

DEVELOPMENT OF WAREHOUSING MANAGEMENT SYSTEM IN TURKEY

Gülsüm Aydın[1], Sibel Bayar Çağlak[2] and Güler Bilen Alkan[3]

Abstract — W*arehouse is a commercial building for storage of goods. Warehouses are used by logistics related parties. The direction and tracking of materials in the warehouse is coordinated by the Warehouse Management System, a database driven computer program. It is used to improve the efficiency of the warehouse by directing put ways and to maintain accurate inventory by recording warehouse transactions. In this study; the general information about warehouse management system will be given. The Traditional warehousing aspects and types of warehouse storage system will be explained. In addition to this, the importance of warehouse management system, major logistics warehouses in warehouse management systems will be emphasize.*

Keywords - Warehousing, Warehousing Management System, Turkey.

INTRODUCTION

In simple words, warehouse is a facility where the supply chain holds or stores goods, until the customers need them. Warehouse can be owned by manufacturers, wholesalers, retailers. The Warehouse Management System coordinates the direction and tracking of materials in the warehouse. It is used to improve the efficiency of the warehouse by directing put ways and to maintain accurate inventory by recording warehouse transactions.. Prior to the early 1970's, a systematic method for determining the cost of materials handling within the warehousing business did not exist. Recent infrastructure improvements that helped the industry include a wave of new regional logistics distribution centers, logistics regions, modern warehouses and improved distribution facilities. Warehouse management is one of the sections having the greatest share within the entire logistic activities. The well management of this section, feeding the sales points at the planned times and keeping the order preparation accuracy rates at the highest level constitute a great importance in terms of reducing the logistic costs, as well as the product costs. WMS is a powerful, feature-rich solution for automating the materials-handling processes of retailers, manufacturers, distributors and third-party logistics providers. In this context, warehouse and related warehouse management definitions will be discussed.

WAREHOUSE

Warehouse is a commercial building for storage of goods and used by manufacturers, importers, exporters, wholesalers, transport businesses, customs etc. They are usually large plain buildings, equipped with loading docks to load and unload consignment from trucks. Based upon the size of the goods and volume of operation they also often have cranes and forklifts for moving goods, which are usually placed on ISO standard pallets [1]. Sometimes they are designed for the loading and unloading of goods directly from railways, airports, or seaports. In order to meet their requirement various types of warehouses came into existence, which may be classified as private, public, government, bonded and Co-operative [2].

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GENERAL FUNCTIONS OF WAREHOUSES

The warehousing functionality today is much more than the traditional function of storage. The following are main function that warehousing serves today [3]:

- ***receiving goods***; receive and accept responsibility by updating records
- ***identifying goods*;** place, label, color code (normal stocks, promotional stocks, special customer stocks like, price changes, batch etc).
- **sorting goods**; sort out the received goods based on identification for appropriate storage area. i.e. special customer goods, revised price goods, promotional goods.
- ***dispatching;*** put away the sorted goods to appropriate storage place such as temporary storage.
- ***holding goods***; security against pilferage and deterioration.
- ***selecting, retrieving, packing***; items are retrieved and grouped according to customer order for dispatch.
- ***marshaling goods*;** check the items of a single order for completeness and order records are updated.
- ***dispatching goods*;** consolidated order is packaged and directed to right transport.
- ***preparing* records and advices;** of stocks and replenishment requirements.

TYPES OF WAREHOUSE STORAGE SYSTEMS

There are many material handling products and systems for improving operational efficiency in manufacturing, assembly, distribution centers (DCs), storage facilities, and warehousing. Some of the most common warehouse storage systems are[4],[5], [6];

- **Pallet racking;** is a material handling storage aid system designed to store materials on pallets, including selective, drive-in, drive-thru, double-deep, pushback, and gravity flow All types allow for the storage of palletized materials in horizontal rows with multiple levels. Forklift trucks are usually an integral part of any pallet rack system
- **Mezzanine**; floor systems are semi-permanent floor systems typically installed within buildings, built between two permanent original stories, including structural, roll formed,rack supported and shell supported. These structures are usually free standing and in most cases can be dismantled and relocated
- **Vertical Lift Modules;** an automated storage and retrieval system (ASRS or AS/RS) consists of a variety of computer-controlled methods for automatically placing and retrieving loads from specific storage locations. ASRS typically used in applications where: there is a very high volume of loads being moved into and out of storage; storage density is important because of space constraints (http://en.wikipedia.org/wiki/AS/RS)
- **Horizontal Carousels;** ASRS consists of a variety of computer-controlled methods for automatically horizontal placing and retrieving loads from specific storage locations.
- **Vertical Carousels** ASRS) consists of a variety of computer-controlled methods for automatically vertical placing and retrieving loads from specific storage locations.

WAREHOUSE MANAGEMENT SYSTEM

Prior to the early 1970's, a systematic method for determining the cost of materials handling within the warehousing business did not exist. Tables were available to calculate the cost of storage, based on pile height, but when it came to calculating the cost of handling the warehouse operator was forced to make general estimates, or to seek help by comparing notes with other operators or the customer. Unfortunately, none of these outside sources were reliable, because engineering was not applied to the development of cost calculations. Gagnon was the innovator who first demonstrated that engineering data can be applied to warehouse operations. As early as the 1970's, he developed a prototype warehouse management system (WMS) for his father's public warehousing business, Taylor Warehousing. During the1980's, he converted the system into Tinman, an acronym for "Total Information Management," and began to sell the WMS to other warehousing companies [7].

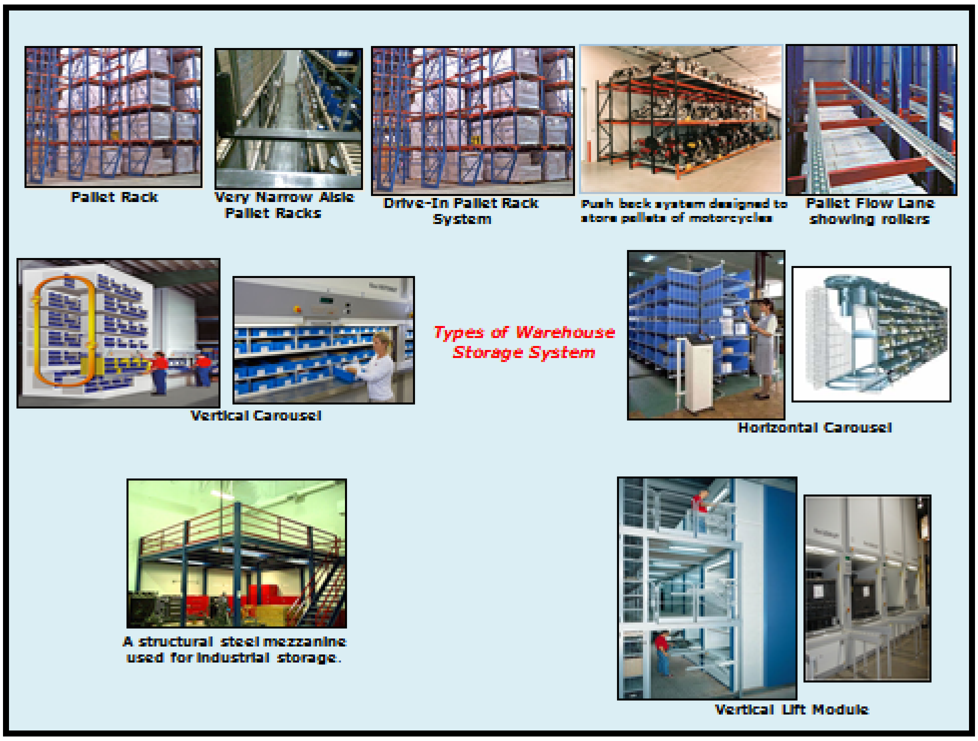

FIGURE. 1
Types of Warehouse Storage System

Warehouse Management (WM) is the sub activity of Logistics Management. Distribution networks play a critical role in the supply chain, and the design and management of these networks has been closely scrutinized. Companies have explored a variety of related strategies in order to adapt to the changing economy [8].

Changes at the warehouse level can lead to a significant improvement in the bottom line such as reducing DC (warehouse) space. Since recognized as a new industry in the late 1980s, the logistics service industry has been experiencing growth [9]. However, the reality is that not all logistics service providers (LSPs) manage to become competitive [10]. A successful real-time data warehouse can be the silver bullet for organization needs to prosper in the Internet era [11].

Furthermore, a real-time data warehouse eliminates the data availability gap and enables organizations to concentrate on processing their valuable customer data [12]. A major issue in supply chain management is the real time visibility of demand [13] when coupled with multiple tiers of members in the chain, which amplifies the bullwhip effect as described by Forrester [14].

The WMS is an integral part of manufacturing and distribution processes. It works in conjunction with the Inventory Management. At the same time, WMS minimizes the number of duplicate records and mismatched data, reduces the hardware requirements for your system, and increases your system's performance [15].

WMS provides flexible, automated support to assist you in processing all goods movements and in maintaining current stock inventories in your warehousing complex. Moreover, manager can structure warehouse in almost limitless detail, so warehouse manager can know the exact location of everything, the exact quantity, and the exact quantity that is available. This detail allows warehouse manager to maintain a continuous flow of goods and gives the competitive edge in delivering goods to customers quickly and efficiently [15].

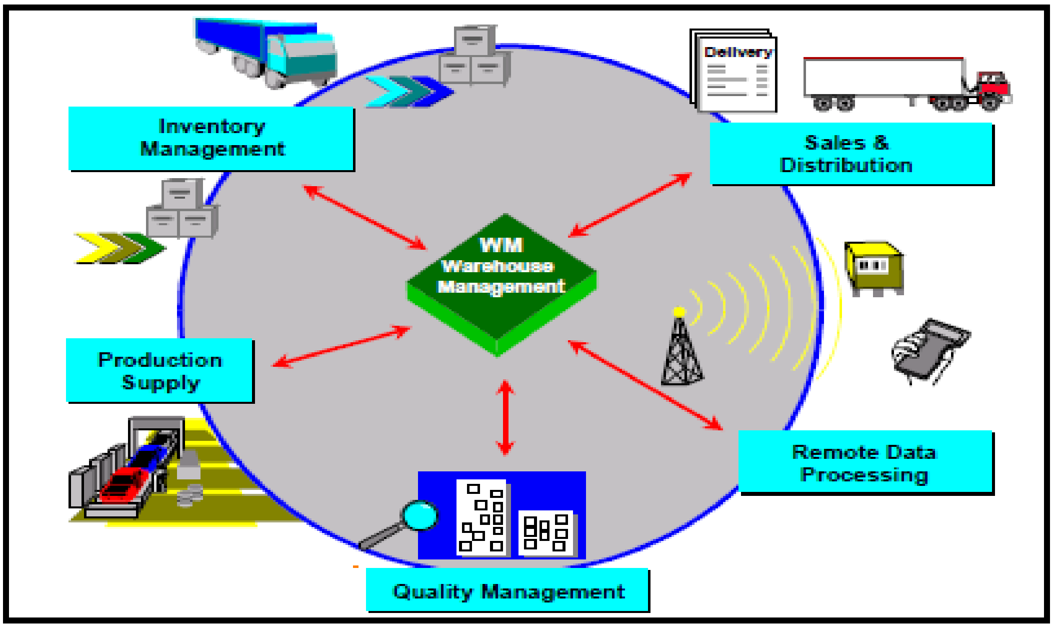

FIGURE. 2
Warehouse Management Cycle

WM supports warehousing processes such as advanced putaway and picking techniques and quickly and easily stock transfers. As shown in Figure. 2. It is also interfaced to Sales and Distribution, Quality Management and Production Planning. Quality Management allows warehouse administrators or managers to track and manage inspection lots that are stored in the warehouse and Production Planning provides materials to supply areas during the production process [16].

The majority of warehousing problems occur because of a lack of control of inventory, operations, and/or management. To become dynamic, successful and consistent, an organization must control its warehouse operations. The warehouse activity monitor helps managers to identify and correct warehousing errors or critical processes soon after they occur, thus enabling managers to carry out warehousing transactions in a timely manner.

WMS often utilize technology such as barcode scanners, RF terminals, mobile computers, wireless LANs, and potentially RFID to monitor the flow of products. Several WMS providers now support RFID data entry in their software. Companies use WMS to store information for marketing, sales and manufacturing to help manager run the organization more effectively. In today's logistics industry the ability to manage and effectively present the volume of data tracked is the cornerstone of warehousing.

EMERGING TECHNOLOGIES

Today, software plays a major role in successful warehouse operations. Most equipment that is purchased requires some type of computer interfacing. In terms of both the system used in warehouse manager and customer must be current and accurate information. Internet technology allows warehouse managers to receive orders more expeditiously and allows them to track the inventory connected with those orders. There are some drawbacks, however. Because the Internet has provided a lower cost way of placing an order, warehouses are experiencing more frequent, smaller quantity orders [17], [18]. The emerging technologies in warehouse management system as follow [3]:

XML Communication; extensible Markup Language, is a communications means where trading partners can define and exchange information in a collaborative format. Most information that is described in EDI can be described in XML, EDI supports semantics and significant processing framework such as security and message acknowledgement. XML brings to the WMS technology is the capability of integration and exchange with other partners, suppliers, or customers' systems as well as ERP or other planning systems through the Internet.

Web Visibility; allows the users to access information such as receipts status, shipment dates, and inventory status remotely through the Internet. This Web enabling capability is also allowing several vendors to host their WMS without physically implementing the software at a customer site.

Supply Chain Execution (SCE) Integration; integration brings a benefit to the customer by reducing custom interface development with increased functionality. Among the more popular SCE integration offerings are the following

- **Labor Management;** providing workload productivity analyses, performance measurements, engineered standards, and other information to identify areas for improvement in the DCs
- **Slotting**; optimizes the location of products in the warehouse by using mathematical techniques based on such criteria as product movement frequency, family, size, grouping, and other relevant parameters
- **Transportation Management System (TMS);** provides the distribution systems with visibility to their inbound shipment and allows for tracking of the outbound deliveries. Economic order consolidation and load building.
- **Yard Management;** assists the warehouse manager in reducing bottlenecks by scheduling inbound and outbound freight and feeding.
- **Order Management**; is used in smaller warehouses when the business system, order entry, product allocation, and delivery can be performed via one software system.
- **Advance Planning and Scheduling (APS);** offers is an extension outside of the four walls by providing visibility to operational attributes such as costs, availability, current and forecast utilization, forecasted demand, and other planning factors. The system provides opportunities for the Distribution (DC) manager to improve planning and utilization of the DC capacity, labor requirement, and overall operation.
- **Material Handling Integration;** provides a bridge between the WMS and material handling equipment such as carousels, conveyors, palletizzers, and sortation trays.

Additionally, mobile WM software that works on any web-enabled device. Mobile WM software applications that have traditionally been built to work on rugged hand-held mobile computers are likely to be replicated to work on other web enabled devices. They may even become platform agnostic. It has already seen examples of companies ruggedising the Apple Ipad to use them to access their WM software system whilst driving fork lifts. This is economically feasible because the cost of consumer devices is significantly lower than their enterprise alternatives due to the quantities produced. Business owners and top management can already access web-based stock control software system reports via devices like the Apple Iphone and models on the Google Android platform. The next following years, mobile stock control technology will enter onto other devices and enabling warehouse managers to monitor their warehouse wherever they are [19].

MAJOR WAREHOUSES IN TURKEY

Many Companies provides effective warehouse activities and solutions for companies from different goods such as textile, medical, electronic, food etc. in Turkey. The warehouse development strategy is based on an individual approach towards clients' needs. According to the Fortune Magazine research in 2011, Netlog Logistics, is the first rank in the Fortune 500 ranking in Turkey in terms of logistics and warehouse sectors [20]. In 2009, Botaş, Netlog, Borusan are the first to three ranking in the Fortune 500. The ranking list continues with the following companies such as Ekol Logistics, Omsan Logistics, Reysaş Logistics, Mars Logistics,and Sdv-Horoz Logistics[21].

Ekol Logistics offers customized solutions to its customers based on the consumer evaluation with the warehouse strategy. Increasing the number of variants managed through the IT infrastructure, recognizing the human power as a qualified source, inspecting and improving the automation systems designed to replace ordinary labor force [22]

Omsan Logistics meets the short and long-term storage needs of their customer with its added value services at bonded and non-bonded warehouses with total capacity of 140.000 sqm ve 75.000 pallets at 15 locations in İstanbul, Ankara, Bursa, İzmir and Paris. In Omsan warehouses, FIFO, FEFO, LIFO, lot and series number tracking, production and expiry date criteria are worked with necessary barcode controlled processes and operations and customers may be furnished with 7/24 web based stock data. Their customer customers may track online the fixed and variable costs incurred in the warehouse and it can approve and report them accordingly [23].

Mars Logistics strive to reduce total operational costs and improve processes along the customer supply chain structure. With this objective we offer customers pre-production (inbound) and post-production (outbound) warehousing services They have also Bonded warehouse, involve the retention of goods, which have entered Turkish borders from abroad but haven't yet been granted free circulation. Transit, export and transfer services are provided in bonded warehouses. Yenibosna logistical headquarters is one of the largest bonded warehouses under jurisdiction of Halkalı Customs Administration with 8,000 m^2 closed space. Mars Logistics' Textile and General Entry bonded warehouses can handle the simultaneous loading and unloading of 35 vehicles. Our experienced personnel and technologically advanced multi-equipment capacity is capable of offering customers high quality, fast and efficient service. We provide flexibility to the varying requests and needs of customers shaped by product specifications within scope of bonded warehouse regime regulations [24].

Barsan Global Logistics provides customs bonded and non-bonded warehousing services based on customer requirements throughout Turkey. Existing warehousing capacity of 5.800.000 m^3 with 380.000 m^2 covered area on a land of 1.311.000 m^2 in total spread over the main arteries of industry and commerce in Turkey. All BGL warehouses are designed to utilize the space in m^3 most efficiently instead of the area in m^2 by having high shelves with narrow aisles and steel construction multi-store design. This enables minimizing the unit storage costs hence providing cost advantages to BGL customers to have an edge in their competitive markets. Stock management at BGL is provided in an efficient and reliable manner by means of technology Goods are placed to stock shelf locations with addresses defined by BARSIS Stock Management Module [25].

Automated data collection in the WMS It increases the effectiveness of the service provided to the customer by reducing the cycle time. Inventory reduction and increased storage capacity are less likely. The level of safety stock can reduced while increasing the efficiency of the system [26]. As a result, customer services like first-in-first-out, cross-docking, order tracking and automated material handling are some of the area that finds an increase in the efficiency in Turkey. There are many more companies offering warehouse and warehouse management solution to their companies, the above mentioned are the top players in Turkey. Warehouses perform value added roles in terms of saving cost and service benefits.

CONCLUSION

Nowadays all transportation and logistics companies have vital assets such as vehicles and warehouses-that guarantee the delivery of quality, flexible services. Recent infrastructure improvements that helped the industry include a wave of new regional logistics distribution centers, logistics regions, modern warehouses and improved distribution facilities. WMS is a powerful, feature-rich solution for automating the materials-handling processes of retailers, manufacturers, distributors and third-party logistics providers. By integrating advanced radio-frequency and barcoding technologies with core warehousing functionality, would reduce the cost in the labor and increases the accuracy of the data.

WMS occupies greater visibility into order, inventory, and task statuses inside the warehouse. And they expect improved productivity to support sales growth, channel expansion, and increasingly tailored fulfillment services for customers. The effective management of your warehouse and fulfillment/distribution operations is critical to the ongoing success of business. In today's tight economy, there is significant pressure to use the WMS. The key to a company's success is customer satisfaction. Customer satisfaction is largely based upon the ability to control the warehouse. A WMS will allow companies to control and optimize a warehouse's operating efficiency. Therefore, a key to achieving customer satisfaction and assuring the company's long-term success is the proper implementation and utilization of a quality WMS.

REFERENCES

[1] http://en.wikipedia.org/wiki/Warehouses.

[2] www.nos.org/Secbuscour/cc11.pdf.

[3] Tompkins Associates, Warehouse Management Systems Technologies: Transforming Customer Satisfaction Through Better Inventory Management, Total Operations Excellence, Worldwide Central Campus, http://www.idii.com/wp/tompkins_wms.pdf.

[4] www.en.wikipedia.org/wiki/Pallet_rack.

[5] http://en.wikipedia.org/wiki/mezzanine_%28architecture%29.

[6] http://en.wikipedia.org/wiki/AS/RS.

[7] Ackerman, In warehousing forum, v. 19, n. 11, October 2004. http://www.warehousing-forum.com/kb_v19n11_oct2004.pdf.

[8] Saddle Creek Corporation, 2010, Distribution Network Trends Report, White Paper Series,http://www.logisticsmgmt.com/article/2010_distribution_network_trends_report/warehouse.

[9] Sheffi, Y., 1990. Third party logistics: present and future prospects. Journal of Business Logistics 11 (2), 27-39

[10] Min, H., Foo, S.F., 2006. Benchmarking the operational efficiency of third party logistics providers using data enveloped analysis. Supply Chain Management: an International Journal 11 (3), 259-265

[11] Schroeck, Michael J., 2000 "E-Analytics—The Next Generation of Data Warehousing," DM Review August 2000. <http://www.dmreview.com/master.cfm?NavID=55&EdID=2551>.

[12] Haisten, Michael, 2000). "Real-Time Data Warehouse: What is Real Time about Real-Time Data Warehousing?," DM Review Online August 2000.

[13] Christopher, M., 2000. The Agile Supply Chain: Competing in Volatile Markets, Industrial Marketing Management 29 (1), 37-44

[14] Forrester, J., 1958. Industrial Dynamics, Harvard Business Review (July–August), 37-66

[15] PeopleSoft,2000.'EnterpriseOne 8.10 Warehouse Management, PeopleBook, 2004 http://download.oracle.com/docs/cd/B28732_01/jded/acrobat/e1-scm810wm0504.pdf.

[16] SAP Transportation Management Solution, 2000. SAP Incorporated, http://help.sap.com/printdocu/core/print46c/en/data/pdf/LEWM/MMWM.pdf.

[17] Szgenda, R., 1999. Information_s competitive edge. InformationWeek 720, 4-10

[18] Lattmann, P., 2000. WMS: Lower costs, more options for growing companies. ID Systems 8, 1-10

[19] Rhodes,O. 2010 http://www.peoplevox.co.uk/warehouse-management-system-wms-070/.

[20] http://www.netlog.com.tr/.

[21] http://www.fortuneturkey.com/fortune500-2009/fortune500_sektorlere_gore.asp.

[22] http://www.ekol.com/en/warehousing.

[23] http://www.omsan.com.tr/en/sayfa.php?id=10&warehouse-management.

[24] http://www.marslogistics.com/en/mars_logistics_warehousing_and_distribution_services.aspx.

[25] http://www.barsan.com/index.ph8p?id=23&L=1.

[26] http://www.management-hub.com/.

WAREHOUSE DESIGN: A COMPREHENSIVE LITERATURE REVIEW

İsmail Karakış[1], Murat Baskak[2], Mehmet Tanyaş[3]

Abstract *— Warehouses are essential components of any supply chain in terms of customer service and cost levels. In this paper, the studies that contain problems, solution methods and/or approaches related to warehouse design will be classified in the light of a comprehensive literature review. First, the studies are classified into three levels as strategic, tactical, and operational according to the problem types from warehouse design perspective. After that, they are classified based on the topics or areas defined under each of these levels. The purpose of this study is the indication of important gaps on warehouse design based on this review.*

Keywords — Warehouse design, warehouse management, warehouse performance evaluation

INTRODUCTION

Warehouses are essential components of the supply chains [1]. They are one of the important players in the success or failure of the businesses from not only customer service levels perspective, but also the cost perspective [4]. Warehouses have several major roles; enabling a buffer for the material flow along the supply chain due to the variability caused by seasonality, batching, transportation, and a value-added service place such as kitting, labeling, and stamping. When market competition is added to this situation, warehouses, as an important role player of supply networks, need to have a continuous improvement in the design and operations to get higher performance from the warehouses [1]. Because of the increase in labor costs, allocating more people for any warehouse performance problem is not a viable solution [5]. Therefore, these improvement efforts result in the adoption of new management philosophies; tighter inventory control, shorter response times, as well as the new technology implementations like bar coding, radio frequency communications (RF), warehouse management systems (WMS), automatic storage and retrieval systems (AS/RS) [1], [5]. All these solutions have a very significant cost impact. Because of that reason, such logistics costs related to warehouses should be very well managed, in other words warehouses should function cost effectively [4]. And these cost drivers are in fact determined during the design phase [2].

Warehouse Design is to make decisions for different design parameters in order to satisfy the objectives in terms of costs and/or performance of the warehouse. In the literature, a structured design approach of decision making at a strategic, tactical, and operational level in which there are multiple interrelated decisions. And for each level, the problems are defined using three axes; processes (receiving, storage, picking, shipping, etc), resources (storage unit, storage system, pick equipment, WMS, etc), and organization (process flow, storage policy, order picking policy, etc) [2]. For instance, selection of storage strategy is a strategic decision that affects the warehouse design [1].

On the other hand, there is a framework for warehouse design problems as shown in Figure. 1. This framework of warehouse design has five major decisions regarding the warehouse design problems. Determining the overall structure means conceptual design that determines the material flow pattern within the warehouse, the specification of the functional departments, and the flow relationships between them. The sizing decisions determine the size (capacity) and dimensions (translation of capacity into floor space). Department layout is the detailed configuration like aisle configuration in the retrieval area, configuration of AS/RS. The equipment selection is for determination of the automation level of the warehouse in terms of storage, transportation, order picking, and sorting. Operation strategy determines how the warehouse will be operated in terms of whether randomized storage or dedicated storage will be used, or whether or not to use zone picking [1], [3].

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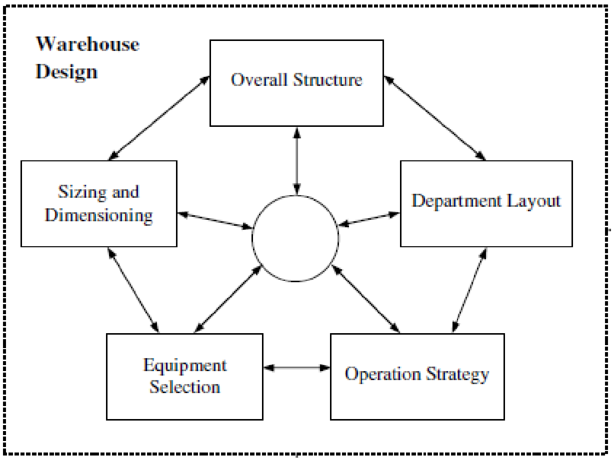

FIGURE. 1
Warehouse Design Problems Framework

A conceptual design; data acquisition regarding the warehouse and then functional and technical high level descriptions of a warehouse are the strategic level of the warehouse design. Based on the technical details determined during the strategic level, equipment selection and internal layout determination of the warehouse are considered as the tactical level. Operational level includes the planning and control policies for the daily processes of the warehouse.

Besides, there are another two approaches for the warehouse design. First is top-down approach with limited details, roughly design at first glance and then branching into the details. Second is the reverse of the first; bottom-up approach [2].

This paper is aimed to provide a comprehensive literature review regarding the warehouse design. It also develops a classification for different kinds of warehouse problems from a systematic and structured approach. In terms of strategic approach, first the studies in the literature are classified into three hierarchical levels; strategic, tactical, and operational. Although both references [1], [2], and [3] do not consider the problem of a warehouse location as a part of warehouse design, this paper treats it as a part of strategic level decisions and will mention recent key studies in the following sections.

AIM AND FOCUS OF THE STUDY

The purpose of the study is to classify the studies related to warehouse design problems through a comprehensive systematic literature review. This paper mainly focuses on the literature review for the design phase of the warehouses. The studies reviewed classified according to the methods and/or approaches as well. The paper seeks a kind of systematic and/or structured approach for the warehouse design phase entirely. Despite the fact that there are several studies regarding the problems of the warehouse design, there is a lack of study on systematic approach and/or methodology [2].

METHODOLOGY

A comprehensive literature review was conducted in terms of articles from journals using library facilities. Searching was done a range of electronic databases including Emerald Insight, EBSCO Host, Science Direct, Springer Link, and Taylor & Francis Journal. These databases were searched using relevant keywords, especially “warehouse” combined with “design”. The references [1], [2], and [3] were taken as starting point of the study as well as the recent leading research papers on each topic given in the following section.

LITERATURE FOR WAREHOUSE DESIGN

The studies in the literature are firstly classified into three levels as strategic, tactical, and operational according to the problem types from warehouse design perspective. It is realized that one study may focus on more than one topics under the same or different hierarchical levels. This is due to warehouse design problems are strongly hard coupled [3]. In other words warehouse design should consider large number interrelated decisions [2].

Strategic Level

The strategic level warehouse design studies are mainly focusing on the technical (process flow, main system types) and economic (minimum investment or operational costs) performance of the warehouses [2]. This paper considers the following topics under strategic level:

- "Warehouse design methodology", is a methodology and/or systematic approach for the design of the overall structure of warehouse [3].
- "Warehouse location selection" deals with the efficient strategic investment decision for the location of the facility [25].
- "Sizing" is the defining the storage capacity of the warehouse [3].
- "Dimensioning" is the translation of the sizing into floor space in order to assess the construction and operating costs [3].
- "AS/RS design" addresses the physical design and control issues to take the full advantages in terms of performance (e.g. travel time, response time, throughput, etc.) for AS/RS that usually consists of racks served by cranes moving through aisles between racks [21].
- "Storage system design" deals with the design of the warehouse resource called storage system that consists of multiple subsystems to store the different types of products [2], [14].

Tactical Level

The tactical level warehouse design studies are mainly focusing on the following topics:

- "Equipment selection" is the determination of the level of automation within the warehouse. It tries to find out the types of storage and material handling systems [2], [3].
- "Storage policies" are set of rules that determine where the unit loads of different products will be located in the warehouse. It can be treated as optimal when the average time required for storage and retrieval of a unit load minimized while the constraints are satisfied [27]. Storage policies are important decisions and mostly there is a need for trade-off between the different policies [26].
- "Organization" addresses the organizational issues from human capital management perspective [2].
- "Order picking" is the design of the order picking systems that have several important questions at tactical level [7], [8], [11]. Since it is a very common activity in a warehouse, it is the second most important topic after the overall structure design of a warehouse. In this stage, general high-level design and functional specifications are determined. It affects on the operational level topics stated below.

Operational Level

The operational level warehouse design studies are mainly focusing on the following topics:

- "Receiving and shipping" refers to incoming and outgoing material flow [1], [2].
- "Batching" is grouping decision of the orders [29]. It is the partition of orders where each partition called as batches to be picked and shipped. It is a part of planning for order picking [1].
- "Sorting" refers to the picking of the multiple orders together [1].
- "Dwell point determination" is the selection of dwell point which is the position of storage and retrieval system where it stops when the system is idle [1]. This positioning by a properly selected policy will reduce the travel time [30].
- "AS/RS operations" refers to problems related to the operational side of AS/RS like determining the storage rules as cube-per-index (COI) rules, and travel time models related to other aspects of performance [31].
- "Storing, routing, and sequencing" refer to the routing policies, sequencing procedures during the order picking. This decision determines the best sequence and route of locations for picking of a set of given items [1].

Methodology

The methodologies of the reviewed research papers are categorized as well. The methods are classified as "A-Analytical" for mathematical and optimization models, quantitative techniques. The studies use heuristics classified as general "H-Heuristics" or "MH-Metaheuristics" based on the heuristics used. The papers that used simulation models are indicated as "S-Simulation" and the ones that use conceptual models like case studies, general approach, or benchmarking are evaluated as "K-Conceptual". The methods classification done based on the objectives of the models as "T-Single" or "C-Multi-objective" models. For the models that use probability distributions or random variables are indicated as "P-Probabilistic" models while the ones that have every set of variables determined by parameters as "D-Deterministic". If all sets of data is ready at the beginning of the model execution, the model is indicated as "S-Static" while the methods that generate the data within the execution phase and/or require the input/decision from the modeler at a further stage are considered as "D-Dynamic" models like simulation or interactive methods.

In the light of this information, the classification is given in Table 1 based on the frequency. In this table, the structure of the classification is given as; "subtopic(s) / the methodology (A, H, MH, S, or K) / the details of the methods (T or C-P or D-S or D)" for totally 170 studies. Table 2 shows the frequency of the 39 studies that have no sufficient information on hand for this classification (i.e. full text is not reached out) in the same manner, and Table 3 gives the details for 34 studies whose neither abstracts nor full texts are reached out.

FINDINGS OF THE LITERATURE REVIEW

As seen the tables for research papers given below, there are 37 studies seen that deal with purely strategic level decisions. With regards to warehouse design methodology, there are 11 studies reviewed in the literature. These studies are mainly proposing conceptual approaches like case study analysis, step-wise design method used in reference [9], or benchmarking as used in the reference [10]. There are also studies that use analytical models validated via simulation. Reference [12] uses mathematical models to analyze travel time while reference [5] uses a hierarchical approach that utilizes a number of mathematical models to evaluate the economic tradeoffs. Data envelopment analysis is another used methodology to measure the performance of a distribution center [13].

It is clearly seen that there are only a few studies regarding the systematic warehouse design. Moreover, warehouse design software is a gap because there is only one study that proposes software, CAD model for warehouse design [3], [23].

Recent studies for warehouse location selection use multi-criteria decision making methods. For the sizing problems, analytical methods like linear programming are widely used. It seems that sizing models employ cost models so validation of these studies should be done [3].

Dimensioning and AS/RS design are two most studied topics of the strategic level. For dimensioning, reference [22] presents a mathematical model for the joint solution for two problems; product allocation to the functional area and the size of each area in a way that minimizes the total material handling costs. Another study seeks for the optimality for shared storage policy, successive storage of units of different products in the same location [27]. Reference [15] uses a non-linear mixed integer programming to optimize AS/RS design while analytical model is used for travel time modeling in order to get maximum throughput [16], [17], [18]. Simulation is used for AS/RS design as well [19]. For storage system design problems, it is observed that mainly conceptual methods are used. And there is no study for dimensions of dock areas.

Regarding the AS/RS design, the research areas should move to develop models, algorithms, and heuristics for the design of non-conventional AS/RS like multi-shuttle. Moreover, there is no study regarding the dwell point selection for them either [21].

For the warehouse layout problem, it is observed that besides single-level warehouses, there are only a few studies for especially multi-level warehouses which make sense for the areas that have limited space [25]. Besides, the recent studies use the multi-criteria decision making methods [24].

Strategic level problems are really complex and have a large set of alternatives. Therefore, especially the systematic warehouse design problem itself is not so flexible to quantify. Because of that reason optimality is often practically impossible [2].

With regards to tactical level, there are 74 studies with related topics that fall into this level. There are a few studies that presents equipment selection problem. These studies use mainly conceptual and/or qualitative methods for the problem. Due to this fact, it can be said that there is no any analytical or quantitative methods regarding how to identify the equipment alternatives reasonable for given storage/retrieval requirements, or how to select among the alternatives. Therefore, there is a need to develop a method for characterizing requirements and equipment [3]. Besides, there is a need to have models to assist the AS/RS type selection [21].

For storage policy problems, there are many research papers in the literature. It is realized that this problem is the most studied one under tactical level. Analytical methods and their validations with simulation are widely used for this problem like in the reference [26]. Heuristics, simulation, and conceptual models are other methodologies used.

Order picking problem is the second frequently researched problem since it is the most costly activity in the warehouse [20]. Analytical models and conceptual models are most preferred methods. For organization, there is no significant study in the literature. Especially for determination of number of the personnel, there is a gap in the literature [2]. It seems that there is only one research paper that integrates the tactical level warehouse design decisions with the inventory planning decisions [6].

For operational level, there are 96 studies focusing on operational level problems with all related areas of higher levels including the literature review papers. 56 studies purely focus on the operational level decisions. There are a few studies focusing on receiving and shipping. The problems about this area are; assigning the trucks to docks, scheduling the services of the trucks assigned to a dock based on the cost models. The large number of the studies focuses on trucks and dispatching rather than the operations of an individual dock area or freight yard [28].

For batching, there are significant number of studies which use heuristics, and simulation models to validate these heuristics. There are only a few studies regarding sorting operations that use analytical models to minimize the time or maximize the throughput. Dwell point selection is also studied with heuristics, and simulation mainly.

AS/RS operating is the most studied topic. Analytical models are widely used to get optimal solutions for cube-per-order index rules, response times, travel times for maximum throughput, sequencing, etc. Heuristics are another commonly used method, and simulation is the third widely used method for the same subject.

Storing, routing and sequencing are the secondly most studied subjects. Analytical models are more frequently used than heuristics for the problems stated under this section as route determination and analysis, storage area assignment with minimum order pick cost, storage location assignment, etc. Besides, simulation is used for both validating and evaluating these different methods.

Most studies are related to storage and picking in general, especially routing and sequencing since these two functions have the largest impact on the overall warehouse operational performance including storage capacity, space utilization, and order picking efficiency. When there are multiple candidate locations available for the retrieval or storage of SKU, storing problem becomes more interesting and challenging [1].

TABLE 1
Research Papers for Warehouse Design

Classification	Frequency (# of studies)
Warehouse design methodology / K	4
Warehouse design methodology / A / C-P-S	1
Warehouse design methodology / A / T-D- S	1
Warehouse design methodology / A,S / T-P-D	1
Warehouse design methodology + order picking / K	3
Warehouse design methodology + order picking / A / C-D-S	1
Warehouse location / A / T-P-D	2
Warehouse location / MH / T-D-D	1
Sizing / A / T-P-S	2
Sizing / A / T-D-S	2
Sizing / A / T-P-D	1
Dimensioning / K	1
Dimensioning / H / C-D-D	1
Dimensioning / S / C-P-D	1
Dimensioning /A / C-P-S	1
Dimensioning / A, S / T-P-D	3
Dimensioning / A, S / T-D-S	1
Dimensioning + AS/RS Design / A,S / T-D-S	1
Dimensioning + AS/RS Design / H / T-D-D	1
Dimensioning + AS/RS Design + order picking / A / T-P-S	1
Dimensioning + storage policies + AS/RS operating / A,S / T-P-D	1
Dimensioning + storage policies / A / T-D-S	1
Dimensioning + storage policies / A, H / C-D-D	1
Dimensioning + storage policies / MH, S / T-P-D	3
Dimensioning + order picking / A / C-P-S	1
Dimensioning + receiving & shipping / A / T-D-S	1
Dimensioning + receiving & shipping / A, S / T-P-S	1
AS/RS design + order picking / A / C-P-D	1
AS/RS design / S / C-P-D	2
AS/RS design / A / T-P-S	3
AS/RS design / A / T-D-S	1
AS/RS design / A / T-P-D	1
AS/RS design / A / C-P-S	1
Storage system design / K	2
Storage system design + storing, routing, sequencing / MH, S / T-P-D	1
Equipment selection / K	1
Storage policies / A / T-D-S	3
Storage policies / A / T-P-S	3
Storage policies / A / C-P-D	1
Storage policies / A, H / C-D-D	1
Storage policies / A, H / T-D-D	1
Storage policies / A, H / T-P-D	1
Storage policies / H / T-D-D	4
Storage policies / H / T-P-D	1
Storage policies / H / C-P-D	1
Storage policies / H, S / C-P-D	1
Storage policies / K	2
Storage policies / MH / T-P-D	1
Storage policies / S / T-P-D	1
Storage policies + order picking / A / C-P-D	1
Storage policies + batching / MH, S / T-P-D	1
Storage policies + AS/RS operating / A / T-P-S	4
Storage policies + AS/RS operating / A / T-D-D	1
Storage policies + AS/RS operating / A / C-P-S	3
Storage policies + AS/RS operating / A, S / T-P-D	1
Storage policies + AS/RS operating / H, S / T-D-D	1
Storage policies + AS/RS operating / MH, S / T-P-D	1
Storage policies + AS/RS operating / S / T-P-D	2
Storage policies + AS/RS operating / S / C-D-D	1

Storage policies + AS/RS operating / S / C-P-D	1
Storage policies + AS/RS operating / S, H / T-P-D	1
Storage policies + order picking + sorting, routing, sequencing / A / T-P-D	1
Storage policies + order picking + sorting, routing, sequencing / A / T-P-S	1
Storage policies + order picking + sorting, routing, sequencing / S / T-P-D	1
Storage policies + dwell point determination + sorting, routing, sequencing / S / C-P-D	1
Storage policies + storing, routing, sequencing / S / T-P-D	2
Storage policies + storing, routing, sequencing / K	1
Order picking / A, H / T-P-D	1
Order picking + sorting / A,S / T-P-D	1
Order picking + storing, routing, sequencing / A / T-P-S	1
Order picking + storing, routing, sequencing / S / T-P-D	1
Order picking + storing, routing, sequencing / A, H / C-D-D	1
Order picking + storing, routing, sequencing / MH / T-D-D	1
Receiving & shipping / A / T-D-S	1
Receiving & shipping / A / T-P-D	1
Receiving & shipping / A / C-D-D	1
Batching / A / T-P-D	1
Batching / A, H / C-D-D	1
Batching / H / T-D-D	2
Batching / H / C-P-D	1
Batching / MH / T-P-D	3
Batching / S / C-P-D	1
Batching + AS/RS operating / H / T-P-D	1
Batching + AS/RS operating / H / C-P-D	1
Batching + AS/RS operating / H / T-D-D	1
Batching + AS/RS operating / A, S / T-D-S	1
Batching + AS/RS operating + storing, routing, sequencing / H / T-D-D	1
Batching + storing, routing, sequencing / H / T-D-D	1
Batching + storing, routing, sequencing / H / T-P-D	2
Sorting / A / T-P-S	1
Sorting / A / T-P-D	1
Sorting / A / C-P-D	1
Dwell point determination / A / T-D-S	1
Dwell point determination / A / T-P-D	1
Dwell point determination + AS/RS operating / MH / T-D-S	1
Dwell point determination + AS/RS operating / S / T-P-D	1
Dwell point determination + AS/RS operating / H / T-D-D	1
Dwell point determination + AS/RS operating / A / T-P-D	1
AS/RS operating / K	1
AS/RS operating + storing, routing, sequencing / A / T-P-S	4
AS/RS operating + storing, routing, sequencing / A / T-D-S	3
AS/RS operating + storing, routing, sequencing / H / T-P-D	2
AS/RS operating + storing, routing, sequencing / H / T-D-D	2
AS/RS operating + storing, routing, sequencing / H, S / T-P-D	1
AS/RS operating + storing, routing, sequencing / MH / T-P-D	2
AS/RS operating + storing, routing, sequencing / MH / T-D-D	2
AS/RS operating + storing, routing, sequencing / MH / C-P-D	1
Storing, routing, sequencing / A / T-P-S	1
Storing, routing, sequencing / A / T-D-D	1
Storing, routing, sequencing / H / T-D-D	1
Storing, routing, sequencing / H, S / T-P-D	1
Storing, routing, sequencing / MH / T-P-D	2
Storing, routing, sequencing / MH / T-D-D	1
Storing, routing, sequencing / MH, S / T-D-D	1
Storing, routing, sequencing / S / T-P-D	1
Warehouse Design / K / Literature Review	6
Warehouse Operations / K / Literature Review	3
AS/RS / K / Literature Review	1

TABLE 2

Research Papers with insufficient information to be classified in greater details

Classification	Frequency (# of studies)
Sizing / A	3
Dimensioning / A	3
Dimensioning + AS/RS design / A	2
Dimensioning + storage policies / A	1
AS/RS design / A	1
AS/RS design / S	2
AS/RS design + storage policies + dwell point determination + AS/RS operating + storing, routing, sequencing / S	1
Storage policies + AS/RS operating / A	1
Storage policies + AS/RS operating / S	1
Storage policies + AS/RS operating / H	1
Storage policies / A	3
Storage policies / H, S	1
Storage policies / A, H	2
Storage policies + storing, routing, sequencing / H	1
Order picking / A	1
Order picking / A, H	1
Batching / A	1
Batching + AS/RS operating / S	1
AS/RS operating / H	1
AS/RS operating + storing, routing, sequencing / A	2
AS/RS operating + storing, routing, sequencing / H	1
AS/RS operating + storing, routing, sequencing / H, S	1
AS/RS operating + storing, routing, sequencing / MH	1
AS/RS operating + storing, routing, sequencing / MH, S	1
AS/RS operating + storing, routing, sequencing / S	2
Storing, routing, sequencing / A	1
Storing, routing, sequencing / A, H	1
Storing, routing, sequencing / MH	1

TABLE 3

Research Papers with no detailed information to be classified

Year	Author(s)	Title
1988	J. Ashayeri, M. Goetschalckx	Analysis and design of order picking systems
1994	G.P. Sharp, R. Kittell, K. Hollender	Economics of storage/retrieval systems for item picking
1991	R. Schmidt	Satellitenlagersysteme - leistungsbestimung und betriebsstrategein
1985	I. Mardix, G.P. Sharp	Cost and efficiency analysis of the carousel storage system
1990	G.P. Sharp, J. Eckert, D. Gibson	Order picking using horizontal carousels
1996	D. Spee	Automated order picking system with horizontal racks
1996	H. Stadtler	Optimal dimensions for automated storage/retrieval systems
1985	Y.A. Bozer, G.P. Sharp	An empirical evaluation of a general purpose automated order accumulation and sortation system used in batch picking
1988	Y.A. Bozer, G.P. Sharp, M.A. Quiroz	An evaluation of alternative control strategies and design issues for automated order accumulation and sortation systems
1991	Y.A. Bozer, G.P. Sharp, M.A. Quiroz	Throughput analysis of order accumulation and sortation systems
1991	G.P. Sharp, R. Kittell, K. Hollender	Conveyor input/output systems for pallet AS/RS
1996	G. Grossman	Development of a mobile handling robot for packages
1996	G. Sharp, R. Handelsmann, D. Light, A. Yeremeyev	Productivity and quality impacts of pick-to-light systems
1996	L.M. Bunde, R.J. Graves	The multi-liner palletizer material flow problem
1979	W.H. Marsh	Elements of block storage design
1983	Y. Roll, M.J. Rosenblatt	Random versus grouped storage policies and their effect on warehouse capacity
1985	J.J. Bartholdi, III L.K. Platzman	Design of efficient bin numbering schemes for automated warehouse carousel storage systems
1988	M. Yang	Analysis and optimization of class-based dedicated storage systems
1996	J. Ashayeri, R. Heutz, H.C. Veraart	A new approach for the determination of expected traveling time in an AS/RS under any assignment policy
1996	H. Stadtler	An operational planning concept for deep lane storage systems
1989	M. Guenov, R. Raeside	Real time optimization of man on board order-picking
1987	G. Cormier	On the scheduling of order-picking operations in single-aisle automated storage and retrieval systems
1985	Y.A. Bozer	Optimizing throughput performance in designing order picking systems
1963	J.L. Heskett	Cube-per-order index - a key to warehouse stock location
1964	J.L. Heskett	Putting the cube-per-order index to work in warehouse layout
1987	Y. Roll, M.J. Rosenblatt	Shifting in warehouses
1973	T. Gudehus	Principles of order picking: operations in distribution and warehousing systems
1988	M. Goetschalckx, H.D. Ratliff	Sequencing picking operations in a man-aboard order picking system
1987	M.H. Han, L.F. McGinnis, J.A. White	Analysis of rotary pack operation
1967	R.L. Francis	On some problems of rectangular warehouse design and layout
1965	J.J. Moder, H.M. Thornton	Quantitative analysis of the factors affecting floor space utilization of palletized storage
1996	H.A. Zollinger	Expanded methodology to concept horizontal transportation problem solutions
1981	J.A. White, N.A. DeMars, J.O. Matson	Optimizing storage system selection
1981	J.O. Matson, J.A. White	Storage system optimization

CONCLUSION

Warehouses are essential for any supply chain. Since the most of the parameters that affect the warehouse operations in terms of both costs and performance determined during the design phase, warehouse design is becoming more crucial day by day.

It is obvious from the results of the study that there are lots of studies regarding the operational level. However, for tactical level, the number of the studies are less than operational level ones. Strategic level studies are significantly less than the tactical level research papers. Therefore, this paper asserts that there is a need to focus on warehouse problems at strategic level since there are no significant number of studies on that area. Furthermore, besides the strategic level problems, there are only a few studies on warehouse design methodology. And based on these studies, it is obvious that although there is a general concensus on the overall structure of the approaches there is less concensus on the tools used for warehouse design [4].

With regards to methodologies used, analytical models are widely used in 77 studies for warehouse design, surely validated with heuristics and simulation models. Heuristics and Metaheuristics are the second common method used as it is seen that 51 studies use these methods. Conceptual models, literature reviews included, are mentioned in 25 studies which are mainly related to strategic level topics. There are 17 studies that use simulation models as a primary tool in the literature. As stated in reference [32], the combination of analytical models and simulation is the most practical approach for warehouse design optimization related topics.

It seems that there is not any research paper on determining the number of personnel and allocation or assignment of them to the work items [2].

Another conclusion is that the gap between academic research and practical application [4]. As stated in reference [1], although there are many studies that use different techniques like simulation to validate the models, there is not much studies that validate the models by applying them in practice.

REFERENCES

[1] Gu, J., Goetschalckx, M., McGinnis, L. F., 2007, "Research on Warehouse Operation: A Comprehensive Review", European Journal of Operational Research, vol.177, pp.1-21

[2] Rouwenhorst, B., Reuter, B., Stockrahm, V., van Houtum, G. J., Mantel, R.J., Zijm, W.H.M., 2000, "Warehouse Design and Control: Framework and Literature Review", European Journal of Operational Research, vol.122, pp.515-533

[3] Gu, J., Goetschalckx, M., McGinnis, L. F., 2010, "Research on Warehouse Design and Performance Evaluation: A Comprehensive Review", European Journal of Operational Research, vol. 203, pp.539-549

[4] Baker, P., Canessa, M., 2009, "Warehouse Design: A Structured Approach", European Journal of Operational Research, vol. 193, pp.425-436

[5] Gray, A. E, Karmakar, U. S., and Seidmann, A., 1992, "Design and Operation of an Order-Consolidation Warehouse: Models and Application", European Journal of Operational Research, vol. 58, pp.14-36

[6] Strack, G., Pochet, Y., 2010, "An integrated model for warehouse and inventory planning", European Journal of Operational Research, vol. 204, pp.35-50

[7] Yoon, C.S., Sharp, G.P., 1995, "Example application of the cognitive design procedure for an order picking system", European Journal of Operational Research, vol.87, pp.223-246

[8] Yoon, C.S., Sharp, G.P., 1996, "A structured procedure for analysis and design of order pick systems", IIE Transactions, vol.28, pp.379-389

[9] Duve, B., Mantel, R., 1996, "Logitrace: a decision support system for warehouse design", Progress in Material Handling Research, The Material Handling Industry of America, Charlotte, NC, pp.111-124

[10] Frazelle, E. H., Hackman, S.T., 1994, "The warehouse performance index: a single-point metric for benchmarking warehouse performance", Technical Report MHRC-TD-91-13, Georgia Institute of Technology, Atlanta, GA.

[11] Brynzer, H., Johansson, M., Medbo, L., 1994, "A methodology for evaluation of order picking systems as a base for

system design and managerial decisions", International Journal of Operations & Production Management, vol. 14, no.3, pp. 126-139

[12] Pohl, L., Meller, R. D., Gue, K. R., 2009, "An analysis of dual command operations in common warehouse designs", Transportation Research, vol.45, pp.367-379

[13] Ross, A, Droge, C., 2002, "An integrated benchmarking approach to distribution center performance using DEA model", Journal of Operations Management, vol.20, pp.19-32

[14] Roll, Y., Rosenblatt, M. J., Kadosh, D., 1989, "Determining the size of a warehouse container", International Journal of Production Research, vol.27, pp.1693-1704

[15] Ashayeri, J., Gelders, L., van Wassenhove, L., 1985, "A micro-computer-based optimization model for the design of automated warehouses", International Journal of Production Research, vol.23, no.4, pp.825-839

[16] Pan, C. H., Wang, C. H., 1996, "A framework for dual command cycle travel time model in automated warehousing systems", International Journal of Production Research, vol.34, no.8, pp.2099-2117

[17] Meller, R. D., Mungwattana, A., 1997, "Multi-shuttle automated storage/retrieval systems: analytical models and an application", IIE Transactions, vol.29, no.10, pp.925-938

[18] Hwang, H., Ko, C. S., 1988, "A study on multi-aisle system served by a single storage and retrieval machine", International Journal of Production Research, vol.26, no.11, pp.1727-1737

[19] van der Berg, J. P., Gademann, A. J. R. M., 2000, "Simulation study of an automated storage/retrieval system", International Journal of Production Research, vol.38, no.6, pp.1339-1356

[20] de Koster, R., Le-Duc, T., Roodbergen, K. J., 2007, "Design and control of warehouse order picking: a literature review", European Journal of Operational Research, vol.187, pp.481-501

[21] Roodbergen, K. J., Vis, I. F. A., 2009, "A survey of literature on automated storage and retrieval systems", European Journal of Operational Research, vol.194, pp.343-362

[22] Heragu, S. S., Du, L., Mantel, R. J., Schuur, P. C., 2005, "Mathematical model for warehouse design and product allocation", International Journal of Production Research, vol.43, no.2, pp.327-338

[23] Perlmann, A. M., Bailey, M., 1988, "Warehouse logistics systems - a CAD model", Engineering Costs and Production Economics, vol.13, no.3, pp.229-237

[24] Özcan, T., Çelebi, N., Esnaf, Ş., 2011, "Comparative analysis of multi-criteria decision making methodologies and implementation of a warehouse location selection problem", Expert Systems with Applications, vol.38, pp.9773-9779

[25] Zhang, G. Q., Xue, J., Lai, K. K., 2002, "A class of genetic algorithms for multiple-level warehouse layout problems", International Journal of Production Research, vol.40, no.3, pp.731-744

[26] Malmborg, C. J., 1996, "Storage assignment policy trade-off", International Journal of Production Research, vol.34, no.2, pp.363-378

[27] Ratliff, H. D., Goetschalckx, M., 1990, "Shared storage policies based on the duration stay of unit loads", Management Science, vol.36, no.9, pp.1120-1132

[28] Tsui, L. Y., Chang, C. H., 1990, "A microcomputer based decision support tool for assigning dock doors in freight yards", Computers and Industrial Engineering, vol.19, pp.309-312

[29] Elsayed, E. A., Lee, M. K., Kim, S., Scherer, E., 1993, "Sequencing and batching procedures for minimizing earliness and tardiness penalty of order retrievals", International Journal of Production Research, vol.31, no.3, pp.727-738

[30] van der Berg, J. P., 1999, "A literature survey on planning and control of warehousing systems", IIE Transactions, vol.31, pp.751-762

[31] Sarker, B. R., Babu, P. S., 1995, "Travel time models in automated storage/retrieval systems: a critical review", International Journal of Production Economics, vol.40, pp.173-184

[32] Ashayeri. J., Gelders, L. F., 1985, "Warehouse Design Optimization", European Journal of Operational Research, vol.21, pp.285-294

IN-PLANT LOGISTICS: LITERATURE REVIEW

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Abstract—*The logistics activities in production environment are called in-plant logistics. There are a lot of subjects related with in-plant logistics but there is no classification scheme for it. With the classification scheme, it will be easier to analyze and determine the future research areas. For this aim, firstly, the literature about plant logistics is classified into three main groups and for each group detailed analysis is made. The first group is the warehouses, the second group is the material handling systems and the third and the last main group is the layout and the flows between production units. For each group, the papers are reviewed and analyzed according to their objectives and the solution methodologies used. At the end of the analyses, the fields that need further researches are determined.*

Keywords—Plant logistics, warehouses, material handling, facility layout

INTRODUCTION

Logistics is an extensive subject and there are a lot of studies about it. Plant logistics is one of the parts of the logistics. Reference [1] classifies the logistics in three groups such as the in-bound logistics (from supplier to factory), in-plant logistics (logistics in the factory) and the out-bound logistics (from factory to the customer).

Within this study the scope is plant logistics. For improving the efficiency, plant logistics plays a major role. As [2] claims that if a good material handing system design is accomplished, the cost will decrease between %10 and %30.

There are a lot of academic papers related with some subjects of plant logistics. There is not an academic review classifying plant logistics. While some of the subjects take more attention, others are ignored. With this study, firstly plant logistics is classified into three main groups and then for each group some extractions are made for determining further research areas.

The literature reviews that are made with some part of the plant logistics is usually related with the warehouse management subjects. Some of the literature review studies are as follows:

A classification about warehouse management problem was made by [3]. First of all, they made brief explanations about the types of the warehouses. Then, they presented a hierarchy including design, planning and control subjects faced while constructing the warehouse systems.

Reference [4] presented a literature review about the warehouse design and control problems. They examined the storage systems with three sides. These are processes, resources and organization. Processes are the stages happening before the product enters the warehouse, resources are the required personnel and equipments to operate the warehouse and organization includes the planning and control procedures to manage the system.

The studies about loop-based facility planning and material handling systems were analyzed by [5] to determine the further research areas. The warehouse operation problem was studied by [6] in their literature review. They classified the problem into four basic warehouse operations such as receiving, storage, order picking and shipping. Their aim was to highlight the new research areas for the academics.

Reference [7] analyzed the picking order facilities in the warehouse design studies. Within the scope of design and control of manual picking processes, optimum layout, warehouse assignment methods, routing methods, order batching and zoning were focused. It was concluded that the subjects of the made researches were very specific and that there was a need of design procedures for more general situations.

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It was concluded by [8] that there was not a systematic approach for designing the warehouses based on the information gathered from both the literature and warehouse firms. They classified the related literature into two groups, first one included the design steps as a whole and the other one used the specific tools and techniques.

The rest of the paper is organized as follows: Plant logistics literature is classified into three sub categories in the following section. Then, for each sub category literature review is presented in details and finally conclusion and further research areas are provided.

LITERATURE REVIEW

The in-plant logistics literature can mainly be divided into three groups as it is shown in Figure. 1. These are literature about warehouses, literature about material handling systems and literature about layout and flows.

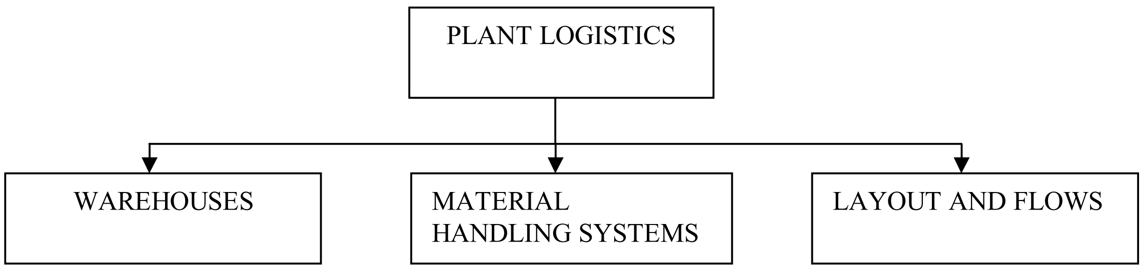

FIGURE. 1
The Sub-subjects of In-Plant Logistics Literature

For each sub-subject, some papers are reviewed and brief information is given about the papers. Table 1 is constructed for classifying the papers according to their subject, purpose and solution method.

Literature about Warehouses

In the literature, there are four main activities that are made in the warehouses. These are receiving, storage, order picking and shipping stages [6]. The papers are mostly written about one or some of these activities.

In their papers, [9] focused on the economic dimensions of the warehouses. In their past studies, the writers presented linear programming formulations when there was high seasonal demand. They both presented solutions for both static and dynamic warehouse problems.

Reference [10] dealt with the sequence of visiting the locations in the order list. They stated that two performance indicators were important in such a situation. One of them was assigning the inventories to the orders and the other one was visiting sequence of the chosen locations. System was modeled like travelling salesman problem.

It was stated by [11] that designing the warehouse to store right quantity of goods was a good operations research problem but these calculations were made roughly. Since these calculations were made roughly, no accurate solutions were gathered. At this point, the writers presented a travel time model with general item location assignment in a rectangular warehouse system.

The minimization of the order picking time was studied by [12] in the warehouses. They determined the factors affecting the travelling time such as warehouse type, warehouse dimensions, number of aisles, layout of the warehouse, order picking vehicle, order list, assignment rules and etc. They specifically analyzed the effect of the layout on travelling time. For the parallel aisled warehouses, they proposed an algorithm and made simulations.

Reference [13] developed control algorithms for managing automatic warehouse systems. For this aim they presented a model executing real time optimizations and increasing the whole performance. To construct their model, they used Colored Timed Petri Nets.

Hybrid heuristics were developed by [14] via combining genetic algorithm and path-relinking for multiple level warehouse layout problems. With their combinations, they developed totally eight algorithms and applied this to multiple level warehouse layout problem.

It was aimed by [15] to develop a performance assessment model for minimizing the travelling distances of the material handling devices used in the warehouses. They both developed a mathematical and simulation model and applied their model on a numerical example.

Reference [16] used an activity based cost model to compare central storage and decentralized storage systems. They presented the advantages and disadvantages of such kinds of storage systems. They applied their methodology on a numerical example. According to their results decentralized storages were better than centralized storages.

A mathematical model was developed by [17] which order picking is optimized in automatic warehouses. They stated that optimizing the order picking in automatic warehouses increased the efficiency. They also developed a genetic algorithm for the mathematical model.

Reference [18] dealt with multiple level warehouse problems. They converted the two dimensions into multiple dimensions in the design problem of the warehouse. The aim of the study was to design a multiple-level warehouse shelf to minimize the annual carrying costs. Since the proposed model was NP-hard. They developed a particle swarm optimization algorithm to solve the problem.

According to the papers analyzed, it is seen that they are mostly about the four main activities of the warehouses such as receiving, storage, order-picking and shipping. Especially, the papers are mostly about order picking and storage. The purposes of the papers are mainly to minimize the distance during order picking, determine optimum dimensions and layout of the warehouse. Most of the solution methods include heuristics. Simulation is also used for the design of warehouses but optimum solution methods are rarely used in such kinds of problems. Instead of real applications, mostly numerical examples are used for the validation of the proposed models.

Literature about Material Handling Systems

While designing the in-plant logistics, material handling systems also play a big role. To use the right vehicle, in the right place, at the right time, with the right method and for the right product are important for the efficiency of the system.

Mainly, the material handling equipments are composed of forklifts, pallet jacks, push-carts, tuggers and trains of tow carts, networks of conveyors and automatic guided vehicles [1]. Some of the papers about material handling systems are as follows.

A conveyor selection problem was studied by [19]. Since there are a lot of alternatives of conveyors, they developed an expert system for choosing the suitable conveyor. The developed expert system is used in two industrial cases and validated.

Reference [20] presented an integrated approach for the operation assignment and material handling system selection in a production system composed of cells. The proposed approach had an iterative property. The aims were to select machine groups, to load the machines to manufacture a given set of part types and to select the most economical material handling devices. Proposed model was successfully applied on a numerical example.

An expert system was developed by [21] for choosing the material handling device. While choosing the material handling device, the efficient use of workforce, providing system flexibility, increasing the efficiency, decreasing the lead times and cost were presented as some important factors. Axiomatic design and fuzziness were also used in the expert system. The developed expert system was applied in a real application.

The material handling scheduling and the production scheduling were integrated by [22]. The machines and material handling devices were regarded as limited sources. Integrated scheduling problem was formulated as a mathematical problem.

Reference [23] proposed a hybrid model for scheduling and routing of automatic guided vehicles in a flexible manufacturing environment. The problem was a hard combinatorial optimization problem. There were two main parts of the proposed model. One of these was the main problem modeled by constraint programming and the other one was the sub problem which was modeled by mixed integer linear programming.

A mixed integer linear programming model was presented by [24] integrating the layout and material handling system's design together. The proposed model was applied in a real facility and good results were obtained in the minimization of the material handling costs.

A two stage analytic approach was developed by [25] to determine the number of material handling equipments between production units. In the first step of the methodology, the loading-unloading of the products, full travelling and empty travelling of the vehicle and the breakdown of the vehicle were taken into consideration. In the second step, as performance measures, the usage situation of the material handling equipment, WIP quantity and product life were used for the ranking of the solutions found in the first step.

For material handling systems literature, the main subject was to select the appropriate material handling equipment, mostly expert systems were developed for this aim. Another important point seen about this subject was to integrate material handling system with production. Simultaneous scheduling techniques were used for this aim. As solution approaches, especially for the selection of material handling equipments, expert systems are commonly used. Besides heuristics, simulation and analytic algorithms like integer programming are used especially for the allocation of material handling equipments to material moves.

Literature about Layout and Flows between Production Units

One other subject that is also related with the in-plant logistics is the layout and the flows between production units. It is also seen that there are a lot of papers about this subject. Some of them are as follows:

Reference [26] regarded the cell formation and cell location in plant layout simultaneously. The aim was to minimize the flow costs between cells. A model was developed by adding dynamic programming to the simulated annealing approach. The model was tried on 24 test problems. The results showed that algorithm worked well.

A genetic algorithm was presented by [27] for solving the problem of facility planning. The aim in the study was to minimize the material handling costs. The proposed algorithm was compared with two reference problems and also with the solution from a different study. It was seen that the proposed algorithm was more efficient according to the other methods. Another new genetic algorithm was developed by [28] for the formation of cells. They proposed new crossing and mutation operators. The developed algorithm was tested on three data sets. Test results showed that algorithm could find the group structure existing in data sets.

Two models were presented by [29] for the cell formation and cell layout problem. In the cell formation problem, while grouping the machines, it was aimed to minimize the movements of the parts both inside and outside the cells. On the other side, in the cell layout problem, it was aimed to minimize the movements between cells in a macro perspective. Both of the problems were solved with genetic algorithm. The algorithm was tested for the data set consisting of 16 machines and 43 parts in literature. Good results were obtained and a real application was made in a steel manufacturer.

Reference [30] proposed one of the multi criteria decision making methods “TOPSIS” for the design of the cellular manufacturing systems. They stated that to design a cell production system, there were three steps. These were cell formation, intracellular machine layout and cell layout. The proposed model was applied on six examples and compared with the results of the popular approaches.

A simulation based study was presented by [31] in a pull-based system where kanbans were being used. The simulation study was hybrid using discrete events and agent based technologies together. The simulation was used for modeling complex material handling activities. What-if scenarios were modeled and system performance was evaluated.

For the layout&flows literature, it is concluded that most of the papers are about the intracellular movements. There are not many papers about the intercellular movements. Especially there are few studies including the flows between warehouse and production units/cells, production units/cells to production units/cells and production units/cells to warehouses. As solution methods, mainly heuristics are used.

CONCLUSION

Plant logistics literature is divided into three groups such as warehouses, material handling systems and layout & flows. For each group, literature review is made and some of the articles are explained briefly and most of the papers are shown in the classification table. The papers about the plant logistics are summarized in the classification table according to the sub-group, purpose and solution method.

For all the subjects under manufacturing logistics, it is concluded that heuristics algorithms are needed due to the complex structure of the systems. Instead of numerical examples which some unreal assumptions are made, real cases should be regarded and solution methodologies should be presented. Another interesting point is that although it has started to have an increasing application there are not many studies for the material handling systems in lean production systems especially related with periodically moving vehicles. The studies about periodically moving vehicles also called milk-run systems are limited and do not have a systematic solution approach. Instead of dealing with very specific theoretical subjects which do not add considerable value to the manufacturing logistics, more applicable and value adding subjects should be taken into consideration.

APPENDIX

TABLE 1
Analysis of In-plant Logistics Literature

Writers	Warehouses	Material Handling	Layout& Flows	Aim	Solution Method
Tang and Chew (1997) [32]	☑			Determining the order batching and warehouse assignment strategies in high quantity orders	Simulation
Rao and Rao (1998) [9]	☑			Determining the economical dimensions of the depots	Dynamic programming
Daniels and etc. (1998) [10]	☑			Developing a model enables deciding and sorting the assignments simultaneously in order picking systems.	Travelling salesman and tabu search heuristics.
Chew and etc.(1999) [11]	☑			Developing a travel time model with general item location assignment in a rectangular warehouse system	Queuing model
Roodbergen and Koster (2001) [12]	☑			Minimizing the order picking tours in parallel aisled depots	Simulation
Brauner and Finke (2001) [33]		☑		Defining the robotic movements for the optimization of the production velocity of a given product	Proofs based on axioms
Kim and etc. (2002) [35]	☑	☑		Developing a method for the optimal number of transfer cranes and optimal storage area for the containers.	Deterministic and stochastic model
Kalfakakou and etc. (2003) [36]	☑			Developing a model which prevents the storage of different products in the same area simultaneously	Graph theory
Makris and Giakoumakis (2003) [37]	☑			Developing a method for order picking procedure in the depots with rectangle shelves.	k-change heuristics
El-Baz (2004) [27]			☑	Developing a model for the minimization of material handling costs in the optimum facility layout.	Genetic algorithm
Fonseca and etc. (2004) [19]		☑		Developing a decision support system for conveyor selection	Expert system
Chiang and Lee (2004) [26]			☑	Minimization of the intercellular movement costs	Simulated annealing approach
Lashkari and etc. (2004) [20]		☑		Developing an integrated approach for the operation assignment and selection of material handling systems in the cell based production systems.	Iterative approach with three steps.
Kulak (2005) [21]		☑		Developing a decision support system for the selection of material handling system	Expert system based on axiomatic design and fuzziness
Amato and etc. (2005) [13]	☑			Developing control algorithms for the management of automatic warehouses	Petri network structure
Yang and etc. (2005) [38]			☑	Developing a model for the design of material flow path and layout	Simulated annealing
Satoğlu and etc. (2006) [16]	☑			Deciding between central storage and decentralized storage in cellular manufacturing environment	Activity based costing
Zhang and etc. (2006) [14]	☑			Minimizing vertical transportation costs in multiple-level warehouse layout problems	Hybrid heuristics
Hwang and etc. (2006) [15]	☑			Minimizing the transportation distances in the order picking in warehouses.	Mathematical and simulation model
Khayat and etc. (2006) [22]		☑		Developing an integrated formulation for the combined production and material handling scheduling problems.	Constraint programming model
Chan and etc. (2006) [29]			☑	To solve mathematical problems related with both part-machine grouping problem and cell layout problems.	Genetic algorithm
Filho and Tiberti (2006) [28]			☑	Developing a model for cell formation	Genetic algorithm

TABLE 1(Continued)
Analysis of In-plant Logistics Literature

Writers	Warehouses	Material Handling	Layout& Flows	Aim	Solution Method
Liang and etc. (2007) [17]	☑			Developing a mathematical model for order picking from an automatic warehouse	Genetic algorithm
Ioannou (2007) [24]		☑	☑	Developing an integrated formulation determining both the design of the material handling system and layout of the resource groups in production environment.	Integer programming
Caricato and etc. (2007) [39]		☑		Design of single loop based material flow system for making the material flows between cells in the shortest time.	Branch and cut algorithm
Le-Duc and etc.(2007) [40]	☑			Determining the quantity of batches in order picking	S shaped heuristics
Vaziri and etc. (2007) [42]			☑	Minimizing the travelling time of loaded and unloaded vehicles.	Binary integer programming
Correa and etc. (2007) [23]		☑		Developing a hybrid methodology for the routing and scheduling of the automatic guided vehicles in flexible manufacturing systems.	Hybrid algorithm
Sujono and Lashkari(2007) [41]		☑		Developing a method able to do operation assignment and material handling system selection simultaneously with multi purpose in flexible production systems.	Multi-purpose model and є-constraint
Önüt and etc. (2008) [18]	☑			Minimizing the annual transportation costs by designing shelf configuration for multiple level warehouse layout	Particle swarm optimization
Raman and etc. (2008) [25]		☑		Determining the number of material handling devices for effective handling between production units.	Analytic approach with two steps.
Zhang and etc. (2008) [45]			☑	Optimally locating a new unit with limited dimension to a current layout	Analytic algorithm
Safaei and etc. (2008) [44]			☑	Developing a mixed integer linear programming model for the design of the cell based production systems in a dynamic environment	Hybrid meta heuristics and simulated annealing
Hao and Shen (2008) [31]		☑	☑	Developing a hybrid simulation model for kanban based material handling system.	Hybrid simulation model
Babiceanu and Chen (2008) [43]		☑		Comparison of decentralized and centralized material handling systems	Simulation
Ahi and etc. (2008) [30]			☑	To make both machine location in cells and cell layout ideal in cell based production systems.	TOPSIS
Im and etc. (2009) [46]		☑		Blocking material handling equipments and minimizing delivery times.	Modified Hungary Method.
Mirhosseyni and Webb (2009) [47]		☑		Choosing the most suitable material handling equipment	Two step methodology (Fuzzy Expert System and genetic algorithm)
Sayarshad (2010) [48]		☑		Determining the required number of material handling equipments in production environment	Bee algorithm
Tuzkaya and etc. (2010) [49]		☑		Choosing the most suitable material handling equipment	Two step methodology (Fuzzy ANP and Fuzzy PROMETHEE)
Xiao ve Zheng (2010) [50]	☑			Assigning the most suitable parts to the storage areas.	A mathematical model and a multi-step heuristics.

REFERENCES

[1] Baudin, M., 2004, “Lean logistics: The Nuts And Bolts of Delivering Materials and Goods”, Productivity Press, New York.

[2] Drira, A., Pierreval, H. and Hajri-Gabouj, S., 2007, “Facility Layout Problems: A Survey, Annual Reviews in Control”, 31, 255-267

[3] Berg, J.P. and Zijm, W.H.M., 1999, “Models for warehouse management: Classification and examples”, International Journal of Production Economics, 59, 519-528

[4] Rouwenhorst, B., Reuter, B., Stockrahm, V., Houtum, G.J., Mantel, R.J. and Zijm, W.H.M., 2000, “Warehouse design and control: Framework and literature review”, European Journal Of Operational Research, 122, 515-533

[5] Vaziri, A. A. and Laporte, G., 2005, “Loop Based Facility Planning and material handling”, European journal of Operational Research, 164, 1-11

[6] Gu, J., Goetschalckx, M. and McGinnis, L.F., 2007, “Research on warehouse operation: A comprehensive review”, European Journal Of Operational Research, 177, 1-21

[7] Koster, R., Le-Duc, T. and Roodbergen, K.J., 2007, “Design and control of warehouse order picking: A literature review”, European Journal Of Operational Research, 182, 481-501

[8] Baker, P. and Canessa, M., 2009, “Warehouse design: A structured approach”, European Journal Of Operational Research, 193, 425-436

[9] Rao, A.K. and Rao, M.R., 1998, “Solution Procedures for sizing of warehouses”, European Journal Of Operational Research, 108, 16-25

[10] Daniels, R. L., Rummel, J.L. and Schantz, R., 1998, “A model for warehouse order picking”, European Journal of Operational Research, 105, 1-17

[11] Chew, E. P. and Tang, L.C., 1999, “Travel time analysis for general item location assignment in a rectangular warehouse”, European Journal Of Operational Research, 112, 582-597

[12] Roodbergen, K.J. and Koster, R., 2001, “Routing order pickers in a warehouse with a middle aisle”, European Journal of Operational Research, 133, 32-43

[13] Amato, F., Basile, F., Carbone, C. and Chiacchio, P., 2005, “An approach to control automated warehouse systems”, Control Engineering Practice, 13, 1223-1241

[14] Zhang, G.Q. and Lai, K.K., 2006, “Combining path relinking and genetic algorithms for the multiple level warehouse layout problem”, European Journal Of Operational Research, 169, 413-425

[15] Hwang, H.S. and Cho, G.S., 2006, “A performance evaluation model for order picking warehouse design”, Computers & Industrial Engineering, 51, 335-342

[16] Satoğlu, Ş. I., Durmuşoğlu, M. B. and Doğan, İ., 2006, “Evaluation of the conversion from central storage to decentralized storages in cellular manufacturing environments using activity based costing”, International Journal of Production Economics, 103, 616-632

[17] Liang, C.F., Zeng-xiao, L., Zheng, X. and Dong-dong, L. 2007, “Research on Order Picking Optimization Problem of Automated Warehouse”, Systems Engineering-Theory&Practice, 27(2), 139-143

[18] Önüt, S., Tuzkaya, U.R. and Doğaç, B., 2008, “A particle swarm optimization algorithm for the multiple level warehouse layout design problem”, Computers & Industrial Engineering, 54, 783-799

[19] Fonseca, D.J., Uppal, G. and Greene, T.J., 2004, “A knowledge-based system for conveyor equipment selection”, Expert Systems with Applications, 26, 615-623

[20] Lashkari, R.S., Boparai, R. and Paulo, J., 2004: Towards an integrated model of operation allocation and material handling selection in cellular manufacturing systems, International Journal of Production Economics, 87, 115-139

[21] Kulak, O., 2005: A decision support system for fuzzy multi attribute selection of material handling equipments, Expert Systems with Applications, 29, 310-319

[22] Khayat, G.E., Langevin, A. and Riopel, D., 2006, "Integrated production and material handling scheduling using mathematical programming and constraint programming", European Journal of Operational Research, 175, 1818-1832

[23] Correa, A.I., Langevin, A. and Rousseau L.M., 2007, "Scheduling and routing of automated guided vehicles: A hybrid approach", Computers & Operations Research, 34, 1688-1707

[24] Ioannou, G., 2007, "An integrated model and a decomposition-based approach for concurrent layout and material handling system design", Computers & Industrial Engineering, 52, 459-485

[25] Raman, D., Nagalingam, S.V., Gurd, B.W. and Lin, G.C.I., 2008, Quantity of material handling equipment-A queuing theory based approach, Robotics and Computer Integrated Manufacturing.

[26] Chiang, C. P. and Lee, S. D., 2004, "Joint determination of machine cells and linear intercell layout", Computers & Operations Research, 31, 1603-1619

[27] El-Baz, M. A., 2004, "A genetic algorithm for facility layout problems of different manufacturing environments", Computers & Industrial Engineering, 47, 233-246

[28] Filho, E.V.G. and Tiberti, A. J., 2006, "A group genetic algorithm for the machine cell formation problem", International Journal of Production Economics, 102, 1-21

[29] Chan, F. T. S., Lau, K.W., Chan, P.L.Y. and Choy, K.L., 2006, "Two-stage approach for machine-part grouping and cell layout problems", Robotics and Computer Integrated Manufacturing, 22, 217-238

[30] Ahi, A., Aryanezhad, M. B., Ashtiani, B. and Makui, A., 2008, "A novel approach to determine cell formation, intracellular machine layout and cell layout in the CMS problem based on TOPSIS method", Computers & Operations Research, Article In Press.

[31] Hao, Q. and Shen, W., 2008, "Implementing a hybrid simulation model for a Kanban-based material handling system", Robotics and Computer Integrated Manufacturing, 24, 635-646

[32] Tang, L.C. and Chew, E.P., 1997, "Order Picking Systems: Batching and Storage Assignment Strategies", Computers Industrial Engineering, 33, 817-820

[33] Brauner, N. and Finke, G. 2001, "Optimal moves of the material handling system in a robotic cell", International Journal Production Economics, 74, 269-277

[34] Roodbergen, K.J. and Koster, R., 2001, "Routing order pickers in a warehouse with a middle aisle", European Journal of Operational Research, 133, 32-43

[35] Kim, K. H. and Kim, H.B., 2002, "The optimal sizing of the storage space and handling facilities for import containers", Transportation Research, 36, 821-835

[36] Kalfakakou, R., Katsavounis, S. and Tsouros, K., 2003, "Minimum number of warehouses for storing simultaneously compatible products", International Journal of Production Economics, 81-82, 559-564

[37] Makris, P. A. and Giakoumakis, I. G., 2003, "k-Interchange heuristic as an optimization procedure for material handling applications", Applied Mathematical Modelling, 27, 345-358

[38] Yang, T., Peters, B. A. and Tu, M., 2005, "Layout design for flexible manufacturing systems considering single-loop directional flow patterns", European Journal of Operational Research, 164, 440-455

[39] Caricato, P., Ghiani, G., Grieco, A. and Musmanno, R., 2007, "Improved formulation, branch and cut and tabu search heuristic for single loop material flow system design", European Journal of Operational Research, 178, 85-91

[40] Le-Duc, T. and Koster, R.M.B.M., 2007, "Travel time estimation and order batching in a 2-block warehouse", European Journal Of Operational Research, 176, 374-388

[41] Sujono, S. and Lashkari, R. S., 2007, "A multi-objective model of operation allocation and material handling system selection in FMS design", International Journal Production Economics, 105, 116-133

[42] Vaziri, A. A., Laporte, G. and Ortiz, R., 2007, "Exact and heuristic procedures for the material handling circular flow path design problem", European journal Of Operational Research, 176, 707-726

[43] Babiceanu, R.F. and Chen, F. F., 2008, "Distributed and centralised material handling scheduling: Comparison and results of simulation study", Robotics and Computer Integrated Manufacturing, Article in Press.

[44] Safaei, N., Saidi-Mehrabad, M. and Jabal-Ameli, M.S., 2008, "A hybrid simulated annealing for solving an extended model of dynamic cellular manufacturing system", European Journal of Operational Research, 185, 563-592

[45] Zhang, M., Savaş, S., Batta, R. and Nagi, R. 2008, "Facility placement with sub-aisle design in an existing layout", European Journal Of Operational Research, Article in Press.

[46] Im, K., Kim, K., Park, T. and Lee, S., 2009, "Effective vehicle dispatching method minimising the blocking and delivery times in automatic material handling systems of 300 mm semiconductor fabrication", International Journal of Production Research, 47, 3997-4011

[47] Mirhosseyni, S. H. L. And Webb, P., 2009, "A hybrid fuzzy knowledge-based expert system and genetic algorithm for efficient selection and assignment of material handling equipment", Expert Systems With Applications, 36, 11875-11887

[48] Sayarshad, H. R., 2010, "Using bees algorithm for material handling equipment planning in manufacturing systems", International Journal of Advanced Manufacturing Technologies, 48, 1009-1018

[49] Tuzkaya, G., Gülsün, B., Kahraman, C. and Özgen, D., 2010, "An integrated fuzzy multi-criteria decision making methodology for material handling equipment selection problem and an application", Expert Systems with Applications, 37, 2853-2863

[50] Xiao, J. and Zheng, L., 2010, "A correlated storage location assignment problem in a single-block-multi aisles warehouse considering BOM information", International Journal of Production Research, 48, 1321-1338

DEVELOPMENTS IN TRANSPORTER CENTERS: A LOGISTICS ORIENTED APPROACH FOR İZMİR

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Abstract *- The term "Transporter Center" refers to a specific area where all the activities relating to logistics, on commercial basis, by various operators are realized. In transporter centers, logistics functions are covered effectively to provide right and suitable services to customers. Companies in transporter centers generally provide services such as distribution, transportation, packaging, labeling, warehousing, materials handling, loading, unloading and storage. These centers are generally connected to an association in order to be in close interaction. Organized industrial zones, free zones, logistics centers and urban freight consolidation centers are also classified as transporter centers due to their site selections and services provided to customers. This study focuses on definition, historical developments, logistics functions, services and practices of transporter centers. In this study, logistics functions and services of transporter centers in Izmir have been analyzed and Işıkkent Transporter Center was chosen as the area of study.*

Keywords - Interviews, Logistics Functions, Services, Transporter Centers

LOGISTICS AND MAJOR LOGISTICS FUNCTIONS

Logistics deals with the planning and control of material flows and related information in organizations, both in the public and private sectors. Broadly speaking the mission of logistics is to get the right materials to the right place at the right time, while optimizing a given measure (e.g. minimizing total operating costs) and satisfying a given set of constraints (e.g. a budget constraint) [1].

Logistics is a process of movement of goods across the suply chain of the company. However, this process consists of various functions, which have to be properly managed to bring effectiveness and efficiency in the supply chain of the organisation. The major logistics functions are as follows [2]:

- Order Processing
- Inventory Management
- Warehousing and Storage System
- Transportation
- Materials Handling
- Packaging
- Providing Information

TRANSPORTER CENTERS

Transporter centers are generally located near a highway or a railway to reduce the traffic and air pollution in cities. This location also reduces the transportation costs and lead time of distribution. On the other hand this location increase efficiency of transportation services [3].

In transporter centers, logistics functions are used effectively to provide right and suitable services to customers. Companies in transporter centers generally provide services to customers such as distribution, transportation, packaging, labeling, warehousing, materials handling, loading, unloading and storage etc [4].

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CLASSIFICATION OF TRANSPORTER CENTERS

According to their locations and services, free zones, organized industrial zones, logistics centers and urban freight consolidation centers are classified as transporter centers.

- **Free Zones**

In general, free zones are places where countries' current commercial, financial and economic fields for the application of legal and administrative regulations are not implemented or are partially implemented. The aim is the recognition of the wider promotion of industrial and commercial activities. These zones are separated from other parts of the country where they can be described as "free" zones [5].

- **Logistics Centers**

A logistics center is a defined area within which all activities relating to transport, logistics and the distribution of goods, both for national and international transit, are carried out by various operators. These operators can either be owners or tenants of buildings and facilities (warehouses, break-bulk centers, storage areas, offices, car parks, etc...) which have been built there [6].

- **Organized Industrial Zones**

Organized Industrial Zones are areas with necessary infrastructure dedicated to industry. The aim of these Zones is to ensure that industrial activities are carried out in appropriate places; to act as guides towards urbanization; to prevent environmental problems; to benefit from information and informatics technologies; and to enable manufacturing industries to locate and develop according to a pre-defined plan [7].

- **Urban Freight Consolidation Centers**

Urban freight consolidation centers are infrastructures designed to promote consolidated delivery, in harmony with the facilitation of logistic activities. Large long-haul trucks stop at the urban freight consolidation center and transfer their shipments to smaller trucks, a process known as transshipment, before these smaller trucks enter the city center. In addition, with freight centers, a city planner can expect the shipments from different companies to be consolidated before deliveries are sent downtown. With the help of these centers a reduction in the number of trucks operating in dense city centers can be expected, hence less congestion, and also safer cities can be aimed [8].

TRANSPORTER CENTERS IN THE WORLD

There are literally thousands of logistics centers, free zones, organized industrial zones and urban freight consolidation centers around the world. Most of companies in these transporter centers generally use Just-in-time (JIT) system for inventory management to give more efficient system to their customers. They also use warehouse and storage system to reduce the supply chain cost due to reduction in inventory costs and possible economies of scale in purchasing. Bonded warehouses are found in free zones.There are diferent types of storage systems according to products such as [9];

1. Storage for the oil and gas industry for equipment and consumables, during exploration and drilling, and bulk tank storage for petroleum.
2. Storage of general cargo, electronics and household goods, steel, automotive industry, fashion industry, etc.

On the other hand, informaton is very significant factor for free zones. Companies use IT tools for managing their operations, competing in the marketplace, supplying services, and augmenting personal lives [9]. They also use Integrated Services Digital Network (ISDN) system which is a a set of communications standards for simultaneous digital trnasmission of voice, video, data,and other network services over the traditional circuits of the public switched telephone network. Prior to ISDN , the phone system was viewed as a way to tranport voice, with some special services available for data. The key future of ISDN is that is integrates speech and data on the same lines, adding features that were not available in the classic telephone system.There are several kinds of access interfaces to ISDN defines as Basic Rate Interface (BRI), Primary Rate Interface (PRI) and Broadband ISDN (B-ISDN) [9].

TRANSPORTER CENTERS IN TURKEY

- **Free Zones in Turkey**

There are 19 free zones established in Turkey. FIGURE. 1 shows the location and establishment date of free zones in Turkey. In general all kind of activities can be performed in Turkish Free Zones such as manufacturing, storing, packing, general trading, banking and insurance. Investors are free to construct their own premises, while zones have also available office spaces or warehouses on rental basis with attractive terms. All field of activities open to Turkish private sector are also open to joint-venture of foreign companies [5].

FIGURE. 1
Free Zones in Turkey

- **Logistics Centers in Turkey**

The introduction of logistics villages by Turkish State Railways (TSR) has an important role in connecting ports to plants, industrial zones in cooperation with private sector. Loading/unloading, custom clearance, warehousing, facilities for trucks are the main functions of these villages. They are being established close to industrial regions along with developed road connections. At the first stage, the transformation of six places (Halkalı, Köseköy, Boğazköprü, Gelemen, Balıkesir, Eskişehir) into logistics villages has been included in the priorities of TSR. FIGURE. 2 shows the location of these logistics center projects . An increase in traffic of 7.6 million tonnes is expected together with the operation of all logistics villages and 56% increase is projected in the use of railways [10].

FIGURE. 2
Logistics Center Projects in Turkey

- **Organized Industrial Zones in Turkey**

There are 107 Organized Industrial Zones (OIZ) in Turkey, with their site selection, expropriation, and the infrastructure completed. There are a further 144 OIZ's where the site selection and the registration are complete, but the establishment and infrastructure works are still in progress. The geographical distribution of 107 OIZs providing full services, and 144 OIZs with infrastructure activities are still in progress [11].

- **Urban Freight Consolidation Centers in Turkey**

There is a web portal which covers all urban freight consolidation centers in Turkey. In addition to this portal, all centers have their own web site and they provide company lists (door-to-door transportaion companies,transportation of heavy cargoes companies,house moving companies etc.) price offer, help for finding suitable truck and distance calculation services for their users. In addition to these services, these centers generally provide transportation, warehousing and packaging services for their customers. Main urban freight consolidation centers in Turkey are Ankara Şaşmaz, Mersin, İstanbul Urban Freight Consolidation Center, Adana and İzmir Işıkkent Urban Freight Consolidation Center [12].

IŞIKKENT URBAN FREIGHT CONSOLIDATION CENTER

Işıkkent Urban Freight Consolidation Center is located near both the highways and hinterland. It is close to Aydin-Cesme and Istanbul-Ankara highways. On the other hand it is close to MOSBAR Logistics (Manisa) and Kemalpaşa Organized Industrial Zone (Kemalpaşa). Distance between center to Manisa and Kemalpaşa is approximately 30km and 40km in order. It is also close to Izmir City center and Alsancak Port.

In additon to 140 offices, there are buffets, restaurants, a mosque and an administration building in Işıkkent Transporter Center. Işıkkent Urban Freight Consolidation Center connected to Izmir Chamber of Commerce, Izmir Chamber of Industry and Commodity Exchange. In this way cargo owners can trust these transport companies. Işıkkent Urban Freight Consolidation Center contributes to develop the Aegean economy.There are both city and intercity transport services provided by this center. Thousands of truck drivers get jobs from this center. Today the center is the heart of carriages in and around Izmir. Most of the logistics companies, door-to-door trasnportation companies, international companies etc. are established in this area [13].

METHODOLOGY OF THE STUDY

The various methods of data collection used in social research help the researchers gain accurate and scientific knowledge about the individuals and their society as far as possible. The important data collection methods are observation case study, content analysis, questionnaire, schedule, and interview. Of these the first three methods observation, content analysis and case study can be termed as qualitative methods in the sense that they provide information about the phenomenon in qualitative descriptive and unstructured form [14].

In this study, a qualitative research is performed and interview is used as the research methodology. Interview may be ragarded as a sytematic method by which a person enters more or less imaginatively into the life of complete stranger. Interview is a process of talking in more purposive and more sytematic manner than our day to day gossipping with each other [14].

SAMPLE SELECTION

Urban freight consolidation centers are generally located near a highway or a railway to reduce the traffic and air pollution in cities. This location also reduces the transportation costs and lead time of distribution. On the other hand this location increase efficiency of transportation services [3].

The main point of regarding the selection of the sample is the role of the Işıkkent Urban Freight Consolidation Center. Although there are many transporter centers in Izmir, Işıkkent Urban Freight Consolidation Center is the heart of the carriage sector in Izmir. Most of the logistics companies, international transportation companies, transportation of heavy cargoes companies, door to door transportation companies etc. are located in this center in order to be in a close interaction [13].

DATA COLLECTION

The aim of the this section of the study is to determine the characteristics and logistics functions of Işıkkent Urban Freight Consolidation Center. For this reason, interviews have been realized with 10 companies in Işıkkent Urban Freight Consolidation Center on the dates of April 12-13, 2011. TABLE 1 lists the company names and authorized people who were interviewed and date of interviews.

TABLE 1
Interviews for Data Collection About Işıkkent Urban Freight Consolidation Center

Company Name	Authorized People	Date
Borusan Logistics (Branch)	Tuncer Minkara	12.04.2011
Aytekinler Logistics	Deniz Şenses	12.04.2011
Inci Logistics (Branch)	Bülent Ayan	12.04.2011
Mustafa Onal Transportation of Heavy Cargoes LTD.	Mustafa Onal	12.04.2011
Nak Cargo	Serhat Çankaya	13.04.2011
Unal Door to Door Transportation	Alp Caglar Ozdemir	13.04.2011
Altunlar International Road Tansportation	Hakan Altun	13.04.2011
Horoz Logistics (Branch)	Hakan Cenikut	13.04.2011
Geyik Door to Door Transportation	Adnan Güner	13.04.2011
TRANSNAK International Road Transortation (Branch)	Serhat Baybostan	13.04.2011

FINDINGS

As mentioned previously, interviews were realized to determine the characteristics and logistics functions of Işıkkent Urban Freight Consolidation Center. According to the logistics functions, interview questions were used about warehousing sytems, loading and unloading procedures, transportation modes and transportation infrasturucture of transportation center, information technologies, order processing sytems, packaging and labelling processing and distribution systems. In addition to these questions, services provided by the companies and vehicle tracking systems have been addressed to the authorized people. Interview questions aimed to evaluate the efficieny of the logistics functions of Işıkkent Urban Freight Consolidation Center. TABLE 2 summarizes the findings of interview results. According to the companies, all of them provide delivery services. Six of the companies provide packaging services. On the other hand only Inci Logistics and Borusan Logistics provide labelling services and only Mustafa Onal Transportation of Heavy Cargoes provides equipment leasing and montage services for their customers. It covers usage of transpotation mode, IT, order proccessing, warehousing and distribution systems, packaging, labelling, loading & unlaoding, insurance, customs, delivery, VTS, equipment leasing and montage services. All companies provide loading/unloading, distribution and insurance services for their customers. Only TRANSNAK provide warehousing services in the center. In addition to these services, 6 companies provide customs services for their customers.

TABLE 2
General Overview of Companies' Services and Logistics Functions Efficiency

	Transportation Mode	IT and Order Processing Systems	Warehousing Systems	Packaging	Labeling	Distribution Systems	Loading/ Unloading	Insurance	Customs	Delivery	Vessel Tracking System	Equipment Leasing and Montage
Borusan Logistics (Branch)	Road	Internet Fax Telephone	________	√	√	Direct Shipment Milk Run	√	√	√	√	√	______
Aytekinler Logistics	Road	Internet Fax Telephone	________	√	________	Direct Shipment Milk Run	√	√	_______	√	√	______
Inci Logistics (Branch)	Road	Internet Fax Telephone	________	√	√	Direct Shipment Milk Run	√	√	√	√	√	______
Mustafa Onal Transportation of Heavy Cargoes LTD.	Road	Internet Fax Telephone	________	_________	________	Direct Shipment	√	√	________	√	√	______
Nak Cargo	Road	Internet Fax Telephone	________	________	________	Direct Shipment	√	√	√	√	√	______
Unal Door to Door Transportation	Road	Internet Fax Telephone	________	√	________	Direct Shipment	√	√	______	√	√	√
Altunlar International Road Tansportation	Road	Internet Fax Telephone	________	________	________	Direct Shipment	√	√	√	√	√	√
Horoz Logistics (Branch)	Road	Internet Fax Telephone	________	√	________	Direct Shipment	√	√	√	√	√	√
Geyik Door to Door Transportation	Road	Internet Fax Telephone	________	√	________	Direct Shipment	√	√	_______	√	√	√
TRANSNAK International Road Transortation	Road	Internet Fax Telephone	√	_________	________	Direct Shipment	√	√	√	√	√	√

Source: Authors

CONCLUSION AND RECOMMENDATIONS

Transporter centers are special areas from which consolidated deliveries are carried out within that area. A range of other value-added logistics and retail services can also be provided at these centers. Logistics and transportation companies with deliveries scheduled for the urban area or site are able to transfer their loads at the center and thereby avoid entering the congested area.The transporter center operator sorts and consolidates the loads from a number of logistics related companies and delivers them to an agreed delivery pattern.

Major advantages of these centers are better planning and implementation of logistics operation, opportunity to introduce new information systems at same time as consolidation centre, provide better inventory control, product availability and customer service and finally public relations for particiants. On the other hand, there are some disadvantages of these centers. These are potential to create monopolistic situations, thus eliminating competition and loss of the direct interface between suppliers and customers.

Evaluation of these features and sample of these transporter centers in the World, Turkey and finally in Izmir; Işıkkent Urban Freight Consolidation Center has been chosen as the sample of this study. Although there are many transporter centers in Izmir, Işıkkent Urban Freight Consolidation Center is the heart of carriage sector in Izmir. Most of the logistics companies, international transportation companies, transportation of heavy cargoes companies, door to door transportation companies etc. are located in this center in order to be in a close interaction.

Main advantage of Işıkkent Urban Freight Consolidation Center is its location near both the highways and hinterland. It is close to Aydin-Ceşme and Istanbul-Ankara highways .On the other hand it is close to MOSBAR Logistics (Manisa) and Kemalpaşa Organized Indsutrial Zone (Kemalpaşa). It is also close to Izmir City center and Alsancak Port. Using these highways more efficiently, it helps to reduce the transportation costs and speed up the services. In this center, all companies use to prefer road transportation with direct shipment and milk run distribution sytems. These systems have a great advantage to as reduce the air pollution and traffic in Izmir city center. In general, companies provide vehicle tracking, delivery, loading and unloading, distribution and insurance services for their customers for increase the satisfaction.

While companies provide these services efficiently, there are some important problems in the urban freight consolidation centers. One of the problems is the warehousing system. There is not enough area for warehousing places. Most of the companies do not have any area for warehousing and they do not have any services for warehousing for their customers. Companies complain about the warehousing leasing prices. Big logistics companies' branches prefer to provide these services in their launch offices. On the other hand, limited number of companies provide packaging and labelling services.Because there is not any suitable area for this services. This is one of the main problems in the center. Another problem in the center is about insufficient information technology system. None of the companies have a complex system of information technology in the transporter center. They only use internet, fax and telephone for information flow. Internet is the priority communication system. All of the companies have their own web site. All of them use internet for internal communication of the company and their customers. Insufficienct information technology system is one of the most important problem of transportation centers. As a result of insufficient information technology system, customers forward their orders via internet and telephone.

In conclusion, if companies start to use more developed information technology systems, they will provide more effective information technology services for their customers. Both customers and companies will follow information flows and order processes in a more reliable and easy way. On the other hand, Işıkkent is a commercial place where trade facilites continue. There are suitable places for warehousing areas. If the administration of the transporter center provide suitable locations near the center for warehousing, companies will provide warehousing services for their customers too.

REFERENCES

[1] Ghiani, G. & Laporte, G. & Musmanno, R. (2004). Introduction to Logistics Systems Planning and Control, England, John Wiley & Sons Ltd.

[2] Sople, V.V. (2007). Logistics Management, India, Baba Barkha Nath Printers.

[3] Lowe, D. (2005). Intermodal Freight Transport, England, Elsevier Butterworth-Heinemann.

[4] Europlatforms (2004). “Logistics Centers Directions for Use.” Europlatforms EEIG, http://www.unece.org/trans/main/eatl/docs/ENREVWhat_is_a_Freight_VillageFinalcorretto.pdf, 18.02.2011.

[5] Undersecretariat of The Prime Ministry for Foreign Trade, Free Zones, http://www.dtm.gov.tr/dtmadmin/upload/SB/ABIiskilerDb/Generalnfopdf, 21.02.2011.

[6] Kondratowicz, L. (2003). “NeLoC- Work Package 1- Planning of Logistics Centres”, Final Report, The Maritime Institute in Gdansk, Gdansk, Poland, pp. 12

[7] Salonen, T. (2010). Strategies, Stuctures, and Process for Network and Resources Management in Industrial Parks: The Cases of Germany and China, Köln, Josef EUL Verlag GmbH.

[8] Wisetjindawat, W. (2010). Review of Good Practices in Urban Freight Tranportation, Nogaya Institute of Technology, Japan.

[9] Yŏn’guwŏn, H. (2005). Free Trade Zone and Port Hinterland Development, Thailand, United Nations Publications.

[10] Şakar, D.G. (2010). Transport Mode Choice Decisions and Multimodal Transport: A Trigulated Approach, Platform, Izmir, Dokuz Eylul University Printing Office.

[11] Izmir Chamber of Trade, www.izto.org.tr, 11.03.2011.

[12] Urban Freight Consolidation Centers, www.nakliyecilersitesi.net, 02.05.2011.

[13] Işıkkent Urban Freight Consolidation Center, www.izknak.com, 15.04.2011.

[14] Goddard, W. & Melville, S. (2001). Research Methodology: An Introduction, FPP Production.

CONCEPTUALIZATION OF LOGISTICS CENTERS FROM AN INDUSTRIAL BUYING APPROACH

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Abstract – *With the increasing effects of globalization and the extended integration requirements between individual companies, logistics services evolve to a more comprehensive and interorganizational structure. This evolving structure is followed by new concepts introduced and adopted in the area of logistics services. Logistics centers which bring the parties involved in the transport, logistics and the distribution of goods together in the same area to provide value added services are the recent examples of this composition and are widely utilized in industrialized regions today. Successful examples are taken as benchmarks in order to be applied in developing countries. As logistics centers provide an industrial service to their customers, the industrial buying criteria of those customers is essential in order to gain competitive advantage in terms of the marketing activities of these centers. This study aims to provide a common ground for the logistics center concept as an industrial service for all scholars and managers working in the related field. A second aim of the study is to exhibit an exploratory effort through the use of focus groups in order to examine the industrial buying criteria of customers whom are expected to utilize the services of logistics centers. The results of the study will provide an enhanced understanding of the logistics center concept and the customers' evaluation criteria when deciding on the industrial services they buy from logistics centers.*

Keywords – Industrial buying, Industrial services marketing, Logistics, Logistics center, Supply chain management

1. INTRODUCTION

High degree of customization, requirements for value-added services, increasing rate of outsourcing among logistics activities and the continuous pressure on the delivery lead times caused an ongoing evolution in logistics services. When it was handled as two separate internal functions called the materials handling and the physical distribution from 1980s till 2000s [4], it was mainly controlled by the organizations as internal processes. In time, the separate activities performed under the name of these two main functions were combined to form the logistics function which required significant expertise due to its complex structure. This required expertise, together with increasing cost pressures and entrance to international markets, urged organizations to focus only on core competencies and outsource the logistics activities to service providers. This wave of outsourcing stimulated the degree of logistics services provided eventually and supply of basic services turned into third party logistics service providers (3PLs). Fourth party logistics service providers (4PLs) followed the voice of the industrial customers and supplied integrated logistics services. The evolution goes on today towards more logistics services centers where 3PLs, 4PLs and other service providers operate in order to supply combined, on time and value added services in strategic locations.

These logistics centers which bring the parties involved in the transport, logistics and the distribution of goods together in the same area to provide value added services, mainly serve to industrial markets. The transaction takes place in and out of a logistics center involves at least two different organizations so they can be evaluated as industrial service providers. The need for the development of a logistics center that can serve as a node within the global supply chain of companies raises due to worldwide globalization of trade and industrial production [25]. The mobile network of industrial production requires a mobile network of the industrial service that complements the overall customer requirements. As logistics excellence is an important

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criteria in the overall competitive power of an organization [20], the business organizations buying this service from logistics centers evaluate them in terms of strategic criteria in order to keep their competitive power. These customer requirements are of strategic importance for logistics centers which are going through their era of evolution. So the specification of customer requirements which are essential during the industrial buying process from logistics centers is crucial information for logistics centers for service design and development.

Setting these as a basis, the main aim of this study is to examine the logistics center concept through the available literature and present examples and perform a conceptualization effort in order to define and describe this new structure in the area of logistics. The description of the structure will be used to discover the main functions and sub-functions that are prevalent in logistics centers and their contribution to the broad industrial service given. A second aim of the study is to utilize the conceptualization of industrial service in order to detect the industrial customers of these logistics centers and to specify the industrial buying criteria of potential customers of the logistics center that is to be established in or near Izmir through a focus group analysis

2. LOGISTICS CENTERS

Refering to the most frequently cited definition logistics is "the process of planning, implementing and controlling procedures for the efficient and effective transportation and storage of goods including services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements" [10]. This definition covers a broad range of activities that are required to fulfill the aim of logistics function. The aggregation of these activities in specific locations and combination of them with other value-added activities that arise due to the increased demands of global supply chains are recent phenomena that is observed in the logistics practice.

Logistics centers have many synonyms like freight villages, dry ports, interports, inland ports, distribution terminals, distribution centers or inland nodes. All concepts represent the same cluster of logistics service. Nevertheless, these services may differ from a logistics center to logistics center depending on the requirements of its customers.

There are several different definitions made for logistics centers. Reference [23] defines them as hinterland intermodal transportation hubs that provide valuable space for logistics and further distribution activities. Reference [22] classifies the inland hubs from city terminals to special logistics areas in terms of their geographical coverage, transportation modes and networks they utilize and the stakeholders that they are linked with. Nathanail emphasizes the intermodality function of transportation and logistics terminals. Reference [25] focuses on the geographical coverage dimension of logistics distribution centers through the literature review they conducted and they saw that serving either to an international, regional, national or local network differentiates logistics centers from each other significantly. By refering to the prior research, they defined the logistics centers as *a special intermodal hub (nodal point) in the transportation system, including different logistics facilities, where separate operators are providing number of services, connected to transportation, logistics and distribution in established geographical coverage.*

Emphasizing the geographical coverage and also the hinterland dimension of the logistics center, it is certain that the logistics center or the dry port is an alternative to the sea port which is located inland and which is linked to the sea port with several transportation modes. So the logistics center can be considered as a common user hub facility located in the hinterland of one or several seaports and where different services are available to carriers and shippers [14]. This concept creates a new node in the transportation network. In order to clarify the nodes and links system, a node can be represented by a transport stop done with the aim of storage, transformation, further process or transshipment. A link is represented by a flow between nodes and with the existing transportation modes. This new nodes of the transportation network are called the logistics centers which are influenced by the characteristics of the landscape, their proximity to the seaports or industrial complexes, their locations relative to transportation infrastructure [26].

The most frequently cited definition of the logistics center concept is the definition made by Europlatforms – the European Association of Freight Villages [12]. According to Europlatforms *A freight village is a defined area within which all activities relating to transport, logistics and the distribution of goods, both for national and international transit, are carried out by various operators. These operators can either be owners or tenants of buildings and facilities (warehouses, break-bulk centres, storage areas, offices, car parks, etc...) which have been built there. Also, in order to comply with free competition rules, a freight village must allow access to all companies involved in the activities set out above. A freight village must also be equipped with all the public facilities to carry out the above mentioned operations. If possible, it should also include public services for the staff and equipment of the users. In order to encourage intermodal transport for the handling of goods, a freight village must preferably be served by a multiplicity of transport modes (road, rail, deep sea, inland waterway, air). Finally, it is imperative that a freight village be run by a single body, either public or private.*

The emphasis attached to the multiplicity of transportation modes can be traced in a recent report which is prepared by Deutsche GVZ-Gesellschaft mbH (DGG) and which provides a general benchmark of the European freight villages as well. According to DGG a freight village is [11]:

a. *Settlement of transport-oriented (independent) companies, logistics service providers and logistics-intensive trade and production enterprises in a commercial area,* so it should contain many different entities with different commercial objectives and expertise in the same node in order to provide transport, logistics or distribution service.

b. *should contain an intermodal road/rail or inland water-way/road/rail terminal with open access to every potential user*, so intermodality is a must and other similar centers with accessibility to only a single mode of transportation can not be considered as a freight village in European terms

c. *A location with commercial and non-commercial synergy potentials for the tenants, including the establishment of suitable organizational structures*, so it should be open to further development for service innovation and collaboration among the customers.

Reference [19] reviewed the literature to find out that there are two major points of view when defining the logistics center concept. The first one sees the logistics center as a part of the transportation infrastructure, the second one views it as a business generator with all value-added activities it serves.

Having reviewed the above given definitions of the logistics centers, the inputs, structure and the outputs of a logistics center are summarized in Figure. 1.

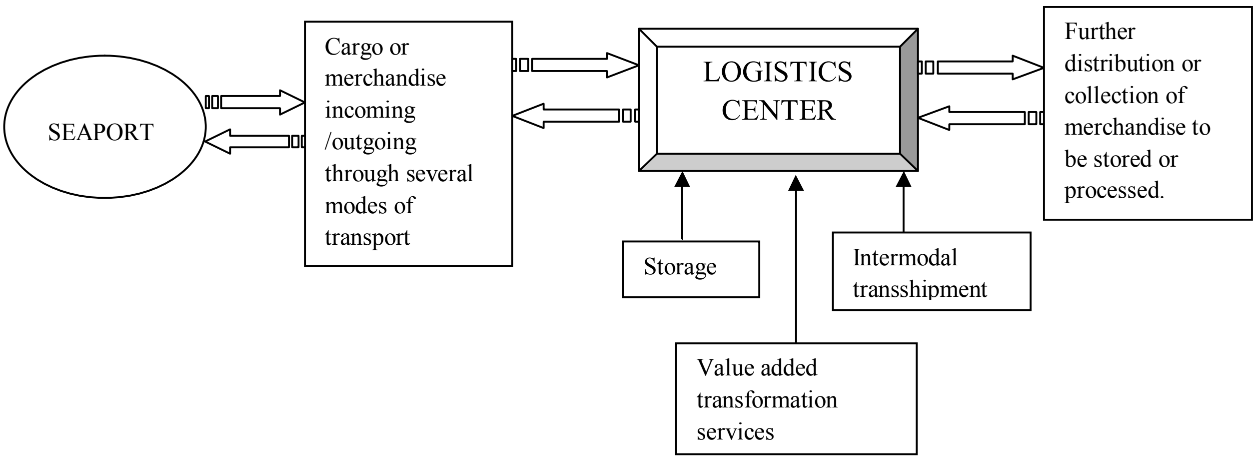

FIGURE. 1
The Logistics Center Structure

With reference to prior work and existing practice, this study defines the logistics center concept as inland nodes of seaports and global supply chains which are accessible through more than one mode of transport and which provide value added logistics services according to the demands of the customers existing within the geographical coverage through the governance of a single logistics center operator serving to a large number of service providers accomodated in the same area.

As the logistics services given by logistics centers serve to other organizations taking part in the overall movement of goods and services from the point of origin to the point of consumption throughout the world, this service can be classified as an industrial service. As there are slightly significant differences between consumer markets and industrial markets, there are several differences between the buying behavior of organizations for physical goods and services. These differences should be taken into account in terms of customer's evaluation criteria during industrial service buying processes.

3. INDUSTRIAL SERVICES PROVIDED BY LOGISTICS CENTERS

Although the services of logistics centers differ among the general demand structure of the markets that they are located in, there are some common services which are generally required from them. Eventually, the services they provide are related with the customers they serve. In general the customers of logistics centers can be gathered under two main titles: (1) the importers, exporters or cargo owners (2) the logistics service providers (including transportation services operators) operating in the logistics center or considering to carry their operations to the logistics center.

The traditional logistics functions like shipping and receiving, storage, order picking, break-bulk, freight consolidation and deconsolidation, containerization are all prevalent in general at logistics centers. However, due to the increasing global competition and technological advancements many value-added services are being demanded from logistics centers today. Just-in-time practices and postponement requirements caused the outsourcing of packaging, labeling, barcoding, inspection, assortment promotional assembly services to logistics centers. Lead logistics management practices require vendor management, procurement, customer service functions, total logistics management, information technology management, inventory control and tracking services by the customers [25]. Other standard services that shall be provided by logistics centers can be listed as container stuffing and unstuffing, rail-road transshipping, customs clearance and container maintenance and repair [14].

According to reference [17], services' marketing has 3 more Ps in addition to the classical 4 Ps of marketing. The 7 Ps of services marketing are product, place, promotion, price, process, physical environment and people. These 7 Ps shall be managed well in order to perform a higher quality service and maintain customer satisfaction. It is important for service providers to learn what their customers look for in excellent service, to classify them under these 7 Ps and manage them in accordance with industry objectives. In addition, the standard characteristics of services like intangibility, inseparability, heterogeneity and perishability [27], industrial services have complementary characteristics like specialization and technology [9]. These characteristics should be taken into account when classifying the customers' industrial buying criteria from logistics centers.

Reference [13] analyzes the industrial buying process over two main dimensions: risk probability and risk importance. Reference [5] states that information/experience availability prior to purchase and ease of interpretation of the information are two important dimensions in logistics service buying process. Communication quality and conflict resolution are important aspects in buyer seller relationships in industrial markets [8]. Reference [6] classifies industrial services into three main groups of elementary services, intermediate services, intricate services depending on five main dimensions which are replacement rate, essentiality, complexity, personal delivery and credence. Reference [18] have conducted a focus group research in order to specify the key success factors of industrial services and according to their findings industrial service providers think that explicit service quality, proactive, total solution and timely, empathic design of new services are key success factors in industrial service.

Being a recent subject which attracts significant attention of trade and industry zones in Turkey, logistics centers are being explored by many scholars and researchers from different aspects [2;3;7;15;16]. However, there seems to be a variety of definitions and conceptualization efforts both in domestic and international literature. It is hard to build up a successful structure on a concept that has vague areas which need to be explored, defined and customized for Turkey. This study is an exploratory effort to discover the important aspects of logistics centers by searching them through the voice of the potential customers.

4. METHODOLOGY

According to reference [21], focus groups are used to generate and collect data in exploratory research especially for previously unexamined topics. By bringing people who share similar background or interest together, focus groups create opportunity to produce new ideas or determine some dimensions in the subjects that the researchers wish to understand.

Focus groups could provide information about a range of ideas and feelings that individuals have about certain issues, as well as illuminating the differences in perspective between groups of individuals. In order to have effective outputs, it is recommended that the size of focus groups should be limited between six and ten so as to gain variety while avoiding fragmentation [24]. Nevertheless, some groups fomed of twelve people might be seen in order to perform a large coverage.

Depending on the exploratory data generating characteristics of focus groups, this research method was chosen for this study. The focus group session was conducted on possible users of a logistics center that is to be established in the area of Izmir in order to explore their buying criteria when deciding to purchase services from the logistics center. Ten people from the different areas of logistics sector were invited to the focus group session. However, due to their schedules and previously planned meetings, only six people were able to attend. Keeping their areas of expertise in mind, these six people formed a homogeneous sample in terms of the knowledge about logistics centers but all represented different points of view due to their customized professions.

Four basic questions were prepared which were sequenced in a deductive nature from the most general towards the most specific subject. The session lasted for 90 minutes and every participant had the chance to reply to each of the questions. They also filled up two question forms, one requiring personal profile information and the other requiring quick notes on the discussion questions. Both forms were collected at the end of the session. The whole session was recorded by two observers and also tape recorded as a cross-checking tool with the recorded transcripts. The findings are analyzed out of these transcripts and question forms.

5. FINDINGS

The demographic profile of the participants can be seen on Table 1. The average age of the participants is 38,8 and average tenure is 11,6 years. The youngest participant is 29 years old and the oldest participant is 55 years old. There is a significant difference in tenure where the shortest tenure is represented by 8 months in the same organization and the longest tenure is represented by 32 years in the same organization. Five of the participants have bachelor’s degree where one participant has associate’s degree.

TABLE 1
Demographic Profiles

Participants	1	2	3	4	5	6
Age	29	45	34	35	35	55
Tenure	2,5 years	19 years	3 years	8 months	12 years	32 years
Duty	Foreign Trade Manager	Fair Transport and Logistics Services Management	Manager (Bonded Warehouse)	Sales & Marketing Manager (Port)	Foreign Agency Management Assistant Manager (Sea Trade)	CargoTransport Manager (Railroads)
Education	Bachelor's	Bachelor's	Associate's	Bachelor's	Bachelor's	Bachelor's
Sector	Dried & Frozen Food Products	International Transport & Logistics	Logistics	Port	International Sea Transport & Shipping Agency Management	Rail Transportation

The discussions are analyzed taking reference [1]'s focus group analysis as basis and the important quotes are listed below. After that, the views are evaluated by the authors.

5.1. Required Services and Buying Criteria

The question asked to generate this information was "What are the general services and characteristics that you think should be available in a logistics center which is possibly to be established in or near Izmir?"

1:*I, as a customer, would like to reach all the services that I need from one stop in a logistics center. This would decrease my communication costs.*

5:*The problem is, one company is not able to handle all of the services that are needed by the logistics customer.*

2: *Let us think that the logistics center is established. I have doubts about the distribution of duties to separate entities.*

The participants started to share their ideas about the distribution of sources and the management style of the logistics center here. According to the findings, different parties are all reluctant about this issue. They are afraid of competition conditions and the quality of service that will be created in such a center. The real shipper view shows that one stop shopping is a great advantage for them but the logistics concept has a wide range of facilities which are not among the expertise limits of single companies.

The required services mentioned by the participants can be listed as seaport-railway connection, telecommunication networks, communication infrastructure, customs, social facilities (accomodation, dining, shower services), banking and finance sector and also repair centers, electronic and mechanic workshops. These repair centers are asked for both machinery and equipment repairs that are urgent and frequent in logistics facilities and also for trucks and other vehicles that oftenly face with break-downs.

6: *The ownership of logistics centers belong to either one single company or public-private partnerships in Europe.* (Gives some examples from Italy and France) *We are in favor of these partnerships. Postal offices, customs, banks, restaurants, information technologies, optical databases, bonded warehouses, warehouses, repair areas must be available in logistics centers. Railways should be present and the necessary infrastructure like receipt and shipment docks that are able to accomodate rail cars, ramps that are able to facilitate forklift stuffing, container stocking yards, portal cranes and rail connections into the warehouses should be prevalent.*

4: *I think logistics centers should be close to ports and industrial zones. Rail and land transport can reach logistics centers but vessels can not!*

2: *Without a railway, there can not be a logistics center. Railways serve as a customs corridor and would facilitate bonded transshipment without a transit declaration or deposit so will save from time and money.* These quotes state that railway connection is a must for the logistics center. As the railroads are operated by the state in Turkey, this requires the government partnership in such an investment for sure. Any project that will be undertaken within this context will require public cooperation.

3: *The main question is "Is Turkey ready for this?" or "Is Izmir ready for this?". I think that Izmir is not ready. When we made a research about this subject last year, we were faced with many barriers from competitors, the state, customs officers. The customs legislation should definitely be changed. The logistics center should not turn into a monopoly. Head of customs, working offices, warehouses, dangerous goods or cold storage facilities, truck parking yard, railroad should be prevalent.*

6: *Extensive planning is necessary.*

(Collective service in a single location emphasized by 6 but was opposed by 3 due to competition concerns.)

5: *The costs are important. The customers are not ready for these services but the investors would expect a decent return for their investment.*

(The legislation, the pace of state procedures, flexibility, adaptability concerns, fast state service are emphasized and a new idea of "*Coordinator Minister*" whom would be able to speed up and eliminate all the bottlenecks in the services of logistics centers is generated.)

The longest discussion lasted upon the first question. The results show that there are many different services required from logistics centers but by checking the repetition numbers and emphasis, the most important aspects are railway connection and state mentality together with the legislation. The good examples from Europe were quoted by the participants but the adaptability of such an organization to Turkey seems to require changes in Turkish logistics business.

5.2. Advantages and Disadvantages

6: *The advantages for us are the ability to deliver cargo to a single point instead of distributing to dispersed locations. This means lower number of personnel, higher speed and efficiency. Besides we will be at the center of the cargo. Marketing research won't be necessary anymore. Empty rail car transports will be eliminated which is a total loss for us.*

5: *The decreased costs for inland transport before loading on to vessels are an advantage.*

The advantages mentioned were the decreasing production costs due to the combined transport opportunities and shortened distances (depending on the location of the logistics center) The port's view is that the logistics center will serve as an empty container stocking yard for them where this service is highly inefficient in the port area. Other advantages mentioned were the unity of all service providers, increased service quality due to increased competition and expertise, employee and employer matching in a specialized are. Another mentioned advantage was the positive effect on the environment as the current facilities in the city are creating a great mass of pollution and the rail connection is an environment friendly way of transportation.

Here the paradox was about the extra costs that will incur due to the incremental services provided as the costs are mentioned both in the advantages and disadvantages part. However, the shipper view states that the customers would bear the cost of an improved service. Logistics costs already form a large portion of the overall manufacturing cost, but elimination of errors and creation of a better working process through a professional center would generate additional competitive advantage for these users. The service providers are cautious about this cost issue because they do not fully believe that this additional price margin will cause a loss in the market share for them. These concerns should be eliminated.

1: *Logistics costs constitute a great portion when the whole production is taken into consideration. So I think that if the service quality will increase at the end, the customers will bear the cost. Also railways would contribute to the environment as the current situation in the middle of the city causes serious environmental pollution.*

Moderator: *What are the disadvantages?*

5: *The inflexibility of state is a disadvantage, private sector must be there. High costs and competition may be disadvantageous.*

2: *The returns of existing investments have not been earned yet. So the establishment of such a center would decrease the value of these existing investments in different locations. Besides there is an alive economy in Alsancak. Carrying all logistics activity to a center located in a different place would incur social and economic problems for Alsancak economy.*

According to the discussions upon question 2, the unity of all service providers, lowered transport, stocking and handling costs are all advantages. However, some participants are hesitant about the costs in terms of extra competition, the value of existing facilities and the situation of current economy.

5.3. Reasons to Participate

What are the reasons that you decide to participate and invest in a logistics center when you think from your institution/company's point of view?

2: *Some companies want to be among the first-movers. This is a strong motivation for us. Investment cost and finance management are important.*

4: *The location is important for us. If it is not close to our port, we would not invest in such a facility. Besides we always talk in terms of containers but bulk cargo facilities are important. Special handling equipment and silos for bulk cargo would attract our attention towards logistics centers.*

Majority of the responses to Question 1 are repeated in this section so they are not quoted once again. Only the new ideas are listed in terms of purchasing criteria. The results are summarized in Table 2.

6. RESULTS AND CONCLUSION

According to the summarized results listed in Table 2, the industrial services that are required from logistics centers vary according to the expectations of different parties. In the mean time, these different parties agree upon some of the services are musts and they create the notion of logistics centers. These musts can be listed as the seaport-railway connection, one-stop shopping characteristics, customs corridors (free zone characteristics were emphasized during the session) and the change in the customs legislation.

When the transcripts are analyzed, it can easily be seen that a logistics center can be defined and characterized by the European best examples. However, adapting this concept to Turkey will require a great deal of customization due to the business structure and the prevailing industrial realities. Even regions differ in terms of customer requirements, customer structures, service demands and the cost bearing thresholds. These all should be taken into consideration before investing in such a facility. Establishing the physical infrastructure with taking the industrial buying criteria mentioned in Table 2 won't be enough to maintain an efficient, developing and promising logistics center. Convincing the possible participants about the management style, the costs, the elimination of governmental procedures will have a greater impact in encouraging them to invest in these centers.

The study also indicates that there will be some conflicting interests in an organization that contains so many different entities within its boundaries. For example, the participant coming from the port states that they would not invest in such a facility if it weren't close to the port. What they need is a back support for their port operations in a logistics center. This requirement may contradict with other participants' requirements as they all are highly sensitive about the investment costs and the transportation costs to/from the logistics center. Location will affect these costs directly.

TABLE 2

The Summary of the Focus Group Session

Participants	1	2	3	4	5	6
Required Services and Buying Criteria	One-stop shopping	Duty distribution Seaport-railway connection Telecommunication network Communication Customs Social facilities Repair center Customs corridor First-mover advantage Investment cost Financing options	Mentality Head of customs Legislation Working offices Warehouses (special cargo storage) Truck parking yard Railroad	Banking and finance services Proximity to ports and industrial zones Location Bulk cargo facilities	The costs The management	Ownership Postal offices Customs Banks Restaurants Information technology Optical database Bonded warehouse Normal warehouse Railroad infrastructure Container yards Extensive planning
Advantages	Service quality Environmental protection (due to railways)	High-skilled labor match		Lower costs Collection of hinterland cargo Empty container stocking yards	Decreased total cost for door to door transport	Single point delivery Efficiency Speed Elimination of empty rail car movement
Disadvantages		Decreasing value of existing facilities The negative social and economical effects on current activity in Alsancak			Inflexible state operations Competition Costs	
Big Idea(s)		Coordinating Minister from the state				

As a result of this study, industrial buying criteria of possible investors in the logistics center that is to be established in or around Izmir are explored. Data generation was done through the help of a 90 minutes focus group session. The findings of this study constitute the views of different parties involved and so present a valuable resource for both researchers and practitioners of this area. The outputs show that besides the services needed, there are some other broader functionalities that are required from logistics centers. These should be examined in greater depth in future studies. More exploratory and empirical effort is needed in order to determine country and region specific demands from a future logistics center.

ACKNOWLEDGEMENT

The authors would like to thank, Assistant Professor Duygu Turker from Yasar University and our student Mr. Ugurcan Soylemez for their assistance during focus group session.

REFERENCES

[1] Allock, S., Plenty, A. Webber, S., Yeates, R. (1999) Section 13: Analysis of Focus Groups. In Business Information and the Internet: Use of Internet as an Information Resource for Small and Medium Sized Enterprises: Final Report. London: the British Library.

[2] Aydin, G.T. & Ogut, K.S. Avrupa ve Türkiye'de Lojistik Köyleri, http://www.ins.itu.edu.tr/ksogut/Avrupada%20ve%20T%C3%BCrkiyede%20lojistik%20k%C3%B6yler.PDF, visited on 11/07/2011.

[3] Aydin, G.T. & Ogut, K.S. Lojistik Köy Nedir? http://www.ins.itu.edu.tr/ksogut/Lojistik%20K%C3%B6y%20Nedir.PDF, visited on 11/07/2011.

[4] Ballou, R.H. (2004). *Business Logistics/Supply Chain Management*. New Jersey: Pearson Education.

[5] Bienstock, C.C. (2002) Understanding Buyer Information Acquisition for the Purchase of Logistics Services, International Journal of Physical Distribution and Logistics Management, 32 (8), pp.636-648

[6] Boyt, T. & Harvey, M. (1997)Classification of Industrial Services A Model with Strategic Implications, Industrial Marketing Management 26, pp. 291-300

[7] Cevik, S. & Kaya, S. (2010) Turkiye'nin Lojistik Potansiyeli ve Izmir'in Lojistik Faaliyetleri Acisindan Durum (SWOT) Analizi, Izmir Ticaret Odası AR-GE Bulten, Kasim, pp.22-28

[8] Claycomb, C. & Frankwick, G.L. (2010) Buyers Perspectives of Buyer-Seller Relationship Development, Industrial Marketing Management, 39, pp. 252-263

[9] Cooper, P.D. & Jackson, R.W. (1988) Applying A Service Marketing Orientation To The Industrial Services Sector, *The Journal of Services Marketing;* 2 (4); pp. 67-70

[10] Council of Supply Chain Management Professionals, CSCMP, http://cscmp.org/digital/glossary/glossary.asp visited on 10/06/2011.

[11] DGG, (2010) Ranking of the European Freight Village locations – Benchmarking of the European experiences, Bremen: Deutsche GVZ-Gesellschaft mbH.

[12] Europlatforms, http://www.freight-village.com/definition.php visited on 11/06/2011.

[13] Hunter, L.M., Kasouf, C.J., Celuch, K.G. & Curry, K..A. (2004) A Classification of Business-to-Business Buying Decisions: Rish Importance and Probability as a Framework for E-Business Benefits, Industrial Marketing Management, 33, pp. 145-154

[14] Iannone, F., Thore, S. & Forte, E. (2007) Inland Container Logistics and Interports. Goals and Features of an Ongoing Applied Research, Italian Society of Transport Economists, Ninth Scientific Meeting, Naples.

[15] Kaynak, M. & Zeybek, H. (2007) Intermodal Terminallerin Gelişiminde Lojistik Merkezler, Dağıtım Parkları ve Türkiye'deki Durum, *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi 9(2)*pp. 39-58

[16] Kilic, Y., Karaatli, A., Demiral, F., Pala, Y. Gelişmekte Olan Ülkelerde Sürdürülebilir Kalkınma Açısından Lojistik Köyler: Türkiye Örneği, http://idc.sdu.edu.tr/tammetinler/kalkinma/kalkinma50.pdf, visited on 11/07/2011.

[17] Lovelock, C. & Wirtz, J. (2011) Services Marketing: People, Technology, Strategy, USA: Pearson.

[18] Matthyssens, P. & Vandenbemt, K. (1998) Creating Competitive Advantage in Industrial Services, Journal of Business & Industrial Marketing, 13 (4/5), pp. 339-355

[19] Meidute, I (2005) Comparative Analysis of the Definitions of Logistics Centers, Transport 20 (3) 106-110

[20] Mentzer, J.T., Flint, D.J. & Hult, T.M. (2001) Logistics Service Quality as a Segment-Customized Process, Journal of Marketing, 65 , pp.82-104

[21] Morgan, D. L. (2008) Focus Groups, in The Sage Encyclopedia of Qualitative Research Methods, Given, L.M. (Ed.), pp.352-354

[22] Nathanail, E. (2007) Developing and Integrated Logistics Terminal Network in the CADSES, Transition Studies Review, 14(1) pp. 125-146

[23] Notteboom, T. (2009) - *Why do we need dry ports? Some experiences from Europe* - In: Proceedings of the International Forum on Shipping, Ports and Airports (IFSPA), Hong Kong Polytechnic University.

[24] Rabiee, F. (2004) Focus- Group Interview and Data Analysis, Proceedings of the Nutrition Society, 63, pp. 655-660

[25] Rimiene, K. & Grundey, D. (2007) Logistics Center Concept through Evolution and Definition, Engineering Economics 54(4), pp. 87-95

[26] Roso, V., Woxenius, J. & Lumsden, K. (2009) The Dry Port Concept: Connecting Container Seaports with the Hinterland, Journal of Transport Geography, 17, pp. 338-345

[27] Zeithaml, V.A., Bitner, M.J. & Gremler, D.D. (2009) Services Marketing: Integrating Customer Focus Across the Firm, Singapore: McGraw Hill.

DISTRIBUTION CENTER LAYOUT DESIGN SELECTION BY USING AXIOMATIC DESIGN: A SPECIFIC CASE FOR FRUITS AND VEGETABLES WHOLESALE MARKET HALL

Mehmet Tanyaş[1], Umut Rıfat Tuzkaya[2], Özge Nalan Alp[3], Nurgül Demirtaş[4], Hayri Baraçlı[5]

Abstract – *Vegetable and fruit halls in metropolises are a kind of urban distribution centers which affect the freight transportation of the city and the neighborhood. The important part of the fruit and vegetable supply chain starts at the agricultural producers. Products come to the hall by big trucks and trailers and then continue from hall to the retailers by pick-ups and vans. The layout design of a vegetable and fruit hall should consider the logistical principals before the architectural and esthetical aspects. While designing hall layout alternatives, integrated logistics activities should be taken into account such as, transportation, warehousing, packing, and value added services etc. In the evaluation of the alternative layouts, cost, time, operation quality, working environment and safety criteria and their probable sub-criteria can be used. In this study, considering these criteria, the most appropriate layout for the fruit and vegetable hall is tried to be determined conceptually. In the first phase of the study alternative layouts are generated inspiring from the good instants of different countries and realizing interviews with the decision makers who are retailers, wholesalers in the hall, truck and pick-up drivers. In the second phase the alternative layouts are evaluated according to the main and sub-criteria by using axiomatic design which is one of the multi criteria decision making techniques.*

Keywords — *Fruits And Vegetables Hall, Layout Selection, Axiomatic Design, City Logistics*

INTRODUCTION

The supply chain of the perishable products with limited shelf life has various critical decisions in strategic and operational levels. Harvesting, packaging, transporting and warehousing can be considered as the main operations of the supply chain and have a vital effect on the shelf life and salability of the perishable products. Most of the products, which transported from harvest place to the city where they are sold, spend a short time for cross docking operations in wholesale market halls. These halls are dynamic environments where the products arrive and leave almost the same day. Beside the accurate operational decision in wholesale market hall, strategic decisions play an important role to deal with quick changing environment. A well design layout is one of the most important points in terms of the stakeholders' benefits.

The facility design process of, especially, a Fruit & Vegetable Wholesale Market Hall (F&VWMH) should perform the expectations of various actors like sponsors and founders of the hall, retailers, wholesalers, truck drivers and pickup drivers, who are the decision makers of this study. Truck and pickup drivers claim to minimize the total duration between entrance and leaving times to the F&VWMH. Retailers hope to see more exhibits of the wholesalers as much as possible in a short time. Since the most of the products are perishable and delicate in a F&VWMH, their handling operations should be minimized to not damage and the environmental effects on them should be considered throughout the process. Local governments, sponsors and founders of the hall are interested in the low investment cost which includes building, materials and equipment to be used, while fulfilling the requirements of the users. Also the operating and supporting costs should be minimized while providing a contemporary working environment. Although the expanding opportunities of a hall are mostly related with the location selection decisions and neighborhood of it, layout also should be designed considering this future necessity.

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Beside the above mentioned stakeholders who are directly affected from the layout of F&VWMH, city residents can be affected badly due to the high-density traffic, visual pollution, environmental pollution etc. A F&VWMH layout with inadequate designed parking areas, storage areas, cold storage warehouses, supporting facilities, loading/unloading platforms and docks causes truck and pickup queues in front of the hall docks or environmental pollution due to the rotten products and wastes. As a result, these objectives and constraints should be taken into account in the design phase of a hall. Determining the relative locations and the sizes of warehouses and the exhibition areas is very important. Relations of the products which can be affected from each other should be considered while calculating the indoor and outdoor requirements. Also by using statistical data, retailers, who are the customers of the F&VWMHs, may be classified to the groups with respect to the product group that they intended to buy. Thus, a cellular layout can be design by providing the aim of short walking time for the retailers in the hall.

In this study, we focused on the selection phase of the most convenient layout for the new planned F&VWMH in east side of Istanbul. The alternative layouts, which are designed considering the facts of Istanbul, are obtained from the hall. The main and sub criteria are determined considering the opinions of the decision makers and the literature. Then the alternatives are evaluated with axiomatic design by using the chosen criteria to find the best layout alternative for Istanbul. The study continues with the literature review to show the lack of F&VWMH layout design problems. The used methodology, axiomatic design, and its calculation steps are given in next section. Then the methodology is applied for Istanbul FVWMH selection problem and the results are discussed.

LAYOUT DESIGN PROBLEMS

In the literature, there are many kinds of studies related facility design and layout alternative selection problems. Ertay et.al. have presented a decision making methodology based on data envelopment analysis (DEA), which uses both quantitative and qualitative criteria for evaluating facility layout design. They integrated DEA and AHP methodology to solve layout design problem by using a real data set of a case study for plastic profile production system [1]. Altuntaş and Selim have studied about static facility layout problem and they have proposed weighted association rule-based algorithms. Their weighting criteria to address the needs in practice are “demand”, “part handling factor” and “efficiency of material handling equipment” [2]. Drira et.al. have suggested a general framework to analyze the literature and presented the studies which uses the manufacturing system features, static/dynamic considerations, continual/discrete representation, problem formulation, and resolution approach criteria [3]. Aboolian et.al. have developed a model that have optimize the location and design for a set of new facilities. They have considered multiple facilities, elastic concave demand and multiple design characteristics [4]. Gonzalez-Cruz and Martinez have proposed an algorithm that generates layouts for workstations and departments in a plant. Their algorithm evaluates each possible arrangement by an entropy function, and then the layout with the lowest entropy value is selected as the optimal solution [5]. Maniya and Bhatt presented a systematic and an alternative multiple attribute decision making methodology based on the preference selection index method for selection of facility layout design selection problems [6]. Sahin has combined the objectives of minimization of the total material handling cost (quantitative) and the maximization of total closeness rating scores (qualitative) and proposed a simulated annealing algorithm to solve this bi-objective facility layout problem [7]. Meller et.al. studied an alternative approach, termed a bottom-up approach to layout, where the problem is reformulated such that detailed layout alternatives are first constructed and then selected for placement in a block layout [8]. Taghavi and Murat have studied layout design and product flow assignment problem in their article. They have developed an efficient iterative heuristic procedure to solve this integrated problem [9]. Ashayeri et.al. have presented a heuristic approach facility location and facility layout problem for a good facility design. These problems have some sub problems and all these problems can be solved by p-median clustering [10]. In this study, we used a multi criteria decision making approach which is not applied in the literature to alternative layout selection for fruits and vegetables wholesale market hall.

METHODOLOGY: AXIOMATIC DESIGN

Axiomatic Design (AD) is a method developed to design scientific fields for products, system and process by Suh. [17]. The most important concept in AD is the existence of the design axioms. The first design axiom is known as the Independence Axiom and the second is known as the Information Axiom. [15]

Axiom 1 (The Independence Axiom): Axiom states that the independence of functional requirements (FRs) must always be maintained, where FRs are defined as the minimum set of independent requirements that characterizes the design goals [16].

Axiom 2 (The Information Axiom): The Information axiom states that among those designs that satisfy the Independence Axiom, the design that has the smallest information content is the best design [15]. Because the information content is defined in terms of probability; but also the design that has the most probability of realization according to the second axiom, is the best design [17].

Information is defined in terms of the information content, I_i, that is related in its simplest form to the probability of satisfying the given FRs [13]. The probability of density function (p_i) identifies the satisfaction level of design characteristics with respect to pre-defined FR_s. Equation (1) gives the I_i [15]:

$$I_i = \log_2(\frac{1}{p_i}) \quad (1)$$

Information is given with a small unit. At the same time the logarithmic function is chosen to add the information content when a lot of FR is needed. When there are n FRs, the total information content is the sum of all these probabilities. If "I" approaches infinity, the system will never work. When all probabilities are one, the information content is zero, and conversely, the information required is infinite when one or more probabilities are equal to zero. If this probability is low, more information is needed for FRs [17].

In any design situation, the probability of success is given by what designer wishes to achieve in terms of tolerance (i.e. design range) and what the system is capable of delivering (i.e. system range). As shown in Figure 1, the overlap between the designer-specified 'design range' and the system capability range 'system range' is the region where the acceptable solution exists. Therefore, in the case of uniform probability distribution function p_i may be written as (2) [13].

$$p_i = \left(\frac{common\,range}{system\,range}\right) \quad (2)$$

Therefore, the I_i can be expressed as (3) [15]:

$$I_i = \log_2\left(\frac{system\ range}{common\ range}\right) \quad (3)$$

The probability of achieving FR_i in the design range may be expressed, if FR_i is a continuous random variable, as (4) [16].

$$p_i = \int_{dr_i}^{dr^u} p_s\left(F\dot{I}_i\right)dF\dot{I}_i \quad (4)$$

$ps(FR_i)$ is the system Probability Density Function (PDF) for FR_i. Equation (4) gives the probability of success by integrating the system PDF over the entire design range (i.e. the lower bound of design range, dr_l, to the upper bound of the design range, dr_u) [13].

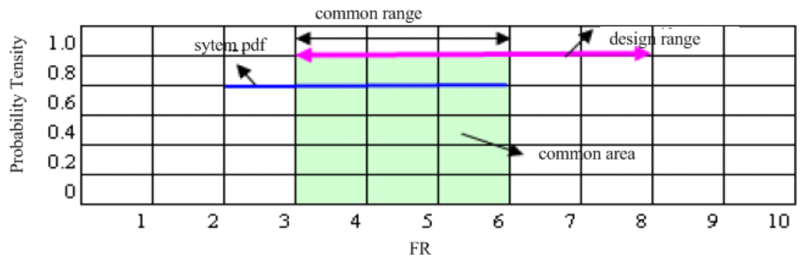

FIGURE. 1
Design Range, System Range, Common Range And PDF Of A FR [17]

Intersection area between design range and system range is common range (cr) and this area only provides FRs (Figure 1). In Figure 2, PDF of FR are given.

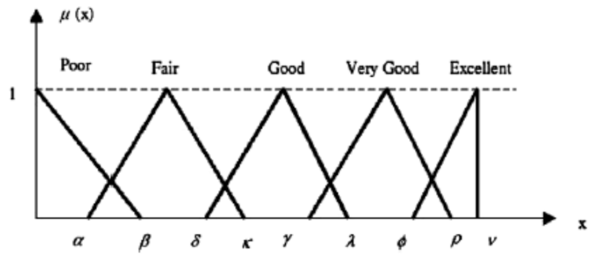

FIGURE. 2
Triangular Fuzzy Numbers [17]

A_{sr} is the bottom area of the system range, A_{cr} is the bottom shaded area of common range. Generally A_{sr} is 1.0, so the Ii can be expressed via (5, 6) [17]:

$$I = \log_2(A_{sr} / A_{cr}) \quad (5)$$

$$I = \log_2(1 / A_{cr}) \quad (6)$$

FUZZY AXIOMATIC DESIGN

Multi criteria decision making techniques in the literature are solutions when data is not crisp and fuzzy AD approach can also be used in a way that data is not crisp. The fuzzy data can be linguistic terms, fuzzy sets, or fuzzy numbers. If the fuzzy data are linguistic terms, they are transformed into fuzzy numbers first. Then all the fuzzy numbers (or fuzzy sets) are assigned crisp scores. Fuzzy set theory is an important tool that can be used at this stage [17]. In Figure 3, numerical approximation systems are proposed to systematically convert linguistic terms to their corresponding fuzzy numbers [16].

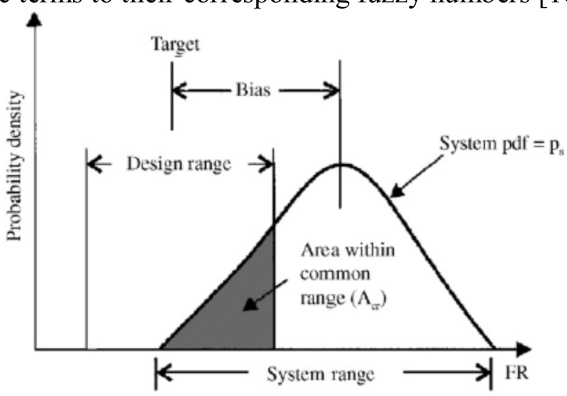

FIGURE. 3
The Numerical Approximation System For Intangible Factors [17]

In the fuzzy case, we have incomplete information about the system and design ranges. The system and design range for a certain criterion will be expressed by using ‘over a number’, ‘around a number’ or ‘between two numbers’. Triangular or trapezoidal fuzzy numbers can represent these kinds of expressions [17].In the fuzzy case, we have incomplete information about the system and design ranges. The system and design range for a certain criterion will be expressed by using ‘over a number’, ‘around a number’ or ‘between two numbers’.

Triangular or trapezoidal fuzzy numbers can represent these kinds of expressions. We now have a membership function of triangular or trapezoidal fuzzy number (TFN), whereas we have a probability density function in the crisp case. So, the common area is the intersection area of triangular or trapezoidal fuzzy numbers. The common area between design range and system range is shown in Figure 4[13]. Therefore, information content is equal to

$$I = \log_2\left(\frac{TFN\ of\ System\,Design}{Common\ Area}\right) \qquad (7)$$

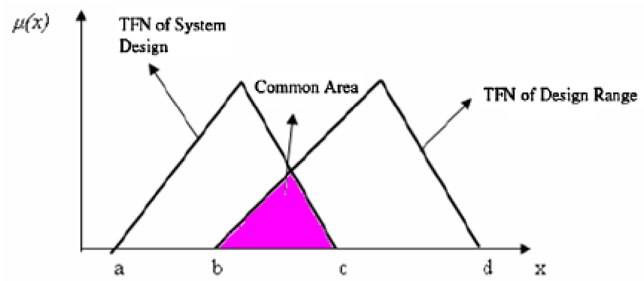

FIGURE. 4
The Common Area Of System And Design Ranges

Weighted Fuzzy Axiomatic Design

In the method in Section 2.2 , the weights for all sub-criteria are equal. If the decision-maker wants to assign a different weight (w_j) for each criterion, the following weighted multi attribute AD approach can be used.

Equation (8) is proposed for the weighted multi-attribute AD approach:

$$\left\{\begin{array}{ll} \left[\log_2\left(\frac{1}{p_{ij}}\right)\right]^{1/w_j} & ,0 \le I_{ij} \le 1 \\ \left[\log_2\left(\frac{1}{p_{ij}}\right)\right]^{w_j} & ,I_{ij \ge 1} \\ w_j & ,I_{ij=1} \end{array}\right\} \qquad (8)$$

Where I_{ij} is the information content of the alternative i for the criterion j; w_j the weight of the criterion j; p_{ij} is the probability of achieving the FR_j for criterion j [17].

APPLICATION OF THE METHODOLOGY FOR F&VWMH LAYOUT SELECTION

In our study we will make the decision among five main criteria and thirteen sub-criteria of these main criteria. Our main criteria are Cost, Time, Operation Quality, Working Environment and Safety.

1. *Cost*
   - ✓ Investment costs: This cost includes the building, land, construction costs.

- ✓ Operation costs like energy, workforce: these costs occur because of the operating costs. The energy costs include electric, water and natural gasses costs and workforce costs include the costs those have work for the agents and the other people those work for the other facilities in the market hall.
- ✓ Overhead costs: these costs are building, land costs etc.

2. *Time*
    - ✓ Time between entry and exit of a truck to hall
    - ✓ Time between entry and exit of a pickup truck or van to hall
3. *Operation Quality*
    - ✓ Handling operations in the hall
    - ✓ Transportation of vegetables and fruits in the hall
    - ✓ Storing conditions
4. *Working Environment*
    - ✓ Supporting facilities (pharmacy, maintenance areas, fuel stations)
    - ✓ Social facilities (fitness center, restaurants , Hotels)
    - ✓ Expansion possibilities
5. *Safety*
    - ✓ Probability of burglary
    - ✓ Probability of accidents

In axiomatic design we have to determine the design and system ranges. So, after we have determined our criteria we have asked the decision makers about design and system ranges. Our decision makers are customers, fruit and vegetable wholesalers (brokers), truck drivers and pickup truck or van drivers. They have evaluated the criteria as Weak, Fair, Good, Very good and Excellent. There are four layout alternatives. The alternatives' figures and their advantages and disadvantages are explained above.

First Alternative:

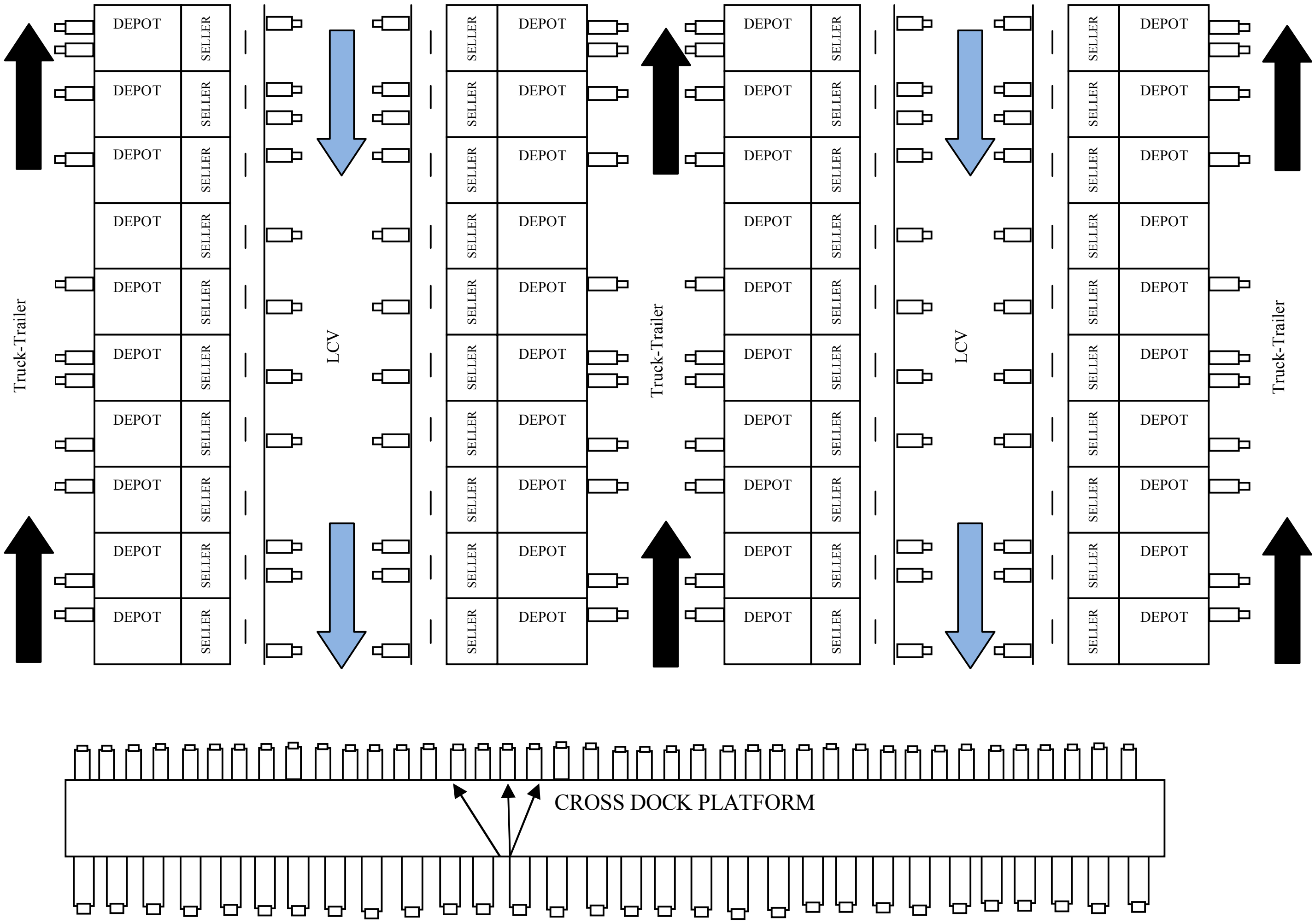

FIGURE. 5
Layout Alternative 1

LCV: Light Commercial Vehicles

Advantages:

- The vehicles that come to unload the freight and the customer vehicles that come to buy the products will not come across and the traffic congestion will be decreased.
- The work places' doors functionality will not be decreased because there will not be any stricture and enlargement on them.
- There will not be any need to invest on handling equipment such as forklifts.
- A new space will be departed for cross docking of some fruits such as melon, watermelon so the traffic congestion will be decreased.

Disadvantages:

- The fruits and vegetables will be influenced by the gasses and will be harmed or special air conditioning cautions will be taken.
- Because of the architectural layouts will be blocked, to supply the customer transition the pedestrian lane will be needed.
- The pedestrians will go out open space and come under the outside conditions.
- Light commercial vehicles(LCV) and commercial vehicles will come across partially.

Second Alternative:

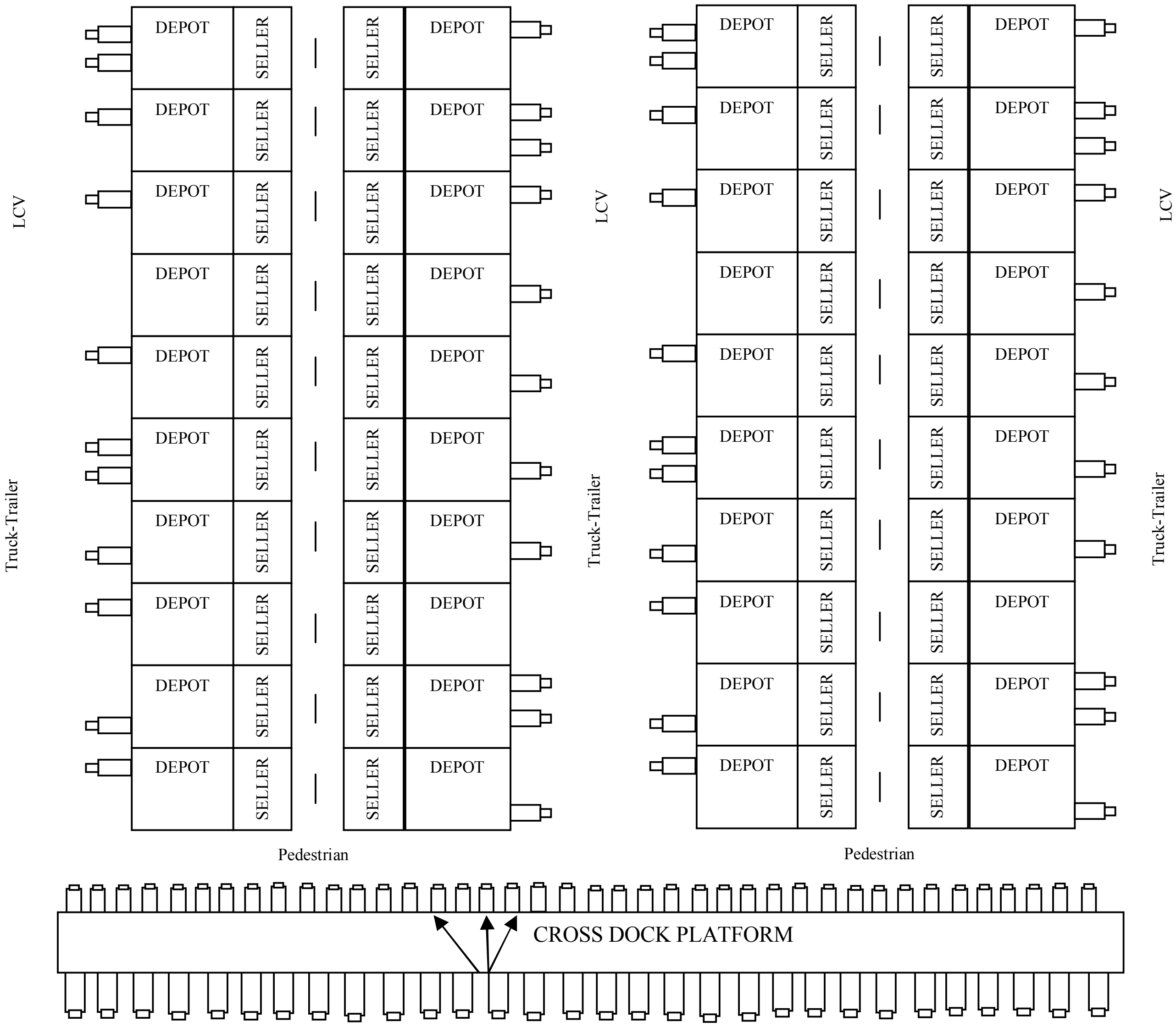

FIGURE. 6
Layout Alternative 2

Advantages:

- The fruits and vegetables will not be damaged by the harmful gasses of vehicles.
- It is not necessary to invest to the handling equipment a lot.
- The traffic congestion will be decreased because an area will be departed for the cross docking.
- The customers will not be affected from the outside air conditions and will do their shopping easily.

Disadvantages:

- The vehicles those come for unloading the products and the customer's vehicles will take the service from the same door. This situation will cause the traffic congestion.

Third Alternative:

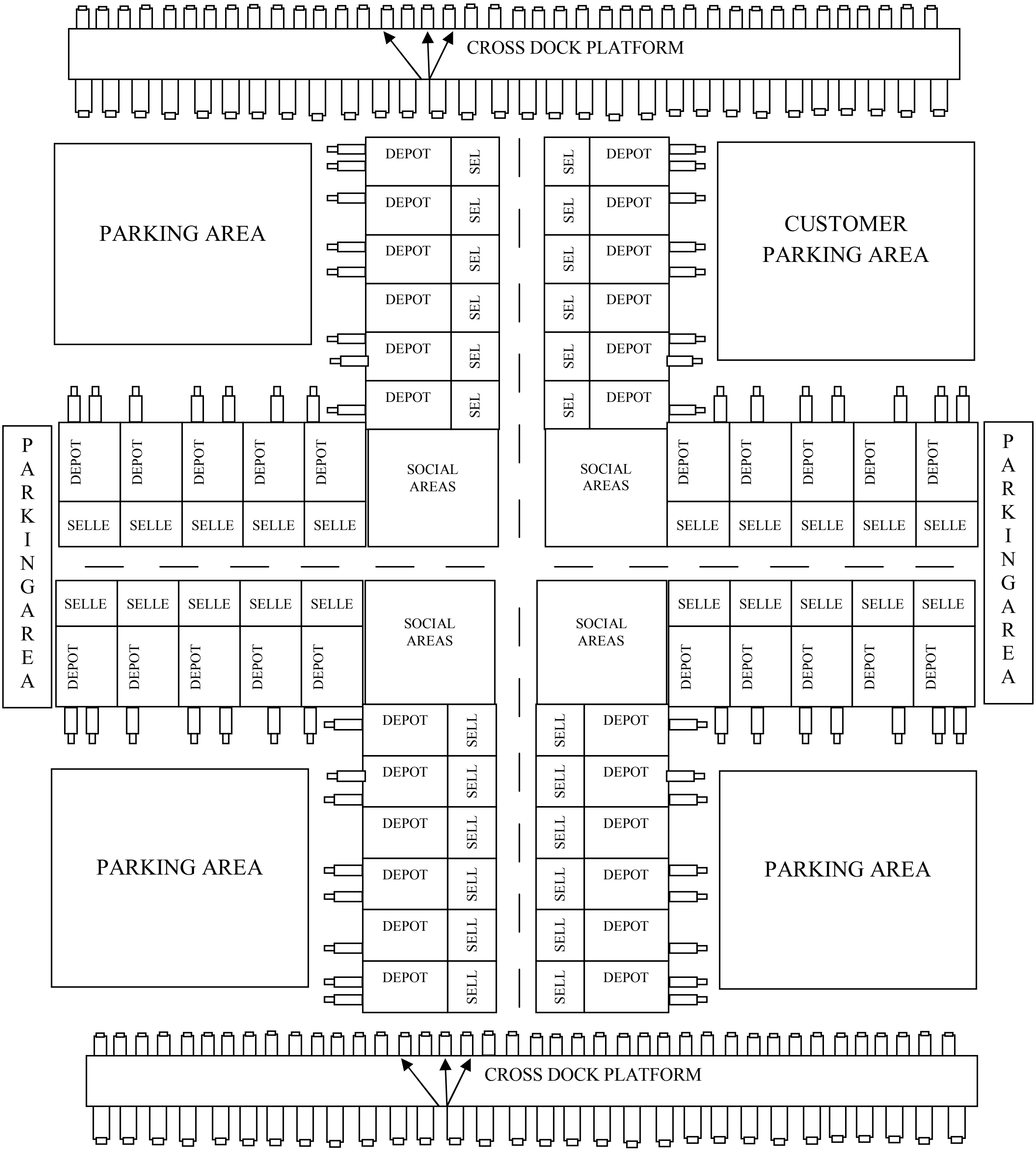

FIGURE. 7
Layout Alternative 3

Advantages:

- The fruits and vegetables will not be damaged by the harmful gasses of vehicles.
- Trucks and LCVs will arrive the loading and unloading points easily.
- The traffic congestion will be decreased because an area will be departed for the cross docking.
- The customers will not be affected from the outside air conditions and will do their shopping easily.

- There will be only one blocks and the customers will see more galleries in a short time
- The investment and operation costs will be decreased because there will be only one block.
- The cold storage houses could be centralized.
- The security and maintenance of the building will be easy. Equipment and personnel costs will be decreased.

Disadvantages:

- The vehicles those come for unloading the products and the customer's vehicles will take the service from the same door. This situation will cause the traffic congestion.

Fourth Alternative:

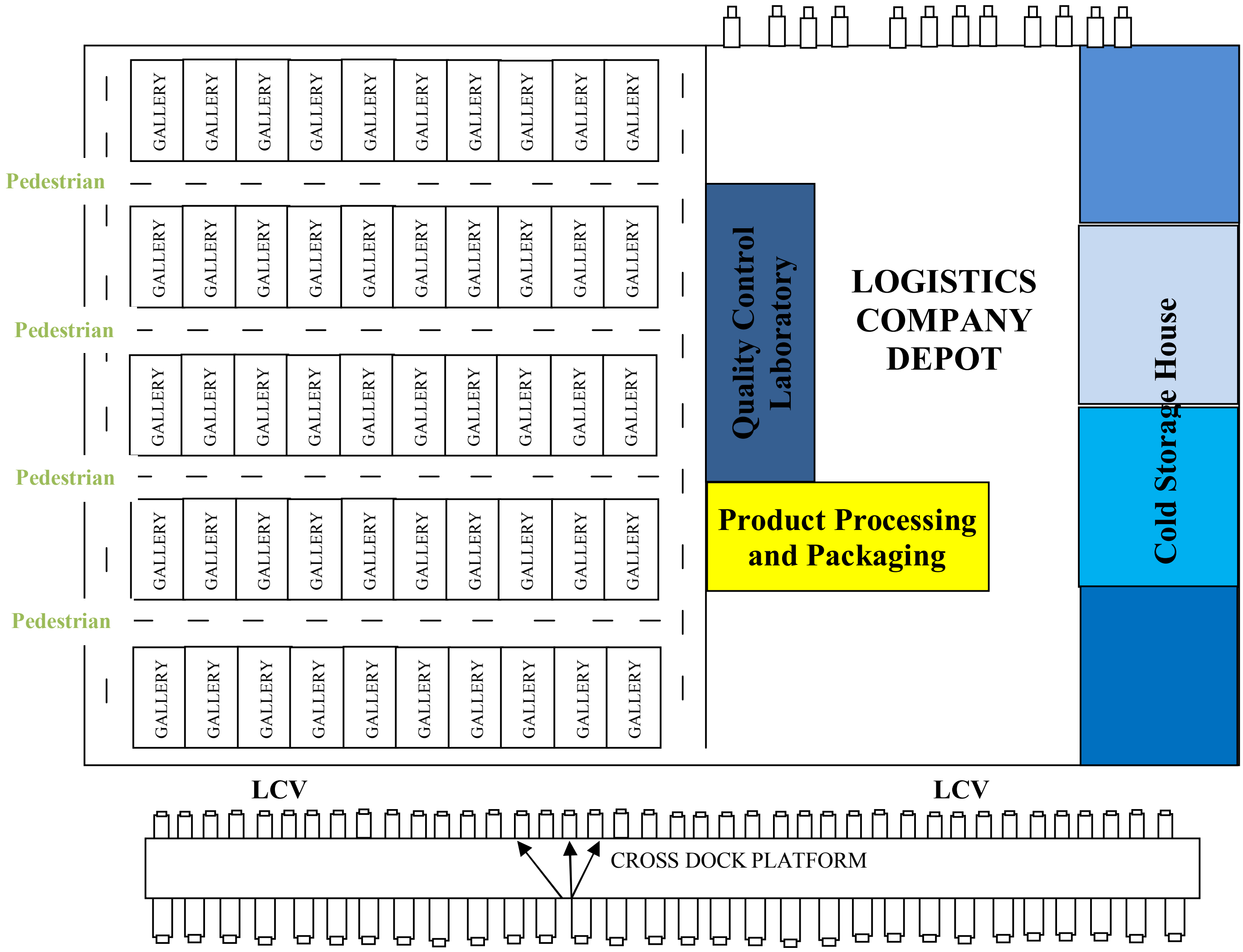

FIGURE. 8
Layout Alternative 4

Advantages:

- The smaller space will be enough to give the same service to the customers because logistics company will use associate warehouse.
- The personnel and equipment costs will be saved mainly. Investment costs will be diminished.
- Because the cold storage houses centralized, the smaller space will be used more effective and efficiently. Energy and equipment costs will be saved.
- The products will be defended in a more hygienic environment and better conditions.
- The pedestrians will not be effected by the outside air conditions and do their shopping easily.

- The traffic congestion will be decreased because an area will be departed for the cross docking.
- The operations like packaging and order preparation will be done by the logistics company.
- The logistics company will be responsible for entry and exit product quality and food safety level will be increased.
- It is more appropriate for electronic commerce.
- To centralize the transportation services and to give consolidated services with bigger vehicles will be possible.
- The gallery areas can be removed and they can be reverted to the electronic auction.

Disadvantages:

- Both the work place owners and customers will not see the products in the loading and unloading operations.

CALCULATIONS

Axiomatic design must ensure the independence axiom of axiomatic design to implement Information Axiom. In this study FRs are independent. The design range of FRs (FI) that is neccessary to calculate information content of each alternative are displayed in the table below.

TABLE 1
Design Range Data

Main Criteria	Sub-criteria	Design Range	Fuzzy Numbers		
COST					
C11	Investment costs	Very good	12	15	18
C12	Operation costs like energy, workforce	Good	8	11	14
C13	Overhead costs	Good	8	11	14
TIME					
C21	Time between entry and exit of a truck to hall	Very good	12	15	18
C22	Time between entry and exit of a pickup truck or van to hall	Good	8	11	14
OPERATION QUALITY					
C31	Handling operations in the hall	Good	8	11	14
C32	Transportation of vegetables and fruits in the hall	Very good	12	15	18
C33	Storing conditions	Very good	12	15	18
WORKING ENVIRONMENT					
C41	Supporting facilities (pharmacy, maintenance areas, fuel stations)	Good	8	11	14
C42	Social facilities (fitness center, restaurants , Hotels)	Fair	4	7	10
C43	Expansion possibilities	Good	8	11	14
SAFETY					
C51	Probability of burglary	Good	8	11	14
C52	Probability of accidents	Good	8	11	14

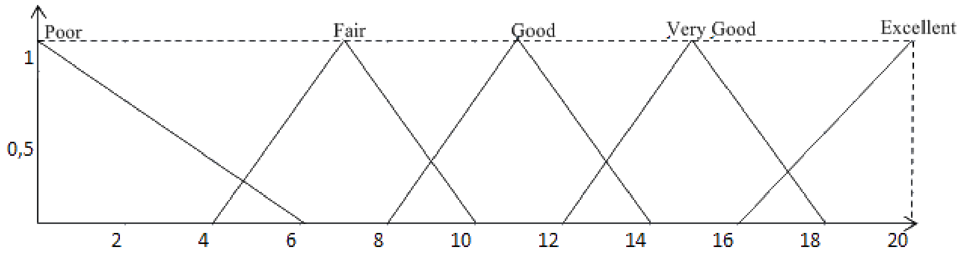

FIGURE. 9
Triangular Fuzzy Sets For Attributes

The Information content for each criteria are calculated using (3) and (7).

For example: for project 2, criteria 11 the calculations are below.

Curve Of Design: $\dfrac{A(12,0)}{B(20,1)}\Bigg|\, X = 8y+12$

Curve of Sytem : $\dfrac{C(10,1)}{D(13,0)}\Bigg|\, X = -3y+13$

8y+12 = -3y+13 => y = 0,1

Common Area = [(13-12)*0,1]/2 = 0,05

System Area = [(13-7)/2]*1 = 2

I = $\log_2(2/0{,}05)$ = 5,32

TABLE 2
The Results Of Information Content For Projects

	I11	I12	I13	I21	I22	I31	I32	I33	I41	I42	I43	I51	I52	Total I
Layout1	Indefinite	5,69	3,79	4,39	1,52	10,06	5,91	3,91	6,53	Indefinite	1,91	2,28	5,42	Indefinite
Layout2	5,32	2	2,26	Indefinite	3,17	2,26	2	3,91	5,12	2,86	3,86	2,09	1,32	Indefinite
Layout 3	3,15	0,82	0,5	15,93	2,37	1,14	3,47	3,91	3,6	1,2	5,44	0,57	4,01	46,11
Layout4	0,42	0,72	0,72	1,26	0,12	0,72	0,36	1,06	1,93	1,59	2,5	3,54	3,54	18,48

*

TABLE 3
Unit Index Of Information Content For Attributes

	I1	I2	I3	I4	I5	Total I	
Layout1	Indefinite	2,955	6,6266667	Indefinite	3,85	Indefinite	
Layout2	3,1933333	Indefinite	2,7233333	3,9466667	1,705	Indefinite	
Layout 3	1,49	9,15	2,84	3,4133333	2,29	19,18333	
Layout4	0,62	0,69	0,7133333	2,0066667	3,54	7,57	*

Project 4 that has minimum information content is selected.

CONCLUSION

In this study, fuzzy AD is used for the selection of fruit and vegetables market hall layout project. The evaluation scores are determined by expert decision makers who are customers, fruit and vegetable wholesalers (brokers), truck drivers and pickup truck or van drivers.

The aim of the using Axiomatic Design can be explained as follows. AD approach aims to determine design range of each attribute by the designer. Thus, design ranges are determined in AD approach for selection of the best alternative. This process provides best levels are selected in many other methods. The determined design range does not exist at other methods like AHP and ANP.

In this study, results show that project 4 is the best layout alternative because axiomatic design evaluation process shows it has the minimum information content. This layout alternative is the most different one compared to the current hall. Even some problems can be occurred in terms of the stakeholders, while constructing a hall like that, the most of the state-of-the-art halls in the world metropolitans show similar features with this layout. In the long term, the productivities of this layout will be seen well.

REFERENCES

[1] Ertay T., Ruan D. and Tuzkaya U.R., 2006, “Integrating data envelopment analysis and analytic hierarchy for the facility layout design in manufacturing systems”, Information Sciences 176, 237–262.

[2] Altuntas S. and Selim H., 2011, “Facility layout using weighted association rule-based data mining algorithms: Evaluation with simulation”, Expert Systems with Applications.

[3] Drira A., Pierreval H. Hajri-Gabouj S., 2007, “Facility layout problems: A survey”, Annual Reviews in Control 31, 255–267.

[4] Aboolian R., Berman O., Krass D., 2007, Competitive facility location and design problem, European Journal of Operational Research 182, 40–62.

[5] Gonzalez-Cruz M. C. and Martınez E. G. S., 2011, “An entropy-based algorithm to solve the facility layout design problem”, Robotics and Computer-Integrated Manufacturing 27, 88–100.

[6] Maniya K.D. and Bhatti M.G., 2011, “An alternative multiple attribute decision making methodology for solving optimal facility layout design selection problems”, Computers & Industrial Engineering.

[7] Sahin R., 2011, “A simulated annealing algorithm for solving the bi-objective facility layout problem”, Expert Systems with Applications 38, 4460–4465.

[8] Mellera R.D., Kirkizoglu Z., Chen W., 2010, “A new optimization model to support a bottom-up approach to facility design”, Computers &Operations Research 37, 42—49.

[9] Taghavi A. and Murat A., 2011, “A heuristic procedure for the integrated facility layout design and flow assignment problem”, Computers & Industrial Engineering 61, 55–63.

[10] Ashayeri J., Heuts R., Tammel B., 2005, “A modified simple heuristic for the p-median problem, with facilities design applications”, Robotics and Computer-Integrated Manufacturing 21, 451–46.

[11] Çelik, M. ve Er, I. D., 2008, “Fuzzy Axiomatic Design Extension for Managing Model Selection Paradigm in Decision Science”(Article In Press), Expert System With Application.

[12] Kahraman C. and Çebi, S, 2008, “A new multi-attribute decision making method: hierarchical fuzzy axiomatic design”, Expert systems with applications, Article In Press.

[13] Kulak, O., 2005, “A decision support system for fuzzy multi-attribute selection of material handling equipments”, Expert Systems with Applications, 29, 310-319.

[14] Kulak, O., Durmuşoğlu, M. B. and Kahraman C., 2005, " Fuzzy Multi-attribute Equipment Selection Based On Information Axiom", Journal of Materials Processing Technology, 169, 337-345
[15] Kulak, O. and Kahraman, C., 2005, "Multi-attribute Comparison of advanced Manufacturing Systems Using Fuzzy vs. Crisp Axiomatic Design Approach", International Journal of Production Economics, 95, 415-424.
[16] Kulak, O. and Kahraman, C., 2005, "Fuzzy Multi-attribute Selection Among Transportation Companies Using Axiomatic Design and Analytic Hierarchy Process", Information Sciences, 170, 191-210
[17] Özel, B. and Özyörük, B., 2007, "Bulanık Aksiyomatik Tasarım ile Tedarikçi Firma Seçimi", Gazi Üniversitesi Mühendislik ve Mimarlık Fakültesi Dergisi, 22(3), 415-423.

SOA-BASED E-SUPPLY CHAINS

Ela Sibel Bayrak Meydanoğlu[1]

Abstract — *There is a growing interest to form supply chains by creating alliances with partners. Realizing on-line, real-time connectivity and visibility among heterogeneous, possibly inconsistent systems in a secure, reliable and efficient manner is the main issue for the effective supply chains. SOA and Web services as the recent trends in cross-platform enterprise application integration seem to be proper solutions to solve this issue. This article focuses on the introduction of these technologies and the benefits gained by using them for the integration of supply chain partners' systems.*

Keywords — *E-Supply Chain, Service Oriented Architecture (SOA), Web Services.*

INTRODUCTION

In the current business era creating alliances with partners by means of forming supply networks is an essential means of survival. As a result, business processes are not fulfilled within a firm, but are fulfilled together with partner-firms. Seamless integration of these firms is an important aspect for effective supply networks, because it helps to reduce cost, improve responsiveness to changes, increase service level, enable better information sharing, enhance supply chain visibility and avoid information delays and distortions [1]. This importance brings along endeavors for the improvement of integration solutions. SOA and Web services are the recent technologies for integration of different systems. This article discusses the advantages of these technologies compared to the existing integration solutions, their definitions as well as their benefits for supply chains. Review of recent literature on the relevance of SOA and Web services to supply chains is selected as the methodology in the article.

TECHNOLOGY SOLUTIONS FOR E-SUPPLY CHAINS

There is a growing interest to use Internet technology while carrying out processes in business networks. E-supply chains, in which actors are connected by Internet technology, arose from this interest. In e-supply chains multiple applications running on varied technologies and platforms need to communicate with each other. Different technologies such as JMS (Java Message Service), CORBA (Common Object Resource Broker Architecture), COM (Component Object Model), DCOM (Distrubeted Component Object Model), RMI (Remote Method Invocation), EDI (Electronic Data Interchange) have been used to support supply chain operations. Recently the utilization of SOA and Web service technologies is proposed for the integration of chain partners. Among the mentioned technologies Web services have an advantage compared to other technologies concerning the following aspects [1]:

1. In terms of model development, only Web services support component oriented service development. The other technologies support object oriented approaches.
2. In terms of interface definition language Web services have an language independency.
3. Only Web services are platfom-independent.
4. Only Web services have interoperability and support for open standards.
5. Only Web services support both synchronous and asynchronous modes of communication

Below Web services and SOA, in which Web services describe a specialized type of software design to realize SOA [1], are introduced closer.

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SERVICE ORIENTED ARCHITECTURE AND WEB SERVICES

"*SOA is a software architecture approach where the basic element of design and development is a service* [2]". Services are self-contained and loosely coupled software components [3]. SOA is composed of the main elements registry, provider and client. The interaction of these elements is shown in Figure 1.

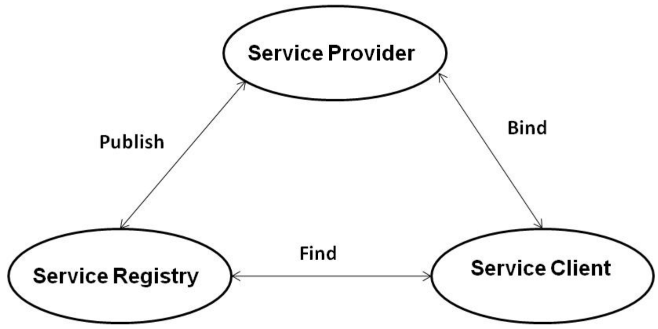

FIGURE. 1
Interaction of SOA Elements [3], [4].

Service registry is a searchable directory where service descriptions can be published and searched. Service providers publish services, which they provide, in service registries. Service requesters (or clients) search service registries for the desired services and use informations in the descriptions to bind services [4].

The Web Service technology is the most likely connection technology to realize SOA [5]. A Web service is a platform-independent, loosely coupled, self-contained programmable Web-enabled application that can be described, published, discovered, orchestrated and programmed for supporting distrubeted interoperable applications over a network [4]. The interoperability is gained through a set of XML-based open standards, such as WSDL (Web Services Description Language), SOAP (Simple Object Access Protocol), and UDDI (Universal Description and Discovery and Integration) [3]. "*SOAP is a XML-based communication protocol for exchanging information between computers regardless of their operating systems, programming environment or object model framework. It is a lightweight protocol for exchange of structured and typed information between computers and systems in a decentralized and distrubuted environment such as Internet* [4]." WSDL is a XML-based specification schema that enables to describe public interface of a Web service. A WSDL document describes how to invoke a service. It also provides information on the data being exchanged, the sequence of messages for an operation, protocol bindings and the location of the service. UDDI is a registry that enables to describe and identify services, query other service providers and enables those registered to share information globally in a distrubeted manner [4].

Figure 2 shows the steps that are executed to provide and consume a Web service [4], [5], [6]:

1. If a service provider wants to publish his service with the registry, he has to describe the service in WSDL. The description includes information about provider, nature of the service and technical information about methods of the service. The directory could use UDDI. Registration, which means storing service descriptions in the service registry, is also a part of the publishing process.
2. A service consumer issues one or more queries to the directory to locate a service and determine how to communicate with that service. A query consists of search criteria such as type of service, preferred price range, what products are associated with this service.
3. As a result of query process Web services matching the needs of a service consumer are listed.
4. After deciding about which services to invoke from the set of services, service consumer sends a request in WSDL about the desired service to service provider.
5. Service provider provides the expected response to the consumer. Consumer can bind to the desired service.

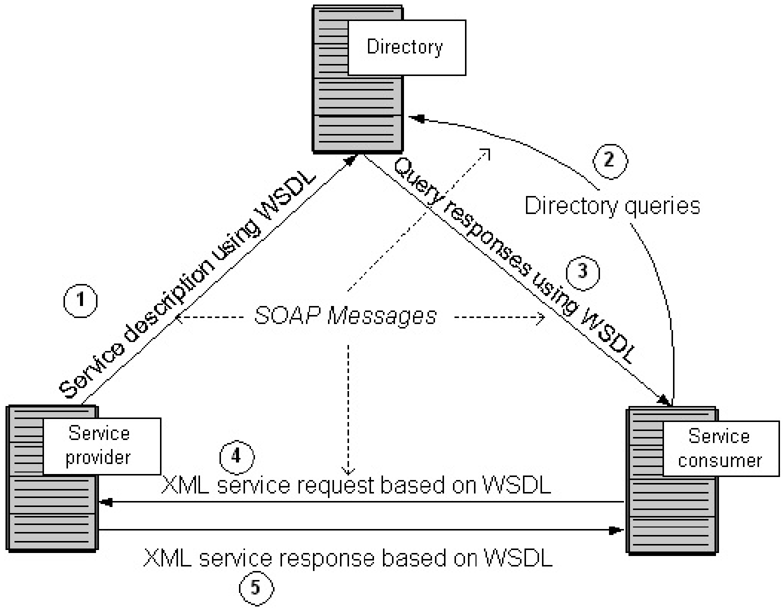

FIGURE. 2
Steps involved in Providing and Consuming of Web Services [5].

BENEFITS OF SOA AND WEB SERVICES FOR SUPPLY CHAINS

There are various benefits supply chains can realize through SOA and Web services. Most important of them are listed below:

1. Integration of partners that are located at various distant locations through traditional distrubeted computing applications may be difficult as there may be proxy servers and firewalls to go through. Web services use traditional transport mechanisms used on World Wide Web. Therefore they are not affected by the presence of firewalls and proxy servers [7].
2. Partners can use heterogeneous technologies. SOA and Web services enable seamless integration of these heterogeneous platforms without the use of any proprietary integration technologies. Using open standards such as XML, SOAP, UDDI, WSDL, SOA and Web Services integrate partners' applications effectively. These standards ensure interoperability of chain partners' applications [1], [7].
3. Development of new software systems is an expensive and time-consuming task. Through SOA and Web services it is easy to expose existing systems to business partners quickly and at a lower price. Through XML-based Web services partners can bundle software assets and application to be shared with XML and make it available to chain partners over the Internet or extranet. This makes it possible to expose applications without writing excessive amounts of customized programs to integrate different applications [7].
4. Data and application sharing with the use of Web services are easy and cost-effective compared to other integration technologies as the necessary Web technologies are already used by chain partners. The implementation of other alternatives (e.g. EDI) requires more time, cost and effort [7].
5. Supply chain agility requires interoperability, which is obtained by using SOA and Web services [1].
6. SOA and Web services enable to aggregate services into a set of composite business applications. Based on these applications decision makers can gain more accurate and comprehensive information. SOA and Web services enable them the flexibility to gain access to the necessary information in the form and presentation that meets their needs [1].
7. By using SOA and Web services employees can concentrate on the important, value-added processes and on collaborative, semi-structured activities instead of trying to conform to the limitations and restrictions of the underlying IT systems. That is to say SOA and Web services lead an increase at employee productivity [1].

8. By making applications and services available to customers and suppliers SOA and Web services make a richer collaboration possible. This is an important aspect for customer/partner satisfaction [1].

CONCLUSION

To improve and strengthen the supply chain linkages, integration and interoperation of heterogeneous systems of chain partners are essential. Concerning its above illustrated advantages SOA - based on Web services - is more efficient and flexible integration approach compared to other existing approaches such as COM, DCOM, RMI, EDI, JMS, CORBA to achive the mentioned integration and interoperation.

Supply chains can realize various benefits by using SOA and Web services. SOA provides seamless integration across chain partners. It offers a way to integrate data and applications across partners by exposing services that are available in a partner organization to the other partners of the chain. As SOA bases on open standards, it promotes interoperability and reusability. These advantages of SOA and Web services form the reason for the preference of these technologies to realize integration in supply chains. Naturally the realization of these in theory foreseen advantages has to be validated through case-based surveys in future studies.

REFERENCES

[1] Rehan, M., Akyuz, G. A., 2010, "Enterprise Application Integration (EAI), Service Oriented Architectures (SOA) and their relevance to e-supply chain formation", African Journal of Business Management, Vol. 4 (13), 2604-2614

[2] Kumar, S., Dakshinamoorthy, V., Krishnan, M. S., 2007, "Does SOA Improve the Supply Chain? An Empirical Analysis of the Impact of SOA Adoption on Electronic Supply Chain Performance", Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS'07), Hawaii, 3-6 Januar 2007, 171b.

[3] Mahmoud, Q. H., 2005, "Service-Oriented Architecture (SOA) and Web Services: The Road to Enterprise Application Integration (EAI) ", http://www.oracle.com/technetwork/articles/javase/soa-142870.html, Access Date: 10.06.2011.

[4] Papazoglou, M. P., Ribbers, P. M. A., 2008, E-Business, Organizational and Technical Foundations, John Wiley & Sons Ltd., Southern Gate, Chichester, England.

[5] http://www.service-architecture.com/web-services/articles/web_services_definition.html, Access Date: 10.06.2011

[6] Steger-Jensen, K., Hvolby, H.-H., 2007, "Web services as supply chain enablers", in: Advanced Manufacturing. An ICT and Systems Perspective, Montorio, M., Taisch, M. and Thoben, K.-D. (ed.), Taylor & Francis, 303-309

[7] Murtaza, M. B., Shah, J., 2004, "Managing Information for Effective Business Partner", Information Systems Management, 21:2, 43-52

BUSINESS COMPETITIVENESS AND CONSUMER PROTECTION IN ECOMMERCE TRENDS IN MULTI-CHANNEL AND CROSS-BORDER RETAILING VIA INTERNET THE EUROPEAN UNION AND THE UNITED STATES COMPARED

Elizabeth Mariotz[1], *Alexander von Lingen*[2]

Globalization and technological innovation, but also changing consumer behaviour and orientation brought with them a fundamental change in retail trade dimension and patterns as well as seller-buyer relations and the regulatory involvement and legislative framework by the states, trade blocs (such as the European Union) and international organizations (such as the WTO).

Retailers worldwide are globalizing, chiefly because of an expanding consumer arena, technological advances and deregulation. Having exhausted opportunities to grow in their relatively small domestic market, and with souring consumer confidence and slowing sales growth, European and American companies are going abroad, looking for international expansion. This allure is added by the projected growth in foreign markets, improving internet access penetration rates, and volatile exchange rates. Instead of building physical locations abroad, which can be risky, expensive and time consuming, retailers are considering using their company's online retail channels to see how the brand ant its products are received abroad before committing the entire business.

The purpose of the study is to compare and contrast trends and effects of these developments on business as well as on consumers in the European Union and the United States, with relevance also to countries like Turkey and Russia – with recent years seeing their emergence as key target destinations of retailers expanding internationally. It gives as examples multi-channel and cross-border retailing and looks at structures, policies, existing and planned legislation and the challenges in ensuring effective protection of consumers' rights, in particular in e-commerce. Thus, the main purpose of the study is to focus primarily on the application, using the comparison of realities going on in the two most developed, yet still not entirely completed Internal Markets. It is suggested that the global issues to be left for further research from a more academic perspective.

Over the past several decades the Internet has grown exponentially and has served the global community well as a tool for communication, education, entertainment and marketplace exchange. It has facilitated global commerce, allowing consumers access to products, goods and services potentially without restrictions, thus creating a "borderless marketplace". Online shopping has provided a shopping environment that gives a lot of benefits to consumers since it saves time, is convenient and offers them value.

The Example of the European Union

In Europe e-commerce is doubling every three years and the majority of stakeholders are now in favour of increased, if not full legal harmonization and a horizontal legislative instrument on all consumer contracts in e-commerce. More and more customers are purchasing over the internet, domestically and cross-border alike and more than half of EU retailers are prepared to sell to customers in different EU countries.

Still 2/3 of retailers sell only on the domestic market of their country and only 1/3 sell cross-border, using distance sales methods to at least one other EU country, only 1/5 advertise cross-border. The businesses most likely to be involved in cross-border retailing are medium or medium-large retail enterprises with a limited number of outlets in other EU countries.

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Because the Internet has no geographical boundaries, other countries face similar challenges to be addressed. As the Internet continues to be a major vehicle for commerce, growing concerns abound regarding consumer rights protection, their privacy and security.

However, legislation has not kept up domestically and world-wide and has lacked in developing a framework for internet interplay globally. Everywhere, setting standards for cyber security has been challenging and difficult.

Individual countries struggle to establish standards for cyber security and best practices for Internet exchange and develop policies that both embrace innovation and at the same time protect privacy and guarantee security. As standards vary across the globe given the different ideologies and philosophies, so do differences in legislation among the different levels of government on national and regional level.

The regulation of e-commerce has mainly developed at the national and regional levels. So far, few common international rules have been agreed upon and established. Recognizing the challenge of a dialogue needed to work towards harmonizing policies for the internet in a globalized marketplace, the Organization for Economic Cooperation and Development (OECD) sees an opportunity to bring governments around the world to the table to have this discussion and establish parameters for ensuring also internet security and consumer rights.

By creating the European Union and setting up its Internal (single or common) Market, the EU Member States had conferred on the EU institutions the competence to legislate and adopt a legally binding regulatory framework, deemed necessary to ensure the well functioning of the single market, now comprising 27 member countries. And to guarantee the free movement of goods, services, capital and persons within this market, trade and competition policy tools and instruments were put in place.

The EU with its Internal Market is a living example of a two level regulatory competence namely between the EU (deciding on the framework and the general rules) and its Member States (transposition of community law and implementation of EU directives).

Online Retailing in the EU Internal Market (Cross-border E-commerce)

With technical innovation and the general trend to globalization, more and more individuals across the globe have access to the internet to conduct their day-to-day operations and the percentage of consumers, who have ordered goods and services over the internet for private use is increasing steadily. By now most traders have a website, visible to consumers everywhere. Therefore internet retailing has the potential for setting the course for a more integrated online market and acting as a force for social cohesion.

The present e-commerce markets in Europe can be divided into three main categories:

- a mature market in Northern Europe (UK, Germany, BeNeLux) and Scandinavia, where 60 to 80 % of internet users are also online purchasers;
- a growth market in countries like France, Italy and Spain, where the number of online purchasers is lower compared to that of internet users, but where growth is fast with a strong potential;
- an emerging market in Eastern Europe.

In general, an e-commerce retail Internal Market has a potential to enable consumers to access the goods and services of their choice and shop around for better deals and obtain quality and choice not available at home. They can also get comparable information to make cross-border comparisons and identify cross-border offers (through comparison websites). Comparability can be achieved also by cross-border advertising and identification of reputable traders and brands unknown outside the home markets. The same can be said for a sustainable, EU-wide trust-mark.

However, the gap between domestic and cross-border e-commerce is widening because of a number ob obstacles that are very complex and often independent from one another. They can be related to demographics, individual preferences, internet penetration and the efficiency of the postal or payment systems. To achieve the full potential of the EU Internal Market and its advantages for consumers and retailers alike, trends of retail market as well as consumer behaviour and perceptions have to be monitored closely.

The most important obstacles to cross-border trade are the perceived insecurity of transactions, concern about different national fiscal and customs regulations and laws regulating consumer transactions, the difficulties to resolve complaints and conflicts and in ensuring an efficient after-sales service.

To achieve a real consumer internal market - and to ensure the right balance between a high level of consumer protection and competiveness of enterprises, a predictable regulatory environment is essential and the horizontal cross-sector legislative instrument has to apply to all consumer contracts, domestic and cross-border ones alike. Concerns have to be met of customers, who do not always know if they buy from a national seller or not (.com: no nationality), neither they know about cyberscurity risks, consumer privacy (provision of personal data, credit card information) and their rights in case of redress and complains.

Guaranteeing and enabling customer protection in the European marketplace and beyond: choice, safety, quality (technical harmonization, product labelling and packaging), prices, rights; fighting unfair commercial practices, abuse of dominant position as well as consumer satisfaction - starts with consumer education and information. The ECCnet as an instrument of the EU and its Member States to provide information on European customer legislation on redress provides assistance in resolving cross-border complaints since the situation is varying according to sectors, countries, traditions, and the chance to succeed)

In fostering cross-border online shopping, the influences of consumer trust and satisfaction in online transactions have to be taken into account seriously.

The enforcement of Internal Market directives, in particular on consumer rights, is the responsibility of EU Member States. This has proven not to be so easy to achieve. Therefore, cooperation between enforcement authorities of the Member States is an essential part in meeting consumer and business concerns and assist them in resolution of cross-border complains and redress.

To deal with redress, the basic way is through private enforcement by individual redress legal procedures. Alternatively, resolution of cross-border disputes can achieved amicably through mediation and legal aid. Besides, there mechanisms are put in place on EU level for collective redress, i.e. representative action by consumer rights authorities and consumer organizations. That can be done by injunctive relief in certain areas (consumer law and environmental) to stop illegal business practices that infringe national and EU laws or by compensatory relief for a group of victims harmed by this kind of practices. However, differences still exist in varying sectors, countries, traditions and chance of success.

Comparison Between the EU and the US in Consumer Rights Protection

To start with: the US is a long and well established single market that has developed over time the instruments needed to organize the well functioning of a huge market with over 300 million consumers while the EU and its still not fully accomplished Internal Market is an ongoing construction site with still work in progress. Because of that, the EU has to compensate by pushing for strict rules to prevent a malfunctioning of the single market and to eliminate all kinds of obstacles on the way to a real European retail market and the protection of the consumer.

On the other hand, the US like the EU has federal structures with several levels of legislating and a division of competences.

Even so the EU and the US have some traditional and philosophical differences in their approach to regulation of the market, the two regimes are now finding workable systems from both sides – the two frameworks would at least not be incompatible. Through an intense dialogue and cooperation of the bodies concerned they are reducing regulatory divergences by eliminating measures that impede trade in goods in the transatlantic marketplace. As social networking has dramatically changed the way consumers use technology and think about privacy, the EU and the US approaches to data protection are converging, finding common ground on the basis of taking individuals and their needs and rights seriously.

Some wording of the recent proposed legislation in the US, the "Commercial Privacy Bill of Rights Act", protecting individuals' personal data, is a bipartisan initiative to deal with the privacy challenges coming from new online applications seems to have been lifted from the EU Digital Agenda, adopted in 2010.

There are also US companies developing "do-not-track systems looking for better opportunities in Europe where stricter rules have been introduced.

Consumer Rights Protection in the European Union

The new EU consumer rights directive, the draft of which was first tabled by the European Commission in October 2008, was finally voted in the European Parliament in June 2011. During the whole legislative procedure, the EU policy makers and stockholders where at loggerheads over the scope of the draft law and the principle of full (comprehensive) harmonization of on- and offline contracts across the EU countries versus a mixed approach with basic minimum rights and full specific technical rules.

The directive is updating and replacing existing rules that predate the digital revolution by merging the four EU consumer rights directives in force, namely the directives on unfair consumer contract terms (93/13/EEC); on sales and guarantees (99/44/EC); on distance contracts (97/7/EC) and on doorstep selling (contracts negotiated away from business premises as bulk of cross-border transactions) (85/577/EEC) into a single legal instrument with one set of common rules, creating legal certainty for businesses and better protecting online shoppers in particular.

The enforcement of EU Internal Market legislation in the form of EU directives, including rules on cross-border e-commerce and on consumer rights in particular, is the responsibility of the Member States. They have to assure that the EU law concerned is properly transformed and implemented. In this regard, however, many Member States have a rather bad reputation in not or not fast enough acting by their obligations. To meet the concerns of consumers and business alike and to bring up their trust in engaging in cross-border online shopping, the existing rules on redress, too, have to be enforced.

There are also collective redress mechanisms at EU level in the consumer law area giving the possibility of representative action in dispute resolution. To stop illegal business practices that infringe national and EU law consumer rights and consumer organizations can, in certain areas, use injunctive relief. And a group of victims harmed by these practices can use collective compensatory relief procedure

To develop a more efficient remedy in the hands of European customers and boost their confidence in the EU Internal Market, cross-border enforcement of consumer interests have also to be ensured by cooperation between national enforcement authorities

Alongside with the completion of the EU Internal Market goes the adaptation to the exploding technical innovation in the form of the Internet and to the trends that go with it. Cross-border retailing is becoming multi-channel as a norm integrating online trading together with mail order catalogue and brick/mortar retail stores. The consumer can only benefit from this trend as long as his rights concerning privacy, security and possible redress are protected efficiently.

The Example of the United States

The Internet has facilitated global commerce allowing consumers access to products and goods without restrictions. This has created a "borderless" marketplace. Online shopping has provided a shopping environment that saves time, is convenient and offers value to the consumer.

A survey conducted by Pew Internet in February, 2008 found that "66 percent of Americans" have made purchases on the Internet. [1]

However, the wide use of eCommerce is not primarily in the United States. "The United Kingdom has the biggest e-commerce market in the world when measure by the amount spent per capita…." [2] "The internet economy in the United Kingdom is likely to grow by 10 percent between 2010 and 2015." [3] "Amongst emerging economies, China's e-commerce....has 384 million internet users, China's online shopping sales rose to $36.6 billion in 2009…" [4]

As the Internet continues to be a major vehicle for commerce, growing concerns regarding consumer privacy and security abound.

The Pew Internet survey also found that a great majority, 75 percent, said their main concern with purchasing on the Internet was with using their credit cards and providing personal information. [5]

Setting standards for cybersecurity has been challenging and difficult. E-commerce is exploding and as advances in technology grow, it becomes more arduous for governments world-wide. "The regulation of e-commerce has mainly developed at the national and regional levels and few common international rules have been established." [6]

The issue is now how do countries come together and agree on what are the best practices so standards may be established for internet exchange.

Countries, like individual countries, struggle to develop policies that both embrace innovation and at the same time protect privacy and guarantee security. Standards vary across the globe given the different ideologies and philosophies. Individual countries also have to manage differences in legislation among the various levels of government. [7]

However, a dialogue is needed to work toward harmonizing policies for the Internet in a global marketplace. Recognizing these challenges, the Organization for Economic Cooperation and Development (OECD) sees an opportunity to bring governments around the world to the table to have this discussion and establish parameters. [8]

In the United States, advances are being made. The National Strategy for Trusted Identities in Chyberspace (NSTIC) is a document that covers "issues of privacy and liability, the role of government in establishing standards, and incentives for the private sector to incorporate those standards into their networks." [9]

There needs to be a balance between the private sector and the public sector. While both the Federal Trade Commission (FTC) and the Department of Commerce agree in principle on the issues of privacy and protection, each approaches it from a different perspective. The FTC would like to see "tougher privacy standards" [10] applied, while the Department of Commerce wants "voluntary but enforceable standards." [11]

As the use of the Internet expands for commercial purposes, countries must address the use of personal data and how it is being collected and used. Recent proposed legislation in the United States, "The Commercial Privacy Bill of Rights Act of 2011" protects individuals' personal data. According to this proposal, "Companies would have to seek permission before collecting and sharing sensitive religious, medical and financial data with outside entities." [12]

The Department of Commerce published "basic principles of internet privacy rights…. consumers should be told more about why data are being collected and used; and it called for stricter limits on what companies can do with information they collect." [13]

The European Union has much stricter rules on privacy and is "tightening them further." [14] There are U.S. companies developing "do-not track systems" looking for better opportunities in Europe.

The private sector argues that there are many benefits to using tracking devices which enable marketers to target ads to the characteristics of the consumer. Advertising companies become disengaged, decreasing the revenue for the retailer.

The Internet has become well integrated into the world of commerce. In the retail sector, the amount of business done on the internet has exploded and has grown exponentially. As stated above, the consumer's view on security is very unsettling. Consumers just do not have confidence in the system and therefore their participation may be stymied at the very least. One has to ask, how much business is not being done because of these concerns. Consumers are sceptical because of issues that deal with “advertising misleading/untruthfulness, bad product quality, cheating, privacy, property, information misuse, trust betrayal, etc.” [15]

Whether it be the Internet or the brick/mortar store, retail companies routinely collect information to better serve their customers. While this may be legitimate, this information may be misused and misplaced.

In a recent incident, Sony came under fire when it was discovered that it is possible that “over 1,000,000 users' personal information, including passwords, email address, home addresses, dates of birth, and all Sony opt-in data associated with their accounts” were compromised. [16]

Recently, the Wall Street Journal did a What They Know series [17] (Angwin, Thurm) which revealed “that the top 50 U.S. websites installed an average of 64 tracking tools on visitors' computers. Of those files, an average of 44 was installed by outside companies, primarily advertisers and marketers that track consumer behavior across the Internet.”[18]

Representative Edward Markey (D-Mass) and Representative Joe Barton (R-Texas) are co-chairs of the House Bipartisan Privacy Caucus. [19] Their concern is for the privacy of the citizens of the United States in insuring that there is no abuse in the information that is being collected and shared.

In reviewing companies' policies and procedures, Rep. Markey stated, “While the responses that Rep. Barton and I received cite privacy policies and opt-out choices to enable consumers to preserve their privacy, these policies can be complicated and laborious to navigate.” [20]

To monitor this effect, consumers need to spend an enormous amount of time and energy to truly understand the impact. Legislation being introduced by Representative Bobby Rush (D-Illinois) would “require disclosures about information-collection practices, and require companies to gain specific approval from Internet users before sharing information with others. It would also bolster the Federal Trade Commission's authority to regulate the collection and use of personal information.” [21]

REFERENCES (European Union)

EU Institutions and Bodies

[1] European Commission directorates general on Internal Market and Services Consumer Protection Legal Affairs

[2] European Parliament committees on Internal Market and Consumer Protection (IMCO) Legal Affairs Industry, Research and Energy

[3] EU Council presidency website

[4] Economic and Social Committee (ECOSOC) press releases

[5] Committee of Regions press releases

EU Official Documents

[6] Eurostat (Statistical Office of the EU)

[7] EUR-Lex

[8] European Parliament's legislative observatory (Oeil)

[9] Consumer Markets Scoreboard (European Commission)

Information Websites and Think Tanks

[10] Euractive (independent information website on EU affairs)

[11] European Commission portals, citizens' summary, press releases, Commissioner's website

[12] EuroBarometer: special no. 254, 298; flash no. 224

[13] IMI (Internal Market Information System)

[14] EEC-Net (European consumer centres network in EU member states)

[15] SOLVIT (information, training, legal advice to stakeholders on their rights and instrument put at their disposal)

[16] mlex (market intelligence)

[17] ystats.com (global retail trends 2010)

[18] YouGov Psychonomics 2009

Business, Industry and Other Interest Groups incl.NGOs

[19] Euro Commerce (EU retailers' group)

[20] ERRT (European Retail Round Table for consultation)

[21] Eurochambers (representation of chambers of commerce)

[22] BEUC (consumer groups association)

[23] EMOTA (European e-commerce and mail order trade association-AIM (European brands association)

[24] BusinessEurope (representation of EU biggest companies)

[25] UEAPME (representation of SMEs)

[26] BSA (Business software alliance)

[27] National Industry Bodies

Academic Studies

[28] TNS Infratest ("Retailing in the 21st century")

[29] Institutes of the Humboldt and Freie Universities, Berlin

REFERENCES (United States)

[1] Privacy Rights Clearinghouse: Empowering Consumers.

[2] "Electronic Commerce." Wikipedia.

[3] Ibid.

[4] Ibid.

[5] "Protecting Privacy." Fact Sheet 23: Online Shopping Tips: E-Commerce and You. Copyright: Revised January, 2011.

[6] Jedrzej George Frynas. "The Limits of Globalization---Legal and Political Issues in e-Commerce." Management Decision. London: 2002. Vol. 40, Iss. 9.

[7] Tom Leithauser. "Cybersecurity Policy Framework Gradually Begins to Take Shape." Cybersecurity Policy Report. New York, NY: Jan. 25, 2010.

[8] Tom Leithauser. "Global 'Consensus' Seen 'Fraying' on Internet Security Privacy." Cybersecurity Policy Report. New York, NY: Dec. 13, 2010.

[9] John Curran. " 'Trusted Identities' Strategy Said to be Nearing Finish Line." Cybersecurity Policy Report. New York, NY: Feb. 7, 2011.

[10] "United States Moving Toward online Privacy." Information Management Journal._Lenexa. Jan/Feb 2011. Vol. 45, Iss. 1

[11] Ibid.

[12] Julia Angwin. "Senators Offer Privacy Bill to Protect Personal Data." The Wall Street Journal. Eastern Division. New York, NY: April 13, 2011.

[13] "Business: Stopped in Their Tracks; Online Privacy." The Economist. London: March 19, 2011.

[14] Ibid.

[15] Ming-Hsien Yang, Natalyn Chandlrees, Binshan Lin, Hung-Yi Chao. "The Effect of Perceived Ethical Performance of Shopping Websites on Consumer Trust." The Journal of Computer Information Systems. Stillwater: Fall, 2009. Vol. 50, Iss. 1.

[16] "Sony Slammed Over New Data Breach." The Associated Press. Posted: June 3, 2011.

[17] Julia Angwin and Scott Thurm. "Privacy Defense Mounted; Website Operators Say It Isn't Possible to Keep Track of All Tracking Tools." The Wall Street Journal (Online). New York, NY: October 8, 2010.

[18] Ibid.

[19] Lynn Stanton. "Markey Seeks Legislation to Address Online Tracking." Cybersecurity Policy Report. New York, NY: October 11, 2010.

[20] Ibid.

[21] Angwin and Thurm. "Privacy Defense Mounted; Website Operators Say It Isn't Possible to Keep Track of All Tracking Tools." The Wall Street Journal (Online). New York, NY: October 8, 2010.

WEB BASED PRIVATE SHOPPING COMPANIES: TO WHAT EXTENT DO THEY HAVE E-SUPPLY CHAINS?

Banu Atrek[1]*, Ceren Altuntaş*[2]

Abstract *– Together with the major role that internet and internet based tools are playing in today's consumer and business markets, a new concept called private shopping attracts serious attention. Depending especially on the convenience orientation of customers, these private shopping malls located on the world wide web, present a new form of shopping experience and a different structure of supply chain organization. Considering that these private shopping web sites perform majority of their sales transactions over the internet, it is assumed that they will utilize the benefits of e-supply chain management on the back-end of their operations. Hence, the first aim of this study is to specify the features, technologies and characteristics that are needed to be acquired by firms to comply with e-supply chain practices through literature review. The second aim is to analyze the two major web based private shopping companies in Turkey which are well-known, in terms of their supply chain processes. Through a case study, these processes of both firms will be compared with each other on the basis of internet usage in their supply chain processes in order to determine the extent of internet usage. The results of this study are expected to contribute to supply chain management literature by providing an insight into the analysis of e-supply chain structures of web based private shopping companies in Turkey.*

Keywords – E-supply chain, Internet, Private shopping

1.INTRODUCTION

The way of doing business has a long history and it is not solely common to this era of 20th and 21st century that the models of doing business change and evolve. However, the pace of the change is impressive in today's business world especially after the invention of internet and the development of internet based technological tools. The impacts of developments in transportation, in international business, in international marketing and lowered barriers to international trade were all effective causes on the increase of interdependency among companies. With the globalization of markets and ability of sourcing internationally, companies were no longer able to operate and compete individually. So they formed integrated networks with their suppliers and customers all over the world in order to operate in harmony and compete all together against other global networks. The internet, as a low cost and highly accessible tool, supported the formation of this network and expanded the scope of business to an upper level.

After the integration of materials management with physical distribution and combining them under the single heading of logistics during 1960s and 70s, the companies were mainly focused on executing all logistics functions efficiently to provide high raw material, work-in-process or finished goods inventory and thus improve product availability in the marketplaces that were mainly targeted. Towards the beginning of 1990s, these functions were examined by firstly textile retail industries and grocery industries whom had realized the inefficiencies located in the various step of their logistics networks and whom collaborated with several business partners in order to eliminate these from their systems. Quick Response programs and Efficient Consumer Response programs were developed during this period [17]. Since then, the concept of supply chain management has been studied by both practitioners and scholars to develop better ways that integrate entities in order to establish a new management point of view which eliminates the traditional boundaries between organizations.

Today with the invention of internet, supply chains have evolved to the electronic phase. Online collaboration of individual companies as suppliers, customers or service providers facilitate business in a more efficient and rapid way and thus assist companies in their challenges to face the global, intense competition.

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2.THE AIM OF THE STUDY

Recent technological developments in information systems and internet facilitated the integration between companies to a virtual level and introduced a new term called the electronic supply chain (e-supply chain). Today's managers not only collect real-time online information from points-of-sales in order to make replenishment decisions but they also use the internet to send market related information to their suppliers to synchronize the production/preparation phase of the products with actual sales [12]. E-business/-E-commerce has a significant impact on the analysis of supply chains and networks [9]. So internet has been a leverage for the easy flow of products, services, information and financial resources through the whole supply chain, up and down. However, which criteria are required in order to be defined as an e-supply chain is still a vague issue. Hence, the first aim of this study is to outline the features, technologies and characteristics that are needed to be acquired by firms to comply with e-supply chain practices through the review of e-supply chain literature.

Another impact of internet can be stated as the introduction of many different business models and organization types that emerged on the web. Reference [4] uses IBM's effort to define e-business and states that e-business is an effort to use internet based technologies in order to transform key business processes like sales, marketing, research and development or procurement. All e-business applications require the extensive usage of logistics functions and they all need to be supported with strong supply chain management effort in order to provide customer satisfaction and sustain their profits.

Reference [25], classifies the various business models observable on the web and provides a broad taxonomy under the headings of brokerage, advertising, infomediary, merchant, direct manufacturer, affiliate, community, subscription and utility. A new form of web company that is called the private shopping company and that can be located under the heading of merchant e-business category has emerged recently. These private shopping companies are totally web based and electronically operate at their front end systems. Shopping from these companies is only possible if one is a member and this membership is mainly provided through an invitation from an existing user. They sell the well-known branded products at reasonable rates of discount for a limited time period, online via their web pages. Their market communication strategies, sales points, finance transactions are all done via internet technologies. So it can be assumed that they also acquire electronic integration at their back end systems and with their suppliers as well. Based on this assumption, the second aim of this study is to analyze the key supply chain processes of two cases of private shopping companies. Out of these two cases, one serves to goods market and the other one serves to the services market. Both are located in Turkey. Depending on the findings, the extent of internet usage in their supply chains in terms of supply chain processes will be compared and contrasted.

3. E-SUPPLY CHAIN MANAGEMENT

In order to define e-supply chain management, it is needed to comprehend the term supply chain mangement first. Despite being used as a synonym for logistics at the beginning of 1990s [7], it soon has been understood that supply chain management is more than a logistics process. Actually the supply chain has specific business processes which have certain intersection points with the business processes of other firms that perform their roles in several supply chains.

The Council of Supply Chain Management Professionals define supply chain management as *an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model* [8]. Reference [6], defines the supply chain as the *network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the forms of products and services delivered to the ultimate consumer.* So in order to call a network a supply chain, there needs to be the existence of two or more entities or individuals whom take part in the flow of products or services up and down [20] in the integrated business processes that extend between the design and development phase and the final consumption phase.

The recent advances in technology like the internet, broadband and wireless technologies have been significantly effective in both consumer and industrial markets [16]; thus the supply chains serving in these markets must adapt their processes to internet technologies in order to be able to compete with other supply chains. This adaptation of internet to supply chain processes can be a short definition for e-supply chain management. The concept is indeed defined by reference [12] as *the impact internet has on the integration of key business processes from end-user through original suppliers that provide products, services and information that add value for customers and other stakeholders.* Reference [18] defines e-supply chain *an emerging business strategy that incorporates the power of e-commerce to streamline the manufacturing processes, speed the product cycles, integrate the supply chains, and better respond to the customers.*

3.1. Feautres of e-SCM and the Supply Chain Business Processes

Having analyzed these definitions, it is a clear requirement that in order to evaluate an e-supply chain, it is necessary to specify the existing business processes first. Then the scope of the integration of these business processes should be examined with the business processes of other companies that are located in a specific supply chain. The e-supply chain serves as a physical “backbone” [19; 29] in order to achieve outstanding performance especially at the base operational level of the front end systems. The extent of the integration and the degree of internet usage in this integration will provide the necessary proof of the existence of an e-supply chain.

The impact of the internet on the supply chain can be based on e-commerce which refers to the electronic transactions between entities in a supply chain. Another impact is information sharing which states the utilization of internet as an intermediary to collect and disseminate information among supply chain partners. The third impact is knowledge sharing which states a strategic and shared decision making or joint planning [12]. According to refrence [11], the direction of the information integration goes backwards from the customers to the suppliers; the direction of the delivery integration goes forward from the suppliers to the customers throughout the whole supply chain. According to reference [1] defining, standardizing and streamlining the internal and external processes of a company, integration of these processes with the existing systems of the company like MRP, MRPII or ERP and replacement of the existing information systems with internet technologies are needed to form an e-supply chain.

As a result, the main features of e-supply chain may be summarized as follows:

-The electronic integration of front-end key business processes with customers

-The electronic integration of back-end key business processes with suppliers

-The extent of electronic information sharing

-The extent of electronic collaboration for joint decision making

-The standardization and seamless integration of supply chain processes with the other information systems or tools

Different approaches to supply chain processes has been developed in the supply chain management literature. However, the eight processes identified by Global Supply Chain Forum (GSCF) has found wide acceptance [15]. The critical supply chain processes are categorized as customer relationship management, customer service management, demand management, fulfillment, procurement, manufacturing flow management, product development and commercialization and returns management. Reference [12] added supply chain relationships, information flows and planning and optimization tools as enablers to the classification of GSFC in order to analyze the supply chain literature. Reference [2] specified five main process areas from the literature: planning, implementation, information technology, inter-organizational structure and measurement.

Reference [9] emphasizes the necessity of business processes to deal with the complexity of supply chain management and utilizes a non-exhaustive list of processes like fulfillment, operations planning and procurement. Reference [21] developed a framework for analyzing supply chains through the usage of reference [29]’s taxonomy and offered the usage of practice variables, contingency variables, supply chain structure variables and supply chain performance variables. On the other hand, the Supply Chain Operations Reference (SCOR) Model developed by the Supply Chain Council in 1996 focuses on five key processes as plan, source, make, deliver and return [28]. Another different approach to the classification of business processes within supply chain management is brought by [5]. According to their classification, there are three macro processes within supply chains which are supplier relationship management, customer relationship management and finally supply chain management processes that focus on internal operations within the enterprise. Having reviewed the different approaches to process classifications, it was thought that the classification of GSFC would be more appropriate in analyzing the usage of internet in supply chains of private shopping firms. Therefore, the above mentioned processes will be discussed in detail in the next section.

3.2.GSCF Supply Chain Processes

Customer Relationship Management: is the process and strategy of acquiring new customers, customer retention and cooperation in order to create superior value both for the firm and the customer [24]. Customer relationship management prepares goods and services contracts according to the needs and requirements of the customers. Teams work with key accounts to improve processes and eliminate demand variability and non-value-added activities [10].

Customer Service Management: is the process where the firm confronts the customer and is the most important source of customer information [3]. Real time information like product availability, shipping dates and order status are provided to the customer. Besides, monitoring and reporting the process performance is carried out by this process [10].

Demand Management: the most important task of demand management process is to balance the customer demand with the firm's capacity of supply [15]. Demand management is about forecasting and synchronizing. Demand forecasts are synchronized with customer service management, order fulfillment, manufacturing flow management and product development and commercialization [10].

Order fulfillment: one of the most critical point in supply chain management is the fulfillment of the customer requirements in a timely manner which is directly linked with integration of manufacturing, logistics and marketing plans of the firm [22]. Orders and information from customer service is gathered and transferred to manufacturing flow process as soon as the inventory is checked [10].

Manufacturing flow management: encompasses all activities of achieving, implementing and managing the production flexibility and shipment of goods from the facilities of supply chain partners [13]. Within this process, production, materials and capacity requirements planning is done and executed [10].

Procurement: suppliers are categorized according to factors like the critical importance they have for the focal firm and the level of their contribution. Strategic plans are made with the suppliers in order to support manufacturing flow management and product development and commercialization. Reference [9] has renamed this process as "supplier relationship management" regarding the fact that this process involves the relationship with the suppliers.

Product development and commercialization: consists of joint activities together with customers and suppliers for new product development and launching the goods in the market [26]. In this process, there is coordination with customer relationship management to determine the needs of the customers.

Returns: or "returns management" called by reference [10] aims the prevention of returns in other words, manufacture and sell in a way to minimize the returns. Besides, returns management makes the decision on recycling, remanufacturing or reselling issues and focus on creating value in reverse flow of goods.

The main GSFC processes and the features of e-supply chain that were summarized in the previous section will form the basis for the case study in evaluating the supply chains and the usage of internet in the supply chains of the two private shopping companies.

4.PRIVATE SHOPPING

Private shopping companies have been a recent market trend especially in electronic commerce. They are similar to the former membership clubs which used to allow only members to shop from certain companies. They work like an e-tailer but they are slightly different in terms of their business models.

Private shopping companies sign special contracts with well-known brands in order to sell unsold products at reasonable discount rates online and only to the members of the web-company. The membership is granted generally through an invitation from an existing member of the company. The discount campaigns have limited time and the users are being informed of the campaign approximately two days prior to the start of the discount. The sales are executed on first comes first served basis. The products are sent to the web company's warehouse by the brand owner/manufacturer and the web company sends the products to the customer. It is a mutual gain for all three parties; the brand depletes the existing inventory during slow sales periods without compromising its image, the private shopping company earns from sales commissions and the customer affords to buy famous brands at a reasonable cost [30].

This business model was introduced by a European company called vente-privee.com. Different from the other e-commerce or internet related initiatives, private shopping is the first model that was born out of the USA and adopted by American companies afterwards [14]. The first private shopping company established in Turkey is markafoni.com. Following them, limango, a company owned by one of the biggest e-commerce companies of the world, Otto Group, was established. Starting with textiles and apparels, nowadays they seem to enter new markets with subdomains like LimangoTech [23].

A different business model that followed this first version, aims to serve to collective services purchasing in order to offer different services like dining, beauty, entertainment or health at lower prices to final customers. Recently emerging companies in this area are offering advantageous prices to their members at famous restaurants, up-to-date cultural activities, popular health and sports servies and such.

Being a new online business model, to the best of our knowledge, private shopping companies are not explored by scholars yet. They are generally grouped together with the other e-commerce companies in analysis of consumer behavior on online markets. Considering their different characteristics, private shopping companies are chosen in order to be analyzed in terms of their e-supply chain processes in this study.

5.METHODOLOGY

According to reference [27], when the aim of a study is to understand in depth, to enhance the experience and to increase an existing conviction about a phenomenon, the usage of case studies would be advantageous. As the concept of e-supply chain is a rather recent issue in the literature, it is assumed to be a better way to narrow down the broad subject that is examined in previous sections to the company level and explore the exemplary applications over the two chosen cases. Therefore, the rationale of using a case study was to allow an in-depth examination of internet usage in supply chain management processes of two existing companies already engaged in private shopping. Both companies are well known brands in their sector; the first company provides goods whereas the other provides services in the sector.

The data is gathered through face to face semi-structured interviews with chief executive officers of the companies due to the absence of a business unit or department for supply chain management. The questions asked in interviews are built up on the conceptual requirements of an e-supply chain listed in section 3.1. and the analysis of supply chain processes defined by GSCF. The results of the analysis are combined in order to build up a comparison among the two private shopping companies' e-supply chain applications.

6. FINDINGS

6.1.Company X on Goods Sector

Company X is an exclusive club of luxury shopping, offering members the world's most exclusive brands of apparel, cosmetics, shoes, decoration etc. and fashion trends with a closed membership structure. Two different membership structures called Boutique and Campaign exist in the system. Boutique membership is based on invitation. Boutique members are entitled to access to the world's most exclusive brands with advantageous prices throughout the year. Boutique members can shop at the same time as they wish in the Campaign category. In the Campaign category, application for membership is open to everyone. Company X confirms the membership applications and members can shop as they wish in campaign category. In this section, a limited number of exclusive products, during a short period of time, with attractive prices are offered for sale. Members of the company X give their order on the web site of the company and pay online. When the campaign is over, the courier company delivers the goods ordered within a week.

The operation of supply chain processes as seen in Figure 1 can be summarized as follows:

Company X decides to launch a new campaign; they negotiate with suppliers (exclusive brands) for the quantity, price of the goods, the duration of the campaign and sign a contract.

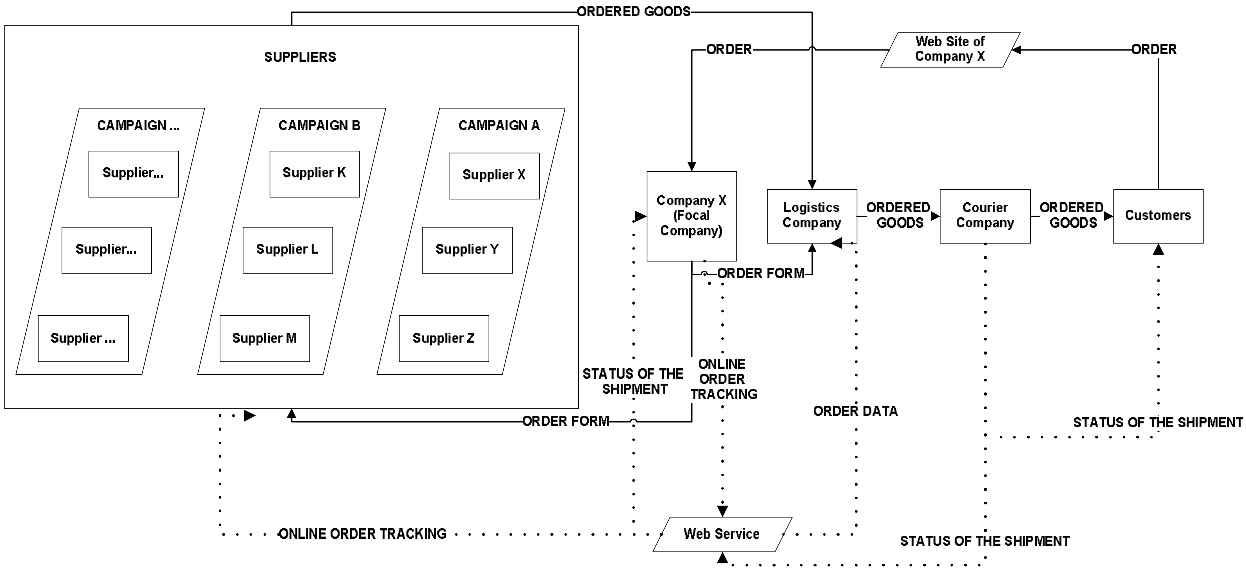

FIGURE 1
Supply Chain Structure of Company X

Supplier fills an excel form consisting of information such as the quantity of the goods available for the campaign, barcode and the description of the goods (size, color, fabric etc.). They send this excel form and a sample of each goods that will be sold during the campaign to company X. Company X takes the photo of each sample and launches the campaign by designing the web site with the photos and related information acquired from the suppliers. As soon as the campaign starts, company X provides a web service for suppliers of the campaign enabling them track the online sales. At the ending date of the campaign, an order form is sent both to the supplier and to the logistics firm. Suppliers ship the orders to the logistics firm from their own warehouses. Logistics firm prepares the barcodes for the goods without barcode, attach them into the goods shipped, package them and print the bills of related goods. Courier company takes the goods from the logistics company, assigns an order number, develops a database of the goods that will be delivered to the customers by scanning the barcodes and deliver the goods to the customers. Both company and the customer can track the status of the shipment of the order from the web site. In case of returns, customers call company X indicating their requirement for return. Company X examines the good and then sends good to the supplier with its bill and pay customer back.

The usage of internet on supply chain of company X is analyzed according to the processes defined by GSCF as follows:

Customer Relationship Management: Company X doesn't adopt CRM applications. The only technique embraced is gift cheques which are delivered through the web site of the company X.

Customer Service Management: The customer can see the product availability online and also track the status of his/her shipment from the website.

Demand Management: Demand is not forecasted however, the dates of the campaigns are planned. Hence, seasonal demand analysis is carried out but this process is not performed collectively with the suppliers. Capacity namely, the quantity of the goods sold is determined solely by the supplier hence, there is no coordination and cooperation on determination of demand and supply. The usage of internet in this process is out of question.

Order Fulfillment: Customers place their orders on the web site. As soon as the campaign expires, an order form is prepared by company X and sent to the supplier and the logistics company via e-mail. Besides, there is a web service between the logistics company and the focal company providing information like code, barcode of the goods ordered. This service saves time for the logistics company as it facilitates the establishment of the database of orders without having to scan the barcodes. Logistics company picks the orders from the suppliers. For the goods that do not contain a barcode, a barcode is assigned by the logistics company, printed and attached to the order. Moreover, bill is printed by the logistics firm and also attached on the package of the order. The courier company takes the goods from the logistics company, scans the barcodes and transfer data to the web service and delivers to the customer. When the customers or company X wants to track the delivery status of the order, the web service of the courier company enables the online tracking available in the web site of company X where the web service of the courier company is directly connected with a link.

Manufacturing Flow Management: Suppliers do not manufacture according to orders. They offer the goods of previous seasons which are already in their stock. Company X doesn't own a warehouse; the logistics company takes the goods from the warehouses of the suppliers. A web service enables the suppliers to track the sales in real time.

Procurement: Purchasing specialists have their own portfolio so they find and contact the suppliers through telephone, make an appointment and visit the suppliers. There are also suppliers that are willing to be involved in the campaigns which apply through the web site of the company X. Suppliers and purchasing specialists mutually agree on the goods that will be offered and the duration of the campaign. These processes are carried out through face to face meetings but not internet. Suppliers fill an excel form regarding information about goods offered for the campaign and send this form to the focal company through e-mail.

Product Development and Commercialization: The needs of the customers are not determined, only the seasonal demand analysis are carried out and special days like mothers day, valentines day are taken into account in launching new campaigns. However, there is no coordination and collaboration with the suppliers in this process.

Returns: Return declaration is mostly done via telephone. The customers send the goods through the courier company to the company X. Company X examines the goods, the customer is informed via e-mail and the goods are sent back to the supplier.

6.2.Company Y on Services Sector

Based on the slogan "The city is now more beautiful!" company Y was founded in March 2010 as one of the first companies that offer collective purchasing service in Turkey. Since the establishment of the company, it acts as a platform that provides their members with restaurants, entertainment venues, health and beauty services, cultural and art activities with advantageous prices.

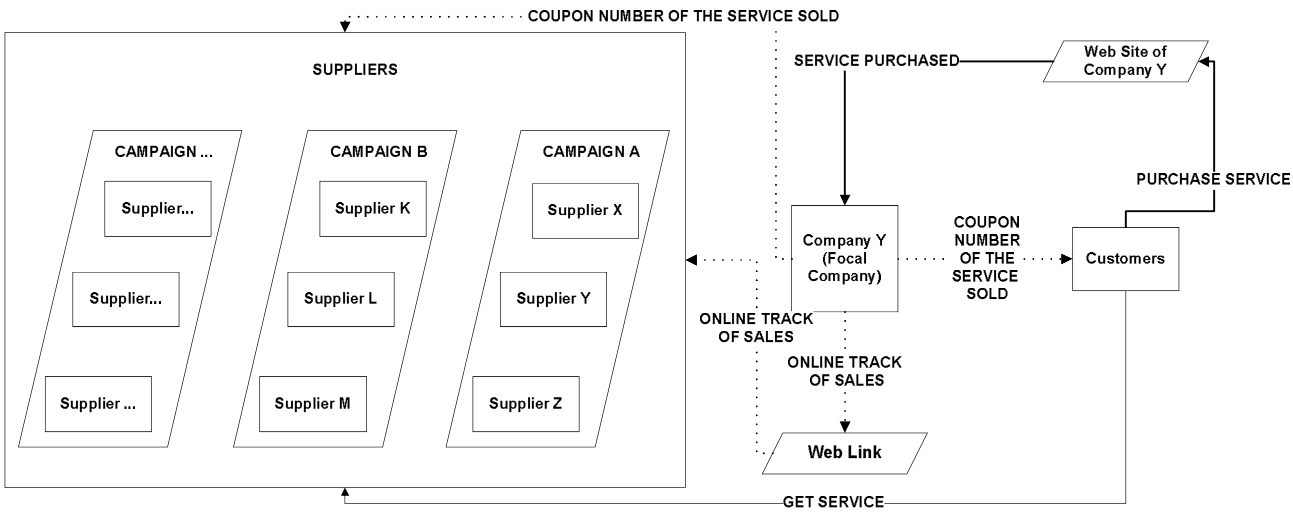

FIGURE 2
Supply Chain Structure of Company Y

As can be seen in Figure 2 members of company Y purchase a service provided at the web site online during the campaign. Just after the purchase, the focal company reproduces a coupon number with 7 digits regarding the service bought. This coupon number is sent to the supplier and the customer so that the customer can receive the service between the dates specified. For example, if the service purchased is a concert, with the coupon number, customer directly goes to the concert and receives service. However, if the service bought is a massage from a health club, the customer should make an appointment first and then receive the service.

The usage of internet on supply chain of company Y is analyzed according to the processes defined by GSCF as follows:

Customer Relationship Management: Company Y acquires a CRM database. The type of the service bought, complaints, returns and the reasons of customer calls and e-mails are recorded in the database. Each mail and call is tagged according to the related category and reports are prepared on a weekly basis. If the results of the report points out a severe ratio of complaints towards a supplier, company Y informs the supplier about the complaints. In case of the repetition of the same complaints, company Y quits working with the supplier.

Customer Service Management: A call center and an e-mail address are provided to customers to enable their contact with the focal company to receive their wishes and complaints.

Demand Management: Suppliers do not inform their capacity; a campaign specialist visits the physical space of the supplier, examines the capacity of the tangibles and forecasts the physical capacity of the supplier. Therefore, there is no collective capacity and demand planning. Besides, demand forecasting doesn't rely on a sound statistical forecasting method.

Order Fulfillment: Customers purchase the service on the web site. Company Y assigns a coupon number to the purchase; send this coupon number to the customer both through e-mail and SMS. Moreover, the same coupon number is sent to the supplier via e-mail. For the services that don't require an appointment, the customer can go and receive the service between the dates specified on the web page.

Manufacturing Flow Management: A web link is provided to suppliers with a username and a password that facilitates the tracking of real time sales.

Procurement: Campaign consultants that are responsible from different districts of the city, search for new restaurants, entertainment venues, health and beauty services, cultural and art activities (suppliers) in magazines, newspapers and in internet. Besides, suppliers also apply both via internet or through personal visits to participate the campaigns. Terms of agreement for the related campaign are determined during face to face meetings. Price and profit margins are negotiated with the supplier furthermore, the validity periods and validity conditions of the coupons are mutually determined and a contract is signed.

Product Development and Commercialization: The needs of the customers are not determined; campaign consultants carry out the development of new campaigns. However, there is no coordination and collaboration with the suppliers in this process.

Returns: Return declaration is done via telephone and e-mail by the customer. The information on return is also informed to the supplier via e-mail.

6.3 Comparison of Internet usage in company X and company Y

Consequently, when the degree of internet usage among these companies is compared, it is observed that internet is used in most of the processes but the degree of utilization is limited. As table 1 depicts, Company X's internet usage in customer relationship process consists of only providing gift cheques via internet whereas, internet isn't used at all in company Y in this process. In customer services management, internet is only used in complaining and communicating the requirements in company Y. On the other hand, internet usage in company X regarding this process is satisfactory. Both company X and Y don't benefit from the advantages of internet in demand management process.

However, company X utilize from internet in order placement and in transferring the order form from suppliers. Similarly, customers of company Y purchase the service offered on the web site, besides, company Y notify their customers through e-mail and SMS to inform that the service is purchased.

TABLE 1
Evaluation on Internet Usage in Supply Chain Processes of Company X and Company Y

	Company X	*Company Y*
Customer Relationship Management	Gift cheques (provided on web site)	None
Customer Service Management	Product availability (web site) Online tracking of delivery status (web site)	Customer requirements and complaints (e-mail)
Demand Management	None	None
Order Fulfillment	Order placement (web site) Order form (e-mail)	Purchase of the service (web site) Notification of the customer (e-mail, SMS)
Manufacturing Flow Management	Real time sales tracking (web service)	Real time sales tracking (web site)
Procurement	Excel form (e-mail) Supplier application (e-mail)	Supplier research (web pages) Supplier application (e-mail)
Product Development and Commercialization	None	None
Returns	Notification to customer (e-mail)	Return declaration of customers (e-mail) Notification to customer (e-mail)

Both companies use internet in online tracking of the sales but there is no internet application in product development and commercialization process. Finally, both companies notify their customers via e-mail in return process whereas, in company Y customers generally declare their return requirements through e-mail.

7.CONCLUSION AND FURTHER RESEARCH

This study was done in order to specify the necessary processes, technologies and characteristics that are needed to be adopted by organizations in order to comply with e-supply chain management practices. These processes, technologies and characteristics are mainly expected to be prevalent in web based companies. In order to explore a recently rising form of web business, private shopping companies were chosen as the research field.

The case study conducted on two private shopping companies operating in goods and services sector reveals that the usage of internet in most of the supply chain processes of both companies are limited. This can be evaluated due to their recency in the electronic markets serving to Turkish consumers and the lack of a well established infrastructure in terms of supply chain management within the organizational boundaries of these firms. Without a holistic supply chain management view, it is hard to analyze the supply chain processes one by one and set them on an automatic basis that utilizes internet technologies.

It is suggested that electronic data interchange (EDI) should be established in order to ensure the data transfer both within the departments of companies and members of the supply chain. Besides, the usage of Enterprise Transportation Management which is an Oracle web application that facilitates the flow of shipment and delivery information throughout the members of supply chain can be suggested to both companies. Moreover, through internet or extranet based digital networks, both companies should carry out their demand and capacity planning in order to be more efficient. Keeping in mind that the competition is very severe in the private shopping market, cost benefits would be crucial for these companies in terms of their success and sustainability. Also an effective electronic infrastructure that strengthens not only the front end systems but also the back end systems of the private shopping companies, would result in customer satisfaction and increase the number of visits and purchase in the future.

This study is conducted on only two of the companies in private shopping sector hence, in order to generalize the findings, further studies should be done on other firms engaged in private shopping. Besides, in order to increase the construct validity, converging findings from different sources should be gathered. These can be conducted on not only web based companies but also on physical supply chain management systems of conventional manufacturing or service companies. Different studies in different sectors can exhibit the potential differences between the traditional supply chain practices and e-supply chain practices.

As the study of private shopping is new, very few studies have been conducted in this area of research. Therefore, it is believed that this study contributes to the literature by exploring the electronic supply chain processes and internet usage among these processes of private shopping companies. Besides, it is hoped that the practitioners will benefit from this study while structuring their e-supply chains.

REFERENCES

[1] Akyuz, G.A., Rehan, M. (2009) Requirements for Forming an 'e-Supply Chain', International Journal of Production Research, 47(12), pp. 3265-3287.

[2] Bechtel, C. ve Jayaram, J. (1997). Supply Chain Management: A Strategic Perspective. The International Journal of Logistics Management. 8(1) pp. 15-34.

[3] Bolumole, Y.A., Knemeyer, A.M. and Lambert, D.M. (2003), The Customer Service Management Process, The International Journal of Logistics Management, Vol. 14, No. 2, pp. 15-31.

[4] Chaffey, D. (2006) E-business and E-commerce Management: Strategy, Implementation and Practice, USA: Prentice Hall.

[5] Chopra, S. ve Meindl, P. (2004). Supply Chain Management Strategy, Planning and Operation. Upper Saddle River, New Jersey: Pearson Education Inc.

[6] Christopher, M. L. (1992) Logistics and Supply Chain Management, London, Pitman Publishing.

[7] Cooper, C.M., Lambert, D.M., Pagh, J.D. (1997) Supply Chain Management: More than a New Name for Logistics, The International Journal of Logistics Management, 8(1), pp. 1-13.

[8] Council of Supply Chain Management Professionals, http://cscmp.org/digital/glossary/glossary.asp, visited on 21 May 2011.

[9] Croom, S.R. (2005). The Impact Of E-Business On Supply Chain Management: An Empirical Study Of Key Developments. International Journal of Opeations & Production Management. 25(1) pp. 55-73.

[10] Croxton, K.L., Garcia-Dastugue, J., Lambert, D.M., Rogers, D.S. (2001). The Supply Chain Management Process. International Journal of Logistics Management. 12(2) pp.13-36.

[11] Frohlich, M.T., Westbrook, R. (2001) Arcs of Integration: An International Study of Supply Chain Strategies, Journal of Operations Management, 19(2), pp. 185–200.

[12] Gimenez, C., Lourenco, H.R. (2008) e-SCM: Internet's Impact on Supply Chain Processes, The International Journal of Logistics Management, 19(3), pp. 309-343.

[13] Goldsby, T.J. and Garcia-Dastugue, J. (2003). The Manufacturing Flow Process, The International Journal of Logistics Management. 14(2) pp. 33-52

[14] Kirtok, A. (2011) ABD Private Shopping Pazarinda Hareketli Gunler, ETicaretMag, available online at http://eticaretmag.com/abd-private-shopping-pazarinda-hareketli-gunler/, visited on 21 May 2011.

[15] Lambert, D.M. and Cooper, M.C. (2000). Issues in Supply Chain Management. Industrial Marketing Management. 29, pp.65-83.

[16] Lancioni, R., Schau, H.J., Smith, M.F. (2003) Internet Impacts on Supply Chain Management, Industrial Marketing Management, 32(3), pp. 173-175.

[17] Lummus, R.R., Vokurka, J.J. (1999) Defining Supply Chain Management: A Historical Perspective and Practical Guidelines, Industrial Management & Data Systems, 99(1), pp.11–17

[18] Luo, Y.; Wirojanagud, P.,Caudill, R.J., (2001) Network-Based Optimization and Simulation of Sustainable e-Supply Chain Management, Proceedings of the 2001 IEEE International Symposium on Electronics and the Environment, Denver, CO, USA, 07 May-09 May 2001, pp.185-190.

[19] Manthou, V., Vlachopoulou, M., Folinas, D. (2004) Virtual e-Chain (VeC) Model for Supply Chain Collaboration, International Journal of Production Economics, 87(3), pp. 241-250.

[20] Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D., Zacharia, Z.G. (2001) Defining Supply Chain Management, Journal of Business Logistics, 22(2), pp. 1-24.

[21] Mukhtar, M., Jailani, N., Abdullah, S., Yahya, Y., Abdullah, Z. (2009) A Framework for Analyzing e-Supply Chains, European Journal of Scientific Research, 25(4), pp. 649-662.

[22] Ozdemir, A.I. (2004). Tedarik Zinciri Yönetiminin Gelisimi, Surecleri ve Yararlari. Erciyes Universitesi IIBF Dergisi. (23) pp. 87-96.

[23] Ozkan, E. Turkish Business, http://www.turkbiz.com/index.php/elektronikte-private-shopping-donemi/2011/03/, visited on 21 May 2011.

[24] Parvatiyar, A. & Sheth, J.N. (2001). Customer Relationship Management: Emerging Practice, Process and Discipline. Journal of Economic & Social Research. 3(2) pp. 1-34
[25] Rappa, M. (2000) Business Models on the Web, http://digitalenterprise.org/models/models.html visited on 21 May 2011.
[26] Rogers, D.S., Lambert, D.M. and Knemeyer, A.M. (2004). The Product Development and Commercialization Process. The International Journal of Logistics Management. 15(2) pp. 43-56.
[27] Stake, R. E. (1978) The Case Study Method in Social Inquiry, Educational Researcher, 7(3), pp.5-8.
[28] Supply Chain Council (2005) Supply Chain Operation Reference Model: SCOR Version 7.0 Overview. http://www.torconsulting.com/downloads/scor7_overview.pdf, visited on 20 May 2011.
[29] Van Hoek, R. (2001) E-Supply Chains – Virtually Non-existing, Supply Chain Management: An International Journal, 6(1), pp.21-28.
[30] http://www.tamisabet.com/internet/private-shopping-ozel-alisveris-ve-vente-priveecom, visited on 21 May 2011.

ANALYSIS OF LOGISTICS CENTRES ACTIVITIES IN EUROPE

Fatma Kalaoğlu[1], Fatma Alev Bilge[1], Selin Hanife Eryürük[1], Besoa Rabenasolo[2,3], Emmanuel Castelain[2,3], Feridun Akpinar[2,3]

Abstract *— Today, global firms in distant places trying to find ways of controlling larger webs of production and distribution. Logistics centres similar in Europe causes significant advantages like logistics chain optimization, truck usage optimization, warehouse usage optimization, manpower usage optimization, decline in total transport costs, drop in total industrial costs, decline in personal expenses and increase the total turnover of the transport operations. In this study we aim to analyse the activities of logistics centres in Europe. The analysis of the flow of goods, both import and export, and overview of distribution channels is very important to identify the strategy for logistics centre.*

Keywords — Logistics centre, logistics activity, logistics concept

INTRODUCTION

A Logistics Centre is the hub of a specific area where all the activities relating to transport, logistics and goods distribution – both for national and international transit – are carried out, on a commercial basis, by various operators. In order to encourage intermodal transport for goods handling, a Logistics Centre should preferably be served by a variety of transport methods (roads, rail, sea, inland waterways, air).

The most important elements for logistics centres are, land plot with good infrastructure near main road and rail corridors; intermodal terminal and warehouses; and possibility to combine two or more transport modes. Logistics centres should consist of customs infrastructures; postal/bank/insurance services; offices; intermodal terminals; warehouses; other added value service (such as – refill station, service station).

Managing company's responsibilities consist of investments and centre development; expansion planning; looking for new investors; attracting more cargoes to the centre; promotion of the logistics centre; land, warehouse and office leasing (sale) to companies; upkeep and management of logistics centre property.

Private Public Partnership is the most common, widespread organizational structure for companies managing logistics centres. The choice of PPP model as well as involvement and size of investments depends of Public Authorities demands – financial, infrastructure and planning reasons. Shareholders can be national and local authorities, railway companies, local transport associations, Chamber of Commerce, banks, insurance companies, industrial associations, land development companies and other companies [1].

Location, infrastructure, labor costs, proximity to customers, community and site characteristics together determine a distribution facility. Competition in trade is becoming harder not only between the companies but also between the countries. The purpose of this study is to determine the growing importance and activities of Logistics Centres in Europe.

EVOLUTION OF LOGISTICS CONCEPTS

Globalization strategies of companies can be explained by two motives: the market expansion with increasing foreign sales and the enhancement of a company's competitive position in its home market by shifting the production activities to various regions in the world, based on cost advantages. Globalization is a strong impulse for increased attention for logistics management. Studies highlighted the need for more attention on facility location planning, fleet selection, inventory management and vehicle routeing. Central coordination and logistics platforms replace central distribution [2].

Many multinational manufacturing companies, that have extended their market to Europe in the past decades, deal with ever changing customer requirements. These companies need to be flexible in adjusting to

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these changes in customer requirements. This caused developments regarding logistics concepts in Europe. The evolvement of the concepts are shown in Figure 1, they can be described as follows [3]:

- In the first stages of internationalisation, products are delivered directly to different markets in Europe; goods are delivered on a national basis.
- The developing strategies of companies towards focus on logistics costs and efficiency, together with the ongoing European integration, caused increased centralisation of European distribution. The central distribution concept is characterised by large flows to one central point, where central storage takes place. In these European Distribution Centres (EDC's), value added activities can take place.
- With the combined focus of companies on market effectiveness and logistics efficiency, the central coordination of distribution remains, but physical distribution is not necessarily centralised. Logistics platforms appear in a situation where flexibility of both supply chains and production facilities are required.

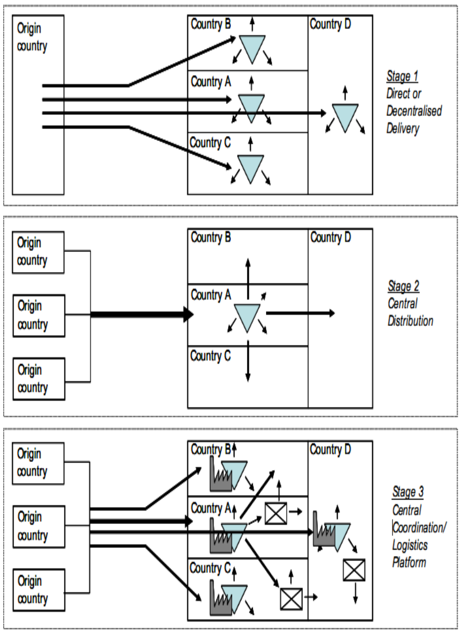


FIGURE. 1
Evaluation of Logistics Concepts [2].

Figure 2 illustrates the translation of the more conceptual logistics concepts into location related distribution concepts. The emergence of central distribution concepts made value adding activities take place within the seaport region and the goods are further distributed to the customers in the hinterland from this central location. The regional scope of physical distribution implies that the distances to the market are often shorter in the hybrid distribution system compared to central distribution.

There is a hypothesis that the development towards hybrid distribution concepts decreases the potential for ports to develop integrated intermodal logistics centres. Development towards hybrid distribution can increase the potential of inland locations where more space is often available against lower prices. Other location factors like proximity to market, knowledgeable labor force, less congestion etc., can become more important in the choice of a location. This development can be seen in the port of Rotterdam. There are companies that decide to move to inland locations. On the other hand, the Port of Rotterdam sees chances in Asian companies that decide to increase their market reach with an European Distribution Centre in the port of Rotterdam [1].

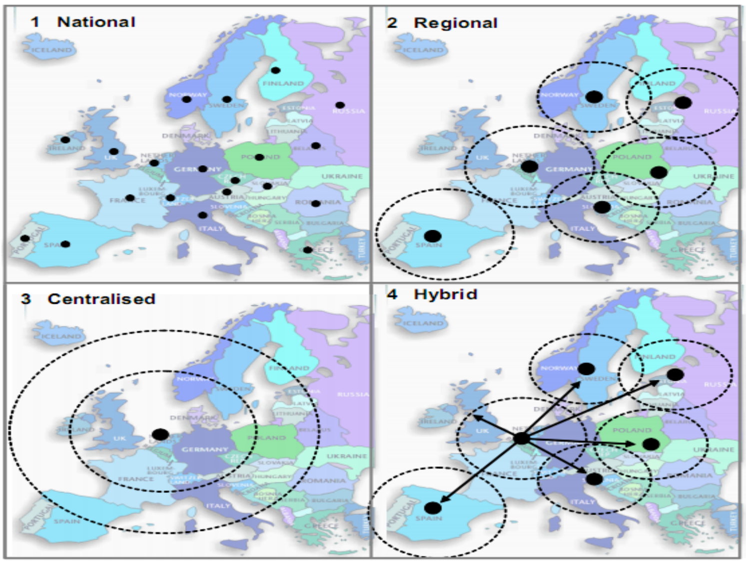


FIGURE. 2
Development in Distribution Concepts [2].

LOGISTICS CENTRES IN EUROPE

The first initiatives for the development of Logistics Centres in Europe did already start in the sixties and seventies, particular in France, Italy and Spain. There are some selected Logistics Centres that show some of the best examples on how efficient Logistics Centres are operated [2].

In Italy, there are 24 logistics centres (one logistics centre per 2,5 mill inhabitants); size approximately 150 ha. Interporto Bologna S.p.A. is one of the first logistics centres built (1971) in Italy and Europe; size – more than 400 hectares; investments made – approximately 285 mill EUR; there are about 100 companies with 1500 employs; turnover – approximately 500 mill EUR per year; management company – Interporto Bologna S.p.A – turnover approximately 25 mill EUR per year [1]. The development is placed at the heart of the main traffic routes that cross Italy from north to south and where 75% of all goods exchanged in the country is carried by rail or road. It is managed by a Private-Public-Partnership.

BILK Kombiterminal – Hungary started in 2002, 70% of the centre is owned by the Waberer's Holding Co Ltd. The good location, available capacity, realized innovative technologies on terminal, and role as environmental diversion reducer for capital city provide the important state for terminal. The BILK is in the XXIII district of Budapest between the main road, the Budapest – Kelebia railway line and the Highway. The territory is 100 hectare. The distance from the Logistics Centre and Ferihegy Airport is just 16 km, and from the MAHART Freeport of Csepel it is only 15 km.

Klaipeda Logistics Centre (KLC) construction has been approved by the Lithuanian government in 2001. This is supported by both the national authorities and the EU. Private investors own 85%, public investors own 15%. KLC has the position as an umbrella organisation for the companies that are operating in it. The Logistics Centre aimed at attracting 180 companies to locate in the area and creating up to 1500 new jobs. Location Klaipeda has rail connections to several connections in Russia. The distance between KLC and Klaipeda Seaport is about 5 km., and closest railway lines 1-2 km. The Palanga airport is at about 25 km. Territory is 92 ha.

Nordic Transport Centre (NTC) is activated in Denmark in 1992. The Centre has been placed outside the city of Aalborg according to local policy for e.g. environmental and security reasons. Regional authorities have managed to establish a cooperation with regional authorities from Southern Norway and Western Sweden down through Jutland, along the transport corridor known as the Nordic Link. Centre is directly connected with the European rail and motorway network. The geographical position of NTC play an important role as the Nordic turntable between the Nordic countries and the rest of EU.

Bikakobo-Aparcabisa (Bizkaia) Transport & Logistics Centre is a public funded society, started in 1983 by the Autonomous Government of the Basque Country in Spain. The terminal has the advantage of its strategic location along the Cantabrian (North-Spanish coast) motorway, at a gravitation point only 6 km., away from the airport of Bilbao. Land area is 20 ha [2].

In Germany, there are 31 logistics centres (one logistics centre per 2,6 mill inhabitants); planning 4 logistics centres; size approximately 140 ha; about 1300 companies; approximately 45000 workers. The Bremen LC is the first Logistics Centre in Germany. This centre accommodates three types of transport: railway, road and waterway transport. From 1987 the logistics centre is managed by the principle of public and private sector partnership. Federal government of Bremen, National German Railways (DB) and several holders are parties to the PPP [1]. Dresden GVZ – Germany was established in 1997. In addition to excellent transport links, it is located away from areas with "conflict potential" (i.e. high population density) and therefore allow round clock operations. Share capital is owned by SVG (Road Haulage Cooperative)75% and Deutsche Bahn 25% [2].

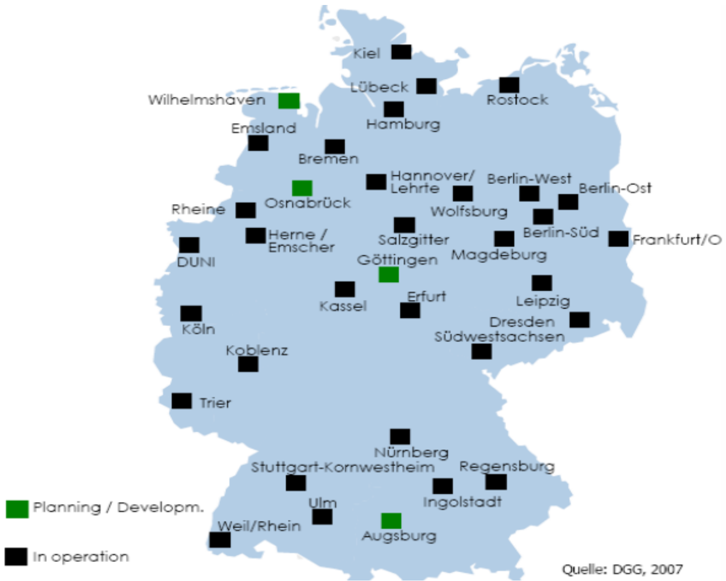
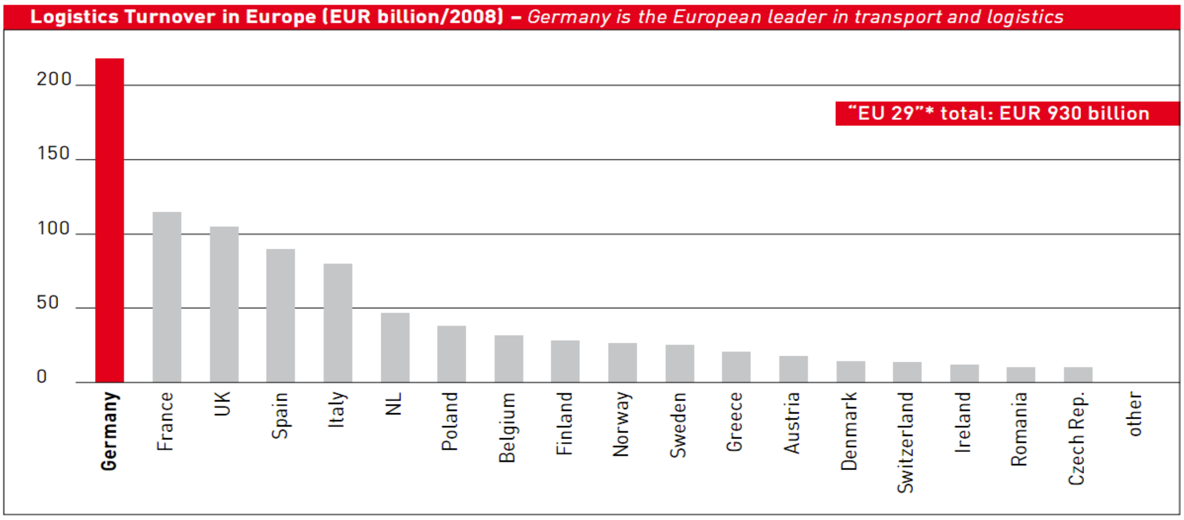


FIGURE. 3
Logistics Centres In Germany [1].

Fraunhofer Institute's Top 100 in European Transport and Logistics reports that Germany accounts for over EUR 218 billion or 23 percent of the EUR 930 billion spent on logistics services. Germany's logistics industry accounts for 8.8 percent of its GDP, which is significantly higher than the European average of 7.1 percent.

TABLE 1

Logistics Turnover in Europe (EU plus Norway and Switzerland) [4].



Germany is Europe's largest logistics market with over EUR 200 billion in annual revenue, ranked no.1 out of 155 countries, by the World Bank's 2010 Logistics Performance Index, and the leader in logistics innovation, technology and services. Proximity is not the only advantage Germany enjoys in the logistics field. Germany has some of Europe's most advanced transportation networks, with both road and rail densities double the EU average. A large well-trained workforce, a stable political and economic environment are also important factors [4].

BEST PRACTICES IN THE FIELD OF LOGISTICS CENTRES

EU Commission has created know-how concerning solutions (best practices) by initiating the Intermodal Development Centre - IDC. Transport and logistics centres can help to practically implement the IDC-concept with their independent management units. The IDC's mission is to stimulate, develop and promote intermodal transport services combining all relevant modes of transport. They need to offer their clients and, consequently, society at large the best service in terms of efficiency, price and environmental impact in the broadest sense (economic, ecological, energy, etc.). They are transport service providers who arrange full load, door-to-door transportation by selecting and combining without prejudice the most sustainable and efficient mode(s) of transportation.

Successful PPP depends on the effectiveness of the national and municipal legislative and regulatory structures. An added value service is a fundamental function within the Logistic Centre concept, many smaller companies combine their efforts and collaborate instead of competing [2].

The factors, which make planning and implementing more difficult than before are as follows [6]:

- Public decision processes: many levels and phases; political, monetary and technical aspects.
- Laws and orders: land use, environment, security, working time, etc.
- The world is changing faster than investments are implemented => uncertain ground for decision making => demands for more information for decision => takes more time, etc.
- Integration to existing network: schedules, logistics technologies, ICT-systems, training of new employees, etc.
- Demands for efficient operations => complex technology.

Logistics centres need to be located near the transport corridors. Access to all transport modes is vital for the success of logistics centres. Environment needs to be considered in planning. Cooperation between the logistics centres and the design and production of infrastructure is important. There will not be any land use conflicts. The success of these centres depend strongly on the development of transit traffic and cooperation between existing logistics centres [6].

Following benefits are most important in working within the logistics centre [5]:
- intermodality benefit,
- forwarders impact,
- IT Solutions,
- new transport flows due to synergy,
- better supply chain management,
- additional services,
- cost sharing,
- economies of scale,
- quality of the services,
- know-how,
- joint marketing impact,
- increasing of third-party logistics services.

The three most expectative technical / logistics aspects relevant to sharing by cooperating with other companies from the same type of business within the logistics centre are (a) container terminals/warehouses, (b) trailer transhipment equipment and (c) innovative transhipment equipment. The three most important benefits / profits from cooperation with the same type of business companies within the logistics centre could be (a) multimodal benefits- interaction of different transport modes, (b) growth of cargo volumes and (c) new additional services [5].

CONCLUSIONS

In March 2010, the European Commission launched the "Europe 2020 - A European strategy for smart, sustainable and inclusive growth" to come out of the crisis and prepare EU economy for the next decade. The three key drivers for growth, to be implemented through specific actions are as follows:
- smart growth meaning fostering knowledge, innovation, education and digital society,
- sustainable growth (making the production more resource efficient while boosting EU competitiveness),
- acquisition of skills and the fight against poverty.

The European transport policy which is based on concepts of sustainability, competitiveness and efficiency will benefit from the strategy through focusing further on innovations in products and IT solutions that will contribute to the development of coherent transport network.

There are many bottlenecks related to private and public partnership and/or the companies with different expectations in the logistics centres, lack of knowledge regarding the possibilities, lack of collaboration during the planning stage. The main concentration needs to be on better understanding of possible short and long term benefits of the cooperation withing logistics centres.

REFERENCES

[1] Rimkus, R, "Management of the Transport and Logistic Terminals (Centres) and Services Provided at Their Territory", 2010. Ministry of Transport and Communications of the Republic of Lithuania Workshop. Kiev.

[2] Bentzen, K, Laugesen, M, S, Cerneckyte, V, "Transport and Logistics Centres", 2007. Sutranet Project WP 3 Final Report - Association of Danish Transport Centres. Aalborg.

[3] Van der Lugt, L, M, Nijdam, M, H, "The Changing Nature of Logistics Centres: Implications for Ports and Terminals", 2005. Sutranet WP 3 Positioning Paper for Cases Studies on Logistics Centres - Erasmus University. Rotterdam.

[4] "Germany: Europe's Logistics Hub", 2010. Germany Trade & Invest Industry Brochure. Berlin.

[5] Jaržemskis, A, "Research on Public Logistics Centre as Tool for Cooperation", 2007, Transport, XXII, No 1, 50–54.

[6] Kondratowicz, L, et al., "Planning of Logistics Centres", 2003. NeLoC Work Package 1 Final Report Vol II - Department of Scientific Publications of the Maritime Institute. Gdańsk.

A DIFFERENTIAL EVOLUTION ALGORITHM FOR THE MEDIAN CYCLE PROBLEM

Ipek Eker[1], Sakir Esnaf[2], M.Fatih Tasgetiren[3]

Abstract*—This paper presents a differential evolution algorithm with variable parameter search (vpsDE) for the Median Cycle Problem. The median cycle problem is concerned with constructing a simple cycle composed of a subset of vertices of a mixed graph. The median cycle problem focuses on minimizing the cost of the cycle and the cost of assigning vertices not on the cycle to the nearest vertex on the cycle. For the problem on hand, a novel solution representation is proposed for the particle swarm optimization algorithm so as to tackle the median cycle problem. No local search is used to see the pure performance of the vpsDE algorithm. The vpsDE algorithm is tested on a set of benchmark instances from the existing literature. In addition, a continuous genetic algorithm is also developed for the comparison purposes. The computational results show its superiority when compared to the genetic algorithm.*

Keywords*— Differential Evolution, Genetic Algorithm, Heuristic Optimization, Median Cycle Problem.*

INTRODUCTION

In general, most logistics problems can be considered as location-allocation problems which are basically concerned with determining a set of points to establish facilities serving all the users. When dealing with these problems, there are two functions to be minimized: the length of connectivity structure amongst the opened facilities (routing cost) and the cost of allocating the users to the facilities (allocation cost). The allocation cost includes a measure of a structure connecting the users with the facilities. These connection structures usually have a tree, cycle or a star shape for each facility. With the star structure, each user is connected by a path to a facility and the allocation cost is the sum of the distances between the users and their nearest facilities. One of these problems is the Median Cycle Problem (MCP) where the connection structure is a cycle visiting a fixed depot and the allocation is of star type. MCP aims at finding an optimal cycle visiting a given vertex, the depot, taking into account the routing and allocation costs. A first variant of the problem, denoted as MCP1, is concerned with finding a cycle minimizing both types of costs. A second variant, denoted as MCP2, deals with minimizing the length of the cycle subject to the constraint that the total allocation cost is bounded by a given threshold.

The MCP is defined as follows. Let $G = (V, E)$ be a complete undirected graph where $V = \{v_1, v_2, .., v_n\}$`is the vertex set and v_1 is the depot. Let $L[v_i, v_j]$ denote the nonnegative length associated to each edge $e = [v_i, v_j] \in E$, and $D[v_i, v_j]$ be the nonnegative allocation cost for each pair $(v_i, v_j) \in V \times V$. A solution is a tour or cycle C including the depot v_1 and at least two other vertices. Every non visited vertex is allocated to its nearest vertex in the cycle, being the allocation cost equal to the distance between them. The length of the cycle is given by

$$Len(C) = \sum_{(v_i, v_j)} L[v_i, v_j] \tag{1}$$

The total allocation cost is given by

$$Cos(C) = \sum_{v_i \in V} \min_{v_j \in V(C)} D[v_i, v_j] \tag{2}$$

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where $V(C)$ is the set of vertices of the cycle C. The MCP1 aims at finding the cycle C visiting the depot that minimizes the total length and allocation costs of $Len(C) + Cos(C)$. On the other hand, the MCP2 deals with finding the cycle C that minimizes $Len(C)$ subject to $Cos(C) \leq d_0$ where d_0 is a given threshold on the total allocation cost.

Both versions of the MCP are solved by Moreno Perez et al. [1] through a variable neighborhood tabu search (VNTS). Labbe et al. [2, 3] also provide integer linear programming formulations and develop a branch-and-cut algorithm for the MCP1 and MCP2. They use the appellation "Ring Star Problem" for MCP1. Renaud et al. [4] presented some efficient heuristics to solve both versions of the MCP where a random key evolutionary algorithm (RKEA) is proposed. A GRASP/VNS algorithm is also presented for both versions of the MCP in [5].

Applications of MCP1 appear in the design of telecommunication networks where user nodes are connected to concentrators lying on a backbone network linked to a root (depot) [6, 7, 8]. Both versions of the MCP have applications in the design of circular metro lines or motorways in which the cost of a circular structure has to be weighted against its access costs. Another application is the location of post-boxes where both collection cost and user access time have to be considered [9].

The MCP is related to a number of *Cycle Problems* where it is required to construct a cycle through a subset of vertices of a graph [10]. It can also be considered as a *Location Routing Problem* [11]. In these problems, there may be constraints on the cycle length or on the distance between the cycle and vertices not on it, or penalties for not visiting vertices, or profits for visiting them. Well-known examples are the *Travelling Salesman Problem with non-visiting penalties* [12], *the selective Travelling Salesman Problem* [13, 14], *the Prize Collecting Travelling Salesman Problem* [15] and *the Covering Tour Problem* [16]. Similar problems exist in the context where a structure such as a path or a tree must be located through a subset of the vertices of a graph [17, 18].

Differential evolution (DE) is an evolutionary optimization method proposed by Storn and Price [19]. Like other evolutionary-type algorithms, DE is a population-based, stochastic global optimizer. In a DE algorithm, candidate solutions are represented as chromosomes based on floating-point numbers. In the mutation process of a DE algorithm, the weighted difference between two randomly selected population members is added to a third member to generate a mutated solution followed by a crossover operator to combine the mutated solution with the target solution so as to generate a trial solution. Then a selection operator is applied to compare the fitness function value of both competing solutions, namely, target and trial solutions to determine who can survive for the next generation.

Since DE was first introduced to solve the Chebychev polynomial fitting problem by Storn and Price [19], [20], it has been successfully applied in a variety of applications that can be found in Corne et al. [21], Lampinen [22], Babu and Onwubolu [23], and Price et al. [20].

Based on the success of local search refinement in the DE algorithm [24], in this paper, we present a differential evolution algorithm with variable parameter search. The DE with the VPS will be denoted as vpsDE from now on throughout the paper.

This paper is organized as follows. Section II gives the methodology of the proposed DE algorithm. Section III gives the details of the GA. The computational results of test problems are shown in Section IV. Finally, Section V summarizes the concluding remarks.

DIFFERENTIAL EVOLUTION ALGORITHM WITH VARIABLE PARAMETER SEARCH

As known, there exist several mutation variations in traditional DEs. We follow the *DE/rand/1/* scheme of Storn and Price [19]. The traditional DE algorithm starts with initializing the target population denoted by *NP*. Each individual in *NP* has a *D*-dimensional vector with parameter values determined randomly and uniformly between predefined search ranges denoted by $x_{\min}$ and $x_{\max}$, respectively:

$$x_{ij}^t = x_{\min} + (x_{\max} - x_{\min}) \times r_1 \tag{3}$$

where x_{ij}^t is the i^{th} target individual with respect to j^{th} dimension at generation t; and r_1 is a uniform random number between 0 and 1.

Mutant individuals are generated in such a way that DE perturbs vectors from the target population by adding the weighted difference between two randomly selected target population members to a third member in the target population as follows:

$$v_{ij}^{t} = x_{aj}^{t-1} + F \times \left(x_{bj}^{t-1} - x_{cj}^{t-1}\right) \tag{4}$$

where a, b, and c are three randomly chosen individuals from the target population such that $\left(a \neq b \neq c \neq i \in (1,..,NP)\right)$. $F > 0$ is a mutation scale factor which affects the differential variation between two individuals.

Mutation phase is followed by the recombination of mutant individual with its corresponding target individual. To do so, a crossover operator is applied to obtain the trial individual such that:

$$u_{ij}^{t} = \begin{cases} v_{ij}^{t} & if \quad r_{ij}^{t} \leq CR \quad or \quad j = D_j \\ x_{ij}^{t-1} & otherwise \end{cases} \tag{5}$$

where the index D_j refers to a randomly chosen dimension $(j = 1,2,..,D)$, which is used to ensure that at least one parameter of each trial individual u_{ij}^{t} differs from its counterpart in the previous generation u_{ij}^{t-1}. CR is a user-defined crossover constant in the range $[0,1]$, and r_{ij}^{t} is a uniform random number between 0 and 1. In other words, the trial individual is made up with some parameters of mutant individual, or at least one of the parameters randomly selected, and some other parameters of the target individual. The Equation (5) is denoted by $u_i^t = \underset{i:=1,2,..,NP}{CR_k}\left(v_i^t, x_i^{t-1}\right)$ to ease the understanding of the pseudo code.

To decide whether or not the trial individual u_{ij}^{t} should be a member of the target population for the next generation, it is compared to its counterpart target individual x_{ij}^{t-1} at the previous generation. The selection is based on the survival of the fittest among the trial and target individuals such that:

$$x_i^t = \begin{cases} u_i^t & if \quad f\left(u_i^t\right) \leq f\left(x_i^{t-1}\right) \\ x_i^{t-1} & otherwise \end{cases} \tag{6}$$

During the reproduction of the DE algorithm, it is possible to extend the search outside of the initial range of the search space. For this reason, parameter values violating the search range are restricted to:

$$x_{ij}^{t} = x_{\min} + \left(x_{\max} - x_{\min}\right) \times r_1$$

The pseudo code of a traditional DE algorithm is given in Figure 1.

```
Initialize parameters
Initialize target population
Evaluate target population
Do
{
   Obtain mutant population
   Obtain trial population
   Evaluate trial population
   Make selection
}
While (Not Termination)
```

FIGURE 1
DE Algorithm

Solution Representation

The solution given by a cycle C visiting m vertices is represented by $S = \lfloor v_j : j = 1,...,n \rfloor$ where v_1 is the depot and v_j is:

- The *j*th vertex of the cycle for $j = 2,...,m$ and

- The $(j-m)$th vertex not belonging to the cycle for $j = m+1,...,n$.

Then the length of the cycle represented by S is given by

$$Len(S) = \sum_{j=2}^{m} L[v_{i-1}, v_i] + L[v_1, v_m] \quad (7)$$

And its allocation cost is given by

$$Cos(S) = \sum_{j=m+1}^{n} \min_{k=1,...,m} D[v_j, v_k] \quad (8)$$

An optimal solution S^* of MCP1 is the one that minimizes $Len(S) + Cos(S)$

In our implementation of vpsDE, a real random number $x_j \in [x_{\min}, x_{\max}]$ is assigned to each vertex v_j on the cycle. In order to determine a cycle, we define a threshold value x_m on the vpsDE vector. The cycle is determined in such a way that a parameter value $x_j \in [x_{\min}, x_m]$ implies the vertices not in the cycle whereas $x_j \in [x_m, x_{\max}]$ implies the vertices in the cycle. Assuming that $x_{\min} = 0$, $x_{\max} = 2$, $x_m = 1$. The solution representation is shown in Figure 2.

j	1	2	3	4	5	6	7	8
x_j	2.00	0.82	1.21	0.28	1.42	0.15	1.34	1.87
S	v_1	v_8	v_5	v_7	v_3	v_2	v_4	v_6
			Cycle In				Cycle Out	

FIGURE 2
Solution representation of MCP1

The above solution generates the cycle $\{v_1, v_8, v_5, v_7, v_3\}$ and the non-cycle $[v_2, v_4, v_6]$. It is achieved by the largest parameter value (LPV) in Tasgetiren et al. [25] such that the vertices are sorted by x_j values in a decreasing order. The vertices less than the threshold value (x_m) will be in the non-cycle and the others will be in the cycle. Thus, the cycle size will be m. For example, $x_3 = 1.21$ is between 1 and 2, so it must be in the cycle. However, the fraction of its value (0.21) implies that it will be in the last position in the cycle since we sort them in a decreasing order with LPV rule. There is always a possibility that the DE algorithm might generate x_j values less than x_m which means that there is no cycle. In order to ensure a cycle, the first dimension of the DE vector must be assigned to $x_{\max}$ so that a cycle starts with the root v_1. Then we make sure that at least two other dimensions of a DE vector must be between $x_j \in [x_m, x_{\max}]$ so that trial individual will have a root v_1 and two other vertices in the solution.

Initial Population

The initial population is constructed randomly. Our search ranges is simply $x_{\min}$ and $x_{\max}$, respectively. We fix at $x_{\min} = 0.0$ and $x_{\max} = 2.0$ and $x_m = 1.0$. Each individual is generated between 0 and 2 as follows:

$$x_{ij}^t = x_{\min} + (x_{\max} - x_{\min}) \times r \quad (9)$$

where x_{ij}^t is the i^{th} target individual with respect to j^{th} dimension at generation t; and r is a uniform random number between 0 and 1. As explained before, the threshold value $x_m = 1.0$ is used to determine the vertices in the cycle and those not in the cycle.

vpsDE Algorithm

The VPS strategy is especially employed in the MEA to enhance its local exploitation capability. In fact, VPS is inspired from variable neighborhood search (VNS) algorithm, which is a recent meta-heuristic proposed by

Mladenovic and Hansen [26] systematically exploiting the idea of neighborhood change, both in descend to local minima and in escape from the valleys containing them. We apply the VPS procedure when generating each trial individual at each generation. Instead of using some local search methods for generating the neighboring solutions, the traditional DE mutation and crossover operators can be applied with variable parameters depending on the value of the neighboring counter k. Since variable mutation and crossover operators stand for generating different neighboring solutions (i.e., when they change, the trial individual will change accordingly), the local refinement of the search is automatically achieved in the vpsDE algorithm. Given that δ and Φ are the temporary individuals, the pseudo codes of the vpsDE algorithm and VPS procedure are given in Figure 3 and 4, respectively.

$\Pr ocedure \quad vpsDE$	
Set NP, $MaxFES$, $k_{\max}$, $N_k(v)$	%Initialize parameters
$nFES := 0$	
$\Pi = \left(x_1^0, \pi_2^0, .., x_{NP}^0\right)$	% Set target population
$\underset{i:=1,2,..,NP,nFES++}{f\left(x_i^0\right)}$	% Evaluate population via NFT
$x_{best}^0 = \underset{i=1,2,..,NP}{\arg\min}\left\{f\left(x_i^0\right)\right\}$	%Find best solution
$t := 1$	
%Start generation	
$while \quad (nFES < MaxFES) \quad do\{$	
$\quad \underset{i=1,2,..,NP}{u_i^t = VPS_i\left(x_i^{t-1}\right)}$	%apply VPS
$\quad if \quad \underset{i=1,2,..,NP;nFES++}{f\left(u_i^t\right) < f\left(x_i^{t-1}\right)} \quad then\{$	%Evaluate trial individual via NFT and Accept via EC and SF
$\quad\quad \underset{i=1,2,..,NP}{x_i^t = u_i^t\}}$	
$\quad else\{$	
$\quad\quad \underset{i=1,2,..,NP}{x_i^t = x_i^{t-1}\}}$	
$x_{best}^t = \arg\min\left\{\underset{i:=1,2,..,NP}{f\left(x_i^t\right)}, f\left(x_{best}^{t-1}\right)\right\}$	%Find best solution
$t := t+1$	%Next generation
$\}endwhile$	
$return \quad x_{best}^t$	%Return best solution
$endprocedure$	

FIGURE 3
The vpsDE Algorithm.

$\Pr ocedure \quad VPS\left(x_i^{t-1}\right)$	
$k_{\max} := 2$	
$k := 1$	
$\delta = x_i^{t-1}$	%Set temporary individual
$\underset{i=1,..,NP}{f(\delta) = f\left(x_i^{t-1}\right)}$	%Set temporary individual
$do\{$	
$\quad a \neq b \neq c \neq i \in (1,.., NP)$	%Select three individuals

$if \quad (k=1) \quad then$

$\quad CR = 0.9$

$\quad F = 0.9$

$if \quad (k=2) \quad then$

$\quad CR = U(0,1)$

$\quad F = U(0,1)$

$\underset{i=1,2,..,NP}{v_i^t = N_k(v_i^{t-1})}$ %Mutant individual

$\underset{i:=1,2,..,NP}{\Phi_i^t = CR(v_i^t, \delta)}$ %Generate individual

$if \quad \underset{i=1,..,NP,nFES++}{f(\Phi_i^t) < f(\delta)} \quad then\{$ %Evaluate via NFT

$\quad \underset{i=1,..,NP}{\delta = \Phi_i^t}$

$\quad k := 1\}$ %Back to first neighborhood

$else\{$

$\quad \delta = \delta$

$\quad k := k+1\}$ %Next neighborhood

$if \quad nFES > MaxFES \quad then \quad break$

$\}while(k \le k_{\max})$

$return \quad \delta$ %Return best trial individual

$endprocedure$

FIGURE 4
The VPS Procedure.

Regarding the parameters of the eDE algorithm, care must be taken. Traditional DE uses only three control parameters. These are *Population Size (* NP *)*, *Mutation Scale Factor (* F *)* and *Crossover Rate (* CR *)*. The choice of these parameters is critical for its performance [27]. F is generally related to the convergence speed. It is necessary for F to be of sufficient magnitude to avoid premature convergence. $F = 0.9$ is suggested as a good compromise between convergence speed and convergence probability [27]. Among F and CR, CR is much more sensitive to problem's properties and multimodality. It is suggested in [28] that $CR = 0.9$ is a good choice. For these reasons, we choose $CR = 0.9$ and $F = 0.9$ as default parameters for the first neighbourhood (i.e., when $k = 1$) in the eDE algorithm. However, as suggested in [27], there exists no best parameter setting for all types of problems. Considering this suggestion, we randomly and uniformly assign CR value between 0 and 1 while F value is determined between 0 and 1 for the second neighbourhood (i.e., when $k = 2$). Regarding the remaining three strategies, CR, F and K values are determined randomly and uniformly between 0 and 1. In addition to the above, the population size is also a critical choice for the performance of DE [28]. We fixed our population size to $NP = 30$.

GENETIC ALGORITHM

To be compared to the DE algorithm, we developed a continuous genetic algorithm (GA) in this study. GAs are a family of parallel search heuristics inspired by the biological process of natural selection and evolution [29]. In GA optimization, solutions are encoded into chromosomes to establish a population being evolved through generations. At each generation, parents are selected and mated from the population to carry out the crossover operator leading to new solutions called children. Then, some of the individuals are mutated or perturbed. Finally, they are pooled together to select new individuals for the next generation.

In the proposed GA, first, the initial population of size NP is randomly constructed. At each generation, two parents are determined by tournament selection of size 2 and a random selection, respectively, to produce an offspring through a crossover operator. This process is conducted in a loop until MP offspring are produced. Instead of traditional mutation operators, we use immigration in our GA. In other words, at each generation, a number of individuals are randomly injected into the population. Hence, the size of the population is increased to $(NP+MP)$ at the end of each generation. For the population of the next generation, **tournament** selection of size 2 is used to establish the population, again among $(NP+MP)$ individuals, thus maintaining a NP size of population. This procedure is repeated until the stopping criterion is achieved. In this study, we use a continuous GA to tackle the MCP.

Solution Representation

The same solution representation is used as in the DE algorithm.

Parametrized Uniform Crossover Operator

In this paper, mating is achieved by using *parametrized uniform crossover* [30] where for each gene a biased coin is flipped to choose which parent passed that gene to a child. An illustration of the *parametrized uniform crossover* operator is shown in Figure 5.

j	1	2	3	4	5	6	7
r	0.40	0.92	0.85	0.45	0.82	0.64	0.32
Parent A	2.00	0.25	0.89	1.45	0.68	1.87	0.98
Parent B	2.00	1.08	0.75	0.93	0.64	1.12	1.75
Offspring	2.00	1.08	0.75	1.45	0.64	1.12	1.75

FIGURE 5
Parametrized Uniform Crossover (Crossover Probability is 0.50)

Note that after the crossover operator, the offspring might be infeasible. To make sure that there must be the root v_1 as well as at least two other vertices in the cycle, $x_{\max}=2.0$ is assigned to the first dimension and if there is less than two vertices in the cycle, necessary vertices are randomly established by $x_j \in (x_m, x_{\max}) = U(1,2)$.

Immigration

Instead of using traditional mutation operators, we employ immigration to the population at each generation. To achieve it, at each generation, a small number of newly created individuals are randomly replaced with some individuals in the target population.

COMPUTATIONAL RESULTS

The vpsDE algorithm was coded in C++ and run on Intel Core 2 Duo 2.4 GHz with 2GB memory. The vpsDE algorithm was tested on a subset of the instances used by Labbe et al [2, 3] which are derived from the TSPLIB library [31] with $51 \le n \le 200$ and Euclidean distance d_{ij}. For MCP1 instances, cycle length and allocation costs were symmetric and proportional to the Euclidean distance. To obtain optimal solutions visiting approximately 75%, 50% and 25% of the total number of vertices in the instances, we set $L(v_i,v_j)=\alpha d_{ij}$ and $D(v_i,v_j)=(10-\alpha)d_{ij}$ for $\alpha \in \{5,7,9\}$.

Regarding the parameters of the algorithms, population size is fixed at *NP*=200 in both algorithms. In the vpsDE algorithm, crossover probability and mutation rate are randomly and uniformly generated between 0 and 1 when generating each trial individual. For the GA, crossover probability is taken as 0.5 and the immigration rate is 0.01 which means that %1 percent of the population is randomly regenerated at each generation. As a termination criterion, both algorithms are terminated if the best so far solution does not improve after 1000 generations. We only consider the MCP1 variant of MCP here in this paper. We use 20 instances ranging from 51 to 200 vertices with 3 α levels in our study, i.e., $\alpha=5; \alpha=7; \alpha=9$ as in [1, 2, 3]. We carried out five runs for each problem instance and report the relative percent deviations from the optimal values in [2, 3] as follows:

$$\Delta_{avg} = \sum_{i=1}^{R} \left(\frac{(H_i - Opt) \times 100}{Opt} \right) / R \qquad (10)$$

where H_i, Opt, and R are the objective function values generated by both algorithms in each run, the optimal value in [2, 3] and the number of runs, respectively. For the computational effort consideration, t denotes the CPU time allowed until termination.

	GA			vpsDE		
	Avg	*Min*	*t*	*Avg*	*Min*	*t*
Eil51-5	4.11	3.26	4.5	3.71	2.76	15.83
Eil51-7	0.27	0.00	2.1	1.33	0.47	7.59
Eil51-9	0.00	0.00	0.1	0.00	0.00	3.36
St70-5	4.63	1.77	10.9	1.22	0.64	37.08
St70-7	0.16	0.00	6.7	1.43	0.09	22.53
St70-9	0.05	0.00	2.4	0.21	0.15	9.79
Eil76-5	6.50	3.25	13.9	3.29	2.03	45.30
Eil76-7	1.26	0.44	5.8	2.16	0.60	28.74
Eil76-9	0.39	0.00	1.1	0.47	0.00	9.18
Pr76-5	8.03	4.45	18.7	5.68	2.78	51.83
Pr76-7	1.74	0.71	9.2	2.08	0.96	35.53
Pr76-9	0.15	0.00	1.3	0.17	0.00	8.69
Rat99-5	10.71	7.39	23.2	6.34	3.74	106.88
Rat99-7	2.90	0.57	14.3	1.55	1.20	69.04
Rat99-9	0.69	0.27	12.4	1.23	0.95	24.47
KroA100-5	13.73	7.72	25.4	4.43	1.69	117.59
KroA100-7	4.79	0.98	16.8	2.19	1.53	75.45
KroA100-9	1.02	0.39	6.1	1.83	1.31	16.97
KroB100-5	11.25	7.24	29.9	4.03	1.54	104.23
KroB100-7	6.06	0.80	20.2	3.60	2.03	49.35
KroB100-9	0.81	0.23	5.5	0.96	0.95	12.56
KroC100-5	13.04	7.36	30.4	3.54	2.20	108.78
KroC100-7	5.87	1.05	15.9	2.16	0.97	63.11
KroC100-9	0.30	0.00	7.8	0.59	0.10	22.08
KroD100-5	9.75	4.55	27.9	9.20	2.50	80.26
KroD100-7	4.15	0.76	10.8	1.80	0.84	68.23
KroD100-9	0.42	0.13	4.9	0.91	0.44	21.60
KroE100-5	8.93	3.47	23.2	3.16	1.75	103.58
KroE100-7	4.23	1.35	17.3	3.82	2.23	57.23
KroE100-9	0.55	0.01	7.2	0.51	0.24	22.75
Avg	4.15	1.90	12.8	2.45	1.22	46.65

TABLE 1
Comparison with GA

We first compare the performance of vpsDE and GA. The computational results are given in Table I. As seen in Table I, the vpsDE algorithm was superior to the GA in terms of relative percent deviations from the optimal solutions. For the *Avg* values, the vpsDE algorithm generated deviations no worst than 2.45% deviations from the optimal values on overall average whereas the GA algorithm yielded 5.86% deviations from the optimal solutions. In terms of *Min* values, again, the vpsDE algorithm was able to yield 1.22% deviations from the optimal values whereas the GA generated 3.13% deviations from the optimal values. A two-sided paired t-test also confirms the significance of the deviations for both algorithms. In terms of CPU times, the vpsDE algorithm was computationally more expensive than the GA. However, the reason was to the fact that the vpsDE was able to escape from local minima and search more spaces whereas the GA was stuck at the local minima at early stage of the evolution.

CONCLUSION

This paper extends the applications of differential evolution algorithms to the *Median Cycle Problem*. The median cycle problem is concerned with constructing a simple cycle composed of a subset of vertices of a mixed graph. The objective is to minimize the cost of the cycle and the cost of assigning vertices not on the cycle to the nearest vertex on the cycle. A unique solution representation is presented for the differential evolution algorithm with variable parameter search in order to solve the median cycle problem. No local search is employed in order to see the performance of the pure differential evolution algorithm. The differential evolution algorithm is tested on a set of benchmark instances from the literature. The performance of the differential evolution algorithm with variable parameter search was superior to the genetic algorithm. In addition, the computational results also show that the differential evolution algorithm with variable parameter search is promising in solving the median cycle problem. As a future research direction, the DE algorithm will be hybridized with some novel local search algorithms such as VNS, 2-opt or Lin-Kernighan heuristics to further improve the solution quality.

REFERENCES

[1] P. J. Moreno, M. M. Vega, I. R. Martin, "Variable neighborhood tabu search and its applications to the median cycle problem", European Journal of Operational Research, 151(2003) 365-378.

[2] M. Labbe, G. Laporte, I. R. Martin, J. S. Gonzalez, "The ring star Problem: plyhedral analysis and exact algorithm", Networks, Vol. 43(3), 177-189, 2004.

[3] M. Labbe, G. Laporte, I. R. Martin, J. S. Gonzalez, "The median cycle problem", Unpublished manuscript, 2001.

[4] J. Renaud, F.F. Boctor, G. Laporte, "Efficient heuristics for median cycle problem", The Journal of the Operational Research Society, 55, 179-186, 2004.

[5] T.C.S. Dias, G.F.S. Filho, E.M. Macambira, L.A.F. Cabral, M.H.C. Fampa, "An efficient heuristic for the ring star problem", In: Alvarez and M. Serna (eds). WEA LNCS 4007, Springer, Berlin, 24-35, 2006.

[6] E. Gourdin, M. Labbe, H. Yaman, "Telecommunication and location", In: Drezner Z and Hamacher H (eds). Facility Location: Applications and Theory. Springer, Berlin, 275-305, 2002.

[7] J. Klincewicz, "Hub location in backbone/tributary network design: a review", Location Science, Vol. 6, 307-335.

[8] M. Labbe, G. Laporte, I. R. Martin, J. S. Gonzalez, "Locating median cycles in networks", European Journal of Operational Research, 160(2005) 457-470.

[9] M. Labbe, G. Laporte, "Maximizing user conveinance and postal service efficiency in post pox location", Belgian J Opns Res Stat Comput Sci 26. 21-35, 1986.

[10] P. Bauer, "The circuit polytope: Facets", Math Opns Res 22: 110-145, 1997.

[11] G. Laporte, "Location-routing problems", In: Golden BL and Assad AA (eds). Vehicle Routing: Methods and Studies, North-Holland, Amsterdam, 163-197, 1998.

[12] T. Volgenant, R. Jonker, "On some generalizations of the traveling salesman problem", J Opl Res Soc 38:1073-1079, 1987.

[13] M. Gendreau, G. Laporte, F. Semet, "The selective traveling salesman problem", Networks 32: 263-273, 1998.

[14] M. Fishetti, JJ Salazar Gonzalez, P. Toth, "Solving the orienteering problem through branch and cut", Informs J Comput 10:133-148, 1998.

[15] E. Balas, "The prize collecting traveling salesman problem", Networks 19: 621-636, 1989.

[16] M. Gendreau, G. Laporte, F. Semet, "The covering tour problem", Opns Res 45: 568-576, 1997.

[17] M. Labbe, G. Laporte, I. R. Martin, "Path, three and cycle location", In: Crainic T and Laporte G (eds). Fleet Management and Logistics. Kluver, Boston, 187-204, 1998.

[18] J. Renaud, F. Boctor, G. Laporte, "Fast composite heuristic for the symmetric traveling salesman problem", ORSA J Comput 3: 134-143, 1996.

[19] R. Storn and K. V. Price, "Differential evolution—A simple and efficient heuristic for global optimization over continuous spaces," *J. Global Opt.*, vol. 11, no. 4, pp. 341–359, Dec. 1997.

[20] K. V. Price, R. M. Storn, and J. A. Lampinen, *Differential Evolution:A Practical Approach to Global Optimization*. Berlin, Germany: Springer-Verlag, 2005.

[21] D. Corne., M. Dorigo., and F.Glover. (eds.) "Part Two: Differential Evolution," *New Ideas in Optimization*, McGraw-Hill, pp. 77-158, 1999.

[22] J. Lampinen. "A Bibliography of Differential Evolution Algorithm," *Technical Report*, Lappeenranta University of Technology, Department of Information Technology, Laboratory of Information Processing., 2001.

[23] B. V. Babu and G. C. Onwubolu. (eds.), *New Optimization Techniques in Engineering*, Springer Verlag, 2004.

[24] N. Noman and H. Iba, “Accelerating differential evolution using an adaptive local search,” *IEEE Transaction on Evolutionary Computation*, Vol. 12, No.1, pp. 107-125, February 2008.
[25] M. Fatih Tasgetiren, Quan-Ke Pan, P. N. Suganthan, Tay Jin Chua, “A differential evolution algorithm for the no-idle permutation flowshop scheduling problem with total flowtime criterion”, International Journal of Production Research, 1-18, 2010.
[26] N. Mladenovic, P. Hansen, “Variable neighborhood search,” *Computers and Operations Research* 24 (1997) 1097-1100.
[27] R. Gämperle, S. D Müller, and P. Koumoutsakos, (2002) “A parameter study for differential evolution,” *in Proc.WSEAS Int. Conf. Advances Intell. Syst., Fuzzy Syst., Evol. Comput*., 2002, pp. 293–298.
[28] J. Rönkkönen, S. Kukkonen and K. Price, “Real-parameter optimization with differential evolution,” *in Proc. 2005 IEEE Congr Evol.Comput*., Sep. 2005, pp. 506–513.
[29] M. Gen and R. Cheng, Genetic Algorithms and Engineering Design, John Wiley & Sons, Wiley Series in Engineering Design and Automation, 1997.
[30] W. M. Spears, K.A. DeJong, On the virtues of parameterized uniform crossover, in: Proceedings of the Fourth International Conference on Genetic Algorithms, 1991, pp. 230–236.
[31] G. Reinelt, “TSPLIB-a traveling salesman problem library”, ORSA J Comput 3: 376-384, 1991.
[32] S. Lin, BW. Kernighan, “An effective heuristic algorithm for the traveling salesman problem”, Opns Res 20: 498-516, 1973.

HOW TO CREATE A STRONG COLLABORATIVE LOGISTICS FOR TURKISH CLOTHING INDUSTRY IN ORDER TO SATISFY LOCAL AND EUROPEAN RETAILERS

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Abstract *— Retail suppliers are increasingly spread across the world. A retailer may have thousands of stores in a number of countries, with tens of thousands of individual product lines. While the retail sector has always been very competitive, in recent years, the competitive nature of the field has increased dramatically. Retailers have responded by increasing the variety of their products, becoming more price competitive, striving towards higher service levels, utilizing advances in computing capabilities and information technologies to improve their supply chain efficiency. However, these developments have also greatly increased the complexity of managing the retail business environment. Managing the logistics mix in an integrated retail supply chain, with balancing cost and service requirements, is the essential element for success. Inside this type of production and distribution system, there is pressure to improve logistic methods such as developing new and more effective ways of managing material and information flows and as a result decrease distribution and stock management costs. The retail structure in clothing can be seen as a complex supply chain consisting of a number of discrete activities. This study aims to analyze the current structure of retail logistics and search new strategies and frameworks to satisfy local and European retailers and to be competitive for Turkish clothing industry.*

Keywords —Retail industry, clothing sector, logistics

INTRODUCTION

Every organization has to move materials. Manufacturers have factories that collect raw materials from suppliers and deliver finished goods to customers. Retail shops have deliveries from wholesalers. Logistics is the function responsible for all aspects of the movement and storage of materials on their journey from original suppliers through to final customers. Logistics is the time-related positioning of resources, or the strategic management of the total supply-chain [1].

In the last twenty years the supply chain has undergone drastic changes. The traditional push system, in which consumer demand outweighed supply, has transformed into a pull system or what some have coined— the demand chain. The consumer is now empowered and they are demanding a continuous supply of new innovative products at low, low prices.Push strategy is a classical distribution strategy in which firms produce goods according to the estimated levels of demand, then place the goods in warehouses of the factories, distribution centers, and retailers, waiting for consumers to purchase the product. Pull strategy expects the presence of a clear market need to enable the transfer of goods. Furthermore, demand-pull enables a firm to produce only what is required , in the correct quantity and at the correct time[2].

The fashion market today is influenced by ever-changing characteristics of consumers, competition and technologies. A global spread of corporate activities in the textile and fashion industry forcing many apparel firms to reshape their supply chain structures and serving their customers in an increasingly timely manner. Quick response within supply chain management has gained much attention as a key managerial philosophy [3].

The ability to respond customer requirements on a timely basis has always been a fundamental element in marketing. The aim of this study is to analyze the current structure of retail logistics and search new strategies and frameworks to satisfy local and European retailers and to be competitive for Turkish clothing industry.

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EVALUATION OF CLOTHING AND LOGISTICS SECTOR IN TURKEY

The past two decades have witnessed a number of important developments in the business world in both developed and developing countries. A considerable expansion of supply chains into international locations, especially in the automobile, computer and apparel industries to enhance value-adding capabilities, have shifted attantion from manufacturing to various Third World locations. Today the world is a small place because of advancements in communication and transportaition. Conducting business on a global basis has become an industrial norm. In this new and ever-expanding environment, international procurement has become a major challenge, and success requires a number of skills [4].

The global apparel market has been changing under the influence of many factors. One of the critical observations are that developed economies have been shifting textile and apparel production to developing economies and four major production blocks seem to emerge as the main competitors for this shifting production capacity: China, India, Latin and South America, and Pan European and Mediterranean regions. Firms from these blocks will not only engage in outsourcing but will also market their own products [5].

In Turkey, industries are dispersed all over the country; furthermore another important point is that 99% of all enterprises are placed in SME category.Major traditional clusters that are scattered in Turkey can be listed below [4]:

- textile yarns and carpets: Gaziantep,
- leather and leather products: Istanbul, Izmir and Corlu,
- towels and bath robes: Denizli,
- clothing: Istanbul.

Turkey's textile and clothing industry is one of the most important low-tech sectors in the Turkish economy and has been its "locomotive" since the early 1980's. Table 1 shows the textile and clothing export and import values of Turkey between the years 1980 and 2009. As seen from the table, textile and clothing export proportions among the total export have been decreasing dramatically after the year 2000[6].

TABLE 1
Turkish Textile&Clothing Export Values Between 1980-2009

YEAR	TOTAL EXPORT (1000 $)	CLOTHING EXPORT (1000 $)	PROPORTION OF CLOTHING INDUSTRY %	TEXTILE EXPORT (1000 $)	PROPORTION OF TEXTILE INDUSTRY %	TEXTILE + CLOTHING EXPORT (1000 $)	TEXTILE + CLOTHING PROPORTION %
1980	2.910.000	106.000	*3,6*	671.000	*23,1*	777.000	*26,7*
1981	4.703.000	302.000	*6,4*	915.000	*19,5*	1.217.000	*25,9*
1982	5.746.000	367.000	*6,4*	1.069.000	*18,6*	1.436.000	*25,0*
1983	5.728.000	544.000	*9,5*	1.055.000	*18,4*	1.599.000	*27,9*
1984	7.134.000	989.000	*13,9*	1.181.000	*16,6*	2.170.000	*30,4*
1985	7.958.000	936.000	*11,8*	1.151.000	*14,5*	2.087.000	*26,2*
1986	7.457.000	1.069.000	*14,3*	1.043.000	*14,0*	2.112.000	*28,3*
1987	10.190.000	1.728.000	*17,0*	1.133.000	*11,1*	2.861.000	*28,1*
1988	11.662.000	2.127.000	*18,2*	1.334.000	*11,4*	3.461.000	*29,7*
1989	11.625.000	2.448.000	*21,1*	1.338.000	*11,5*	3.786.000	*32,6*
1990	12.959.289	2.898.349	*22,4*	1.424.249	*11,0*	4.322.598	*33,4*
1991	13.593.539	3.219.350	*23,7*	1.374.357	*10,1*	4.593.707	*33,8*
1992	14.365.414	4.009.615	*27,9*	1.369.322	*9,5*	5.378.937	*37,4*
1993	15.345.000	4.157.997	*27,1*	1.457.490	*9,5*	5.615.487	*36,6*
1994	18.107.000	4.490.043	*24,8*	1.944.818	*10,7*	6.434.861	*35,5*
1995	21.637.041	6.188.502	*28,6*	2.130.665	*9,8*	8.319.167	*38,4*
1996	23.224.465	6.344.252	*27,3*	2.352.142	*10,1*	8.696.394	*37,4*
1997	26.261.072	7.088.669	*27,0*	2.730.421	*10,4*	9.819.090	*37,4*
1998	26.973.952	7.644.051	*28,3*	2.811.763	*10,4*	10.455.814	*38,8*
1999	26.588.264	7.145.053	*26,9*	2.733.641	*10,3*	9.878.694	*37,2*
2000	27.774.906	7.250.960	*26,1*	2.845.184	*10,2*	10.096.144	*36,3*
2001	31.334.216	7.332.107	*23,4*	3.060.647	*9,8*	10.392.754	*33,2*
2002	36.059.089	8.945.787	*24,8*	3.203.744	*8,9*	12.149.531	*33,7*
2003	47.252.836	11.171.096	*23,6*	3.943.426	*8,3*	15.114.522	*32,0*
2004	63.167.153	12.643.690	*20,0*	4.952.092	*7,8*	17.595.782	*27,9*
2005	73.476.408	13.411.464	*18,3*	5.477.039	*7,5*	18.888.503	*25,7*
2006	85.534.676	13.558.054	*15,9*	6.146.614	*7,2*	19.704.668	*23,0*
2007	107.153.918	15.560.170	*14,5*	6.363.918	*5,9*	21.924.088	*20,5*
2008	132.027.196	15.234.868	*11,5*	6.640.492	*5,0*	21.875.360	*16,6*
2009	102.138.525	12.856.658	*12,6*	5.363.616	*5,3*	18.220.274	*17,8*

When the regional distribution of the textile and clothing industry is investigated, it is seen that industry is concentrated in around Istanbul, Marmara Region. According to the data gathered from TurkStat (Turkish Statistical Institute) it was seen that 59% of the clothing firms were founded in Marmara Region and 49% of the clothing firms were also established in Istanbul [7].

In Turkey there are three types of clothing enterprises (Table 2)[8];

TABLE 2
Types Of Clothing Enterprises In Turkish

Types of Enterprises	Relation	Competition elements
ENTERPRISES WHICH OWN THEIR OWN BRAND DOMESTICALLY AND ABROAD	DIRECT RELATION TO THE CUSTOMER/ CONSUMER DOMESTICALLY AND ABROAD	OWNER OF LOCAL REGINAL GLOBAL BRANDS DIRECT SALE AT DOMESTIC STORES AND STORES ABROAD DESIGN, COLLECTION, FASHION, BRAND PRODUCTION DOMESTICALLY AND ABROAD IN QUALITY AND PRICE COMPETITION MIDDLE-LARGE SCALE
SUPPLYING ENTERPRISES FOR GLOBAL BRANDS AND BUYERS	DIRECT RELATION TO THE WHOLESALER/ RETAILER/ BUYERS ABROAD	DESIGNER COLLECTION CAPACITY FLEXIBLE, SMALL PARTY AND FAST PRODUCTION ABILITY MAKING OR HAVING MADE DOMESTIC AND FOREIGN PRODUCTION IN COST/PRICE-QUALITY COMPETITION SMALL-MIDDLE-LARGE SCALE
SUBCONTRACTOR ENTERPRISES WITH DOMESTIC PRODUCTION	DIIRECT RELATION TO DOMESTIC SUPPLIER ENTERPRISES	HIGH-QUALITY, EFFICIENT AND RICH PRODUCTION FLEXIBLE, SMALL PARTY AND FAST PRODUCTION ABILITY SMALL-MIDDLE SCALE IN COST-PRICE COMPETITION

Enterprises will transform in four areas as shown in Table 3 [8];

TABLE 3
Transformation Areas Of Turkish Clothing Enterprises

Transformation Areas	Old Structure	New Structure
Production	High Capacity Mass Production	Flexible, small party, fast production
Design	Supplier and Sub-contractor products	Additional added value creating subcontractor products and products of their own brands
Marketing	Passive Marketing	Active marketing
Branding	Supplier and Sub-contractor products	Products of their own brands

Turkey is a relatively high-cost country where the real or perceived fear that low-cost countries will have the capacity to wipe out some of the established Turkish suppliers is strong for some product categories, the need for quick replenishment makes it more profitable for Western buyers to source their products from countries with close proximities, even if the products initially cost more. In other words, when inventory related costs and risks outweigh the considerations of manufacturing costs (including especially labor costs), proximity advantages become a driving factor [9].

Turkey was the only 'top 20' exporter to the European Union (EU). In 2010, the 80% of the clothing export was made to the European countries. Germany had the first place with the proportion of 24.7% of total clothing export value in 2010. England had the second place with the 14.1 % and France had the third place with 8.1%[10]. Today, lead times have gradually dropped from two months to under four weeks, while the sector's highly skilled workforce, technology and design capabilities have retained Turkey's value-added edge with retailers who are not keen on having too high an inventory in the current economic climate [11].

Turkey is a Gateway from/to Europe, Central Asia, Black Sea, East Mediterranean and Gulf. Turkey has one of the most important logistics positioning between Europe and Middle East and due to its geographical location and multi-mode connection facilities of Seaport / Free Zone / Railway / Airport / Truck formation. Among world's 10 big emerging markets, Turkey has growing industries in Transport&Logistics, Automotive, Textiles and Retailing with its 60% of the population under age 30 [12].

The development and provision of advanced logistics services varies from country to country. In most developing countries, the market for these services is small, which can be a major deterrent for companies wishing to establish a market presence. The first worldwide Logistics Performance Index (LPI) was developed to provide a better assessment about how respective countries rank in the managerial and physical effectiveness of their logistic. According to the LPI, Germany and Singapore, major global transport and logistics hubs, rank first. At the other extreme are low-income countries, particularly those landlocked in Africa and Central Asia, Turkey has a good level of logistics performance index between 3.00-3.50 [13].

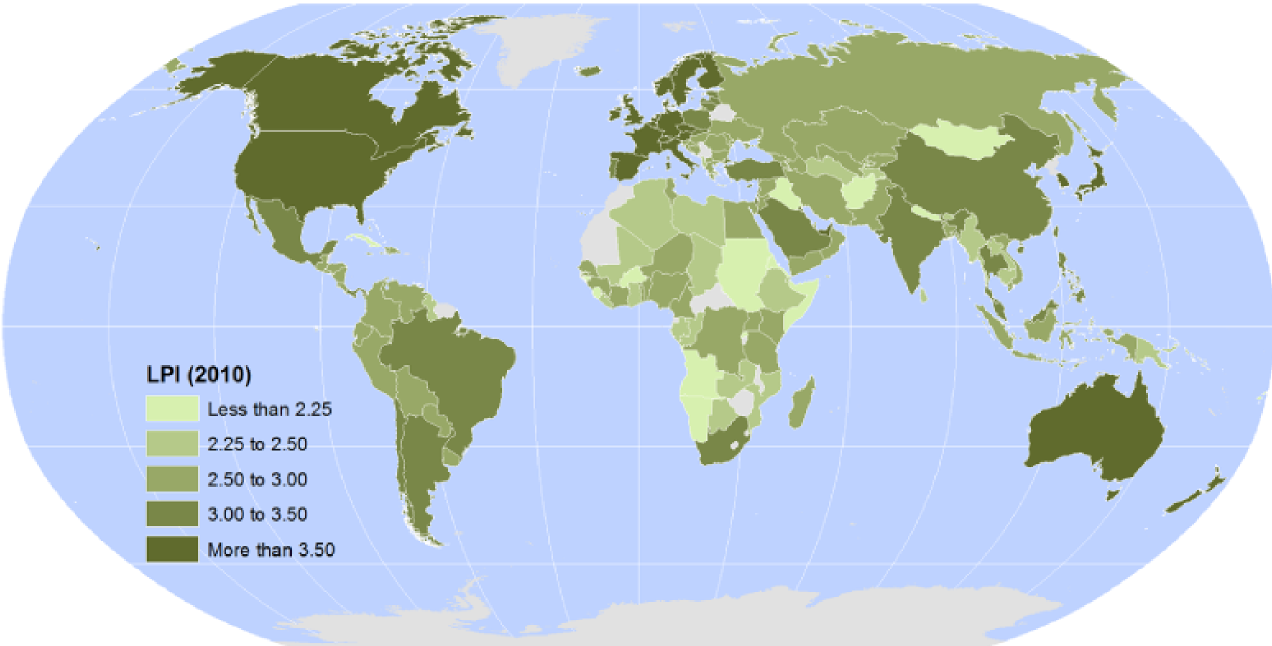

FIGURE 1
Logistics Performance Index [13,14]

In Turkey, logistics has an important place in the development of the industry. Turkey has nearly 50.000 foreign trade companies. Approximately 5.000 of these companies have over 1 million $ foreign trade volume. There are approximately 2.000 customs clearance company, 1200 international road transport companies, 1000 international maritime companies, 250 freight-forwarders and about 250 bonded warehouses that provide logistics services. Also, transportation warehouse operators, transportation job agents, distributors, cargo and courier companies can be included to this sector. [15].

Turkish clothing companies have placed a great emphasis first on the development of new brands that command higher prices relative to costs or that can secure a larger market share in order to preserve their places in global markets. Moreover some big companies that within the global market of clothing, get profits from a combination of design, branding, marketing, retailing, and financial services rather than from manufacturing alone. Second, some companies are transferred their production facilities to low wage areas to keep costs down. Activities can also be relocated to seek out new cheaper sources of materials and components. For the firms placed inside these dense networks, the responsibilities have gone beyond handling logistics activities and include the management of a complex business environment that requires sophisticated forms of coordination. Therefore, the successful combination of highly sophisticated logistics structures has become a requirement for success. Today, big clothing companies in Turkey have started to use logistics as a globalization strategy and outsource their some operations [16].

ANALYSING RETAIL CLOTHING FIRMS IN TURKEY

Retailing includes all business activities that involve the sale of goods and services to consumers for personal, family, or household use. It is the final step in the distribution of these goods and services. Today the retail industry is greatly affected by technological advances, demographic shifts and changing perceptions in the U.S. and globally. We are a busier, more convenience-oriented society than previous generations and the retail landscape must change to meet our demands [4].

The textiles and clothing sectors can be seen as a supply chain consisting of a number of discrete activities. Increasingly the supply chain from sourcing of raw materials via design and production to distribution and marketing is being organized as an integrated production network. The information flow starts with the customer and forms the basis of what is being produced and when. The information flows directly from the retailers to the textile plants in many cases [17].

There are many brands in Turkey like Vakko, Beymen, Damat-Tween, İpekyol,Network, Fabrika, Mudo, CCS Sarar, LC Waikiki,Colins, Collezione, Mavi Jeans etc. These brands trying to be global brands and searching strategies to develop their retail structures[18].

Schematically, three main types of clothing enterprise can be identified in Turkey. The first comprises small-sized manufacturers. The core strategy of this group is low-cost strategy. A number of large firms use them as subcontractors for their export businesses. They do this ostensibly to combat the increasing labor wages and high-energy costs that make their prices unattractive to American and European companies searching for subcontractors to fulfill their manufacturing needs. Another group of companies uses quality leadership and channel control as their core business strategy. It includes Vakko (exclusive department store,) Beymen (fancy department store,) Ramsey (brand name,) Ipekyol (specialized informal women dresses,) Damat (targets young men; has stores in Madrid, Spain and in the USA,) Cotton (targets young women,) UKI and Sarar (producer and chain stores of men clothing). Some of these companies, like Vakko and Beymen, focus on the high-end of the domestic apparel market. Others have retail operations, which are either vertically integrated, (e.g., manufacture their own brands,) or subcontract their merchandise production to other manufacturers. A small number of others, like Mavi (also markets in the USA and Western Europe,) PROMAR (Quick Silver, has stores in Moscow and in some Gulf countries), Colin Jeans (well known in Russia,) Motor Jeans (dominant in Bulgaria,) have successfully built brands not only recognized in domestic markets but in foreign countries as well. The core marketing strategy among this group appears to be brand management and franchising their brand domestically and internationally. Strategic alliances between Western and Turkish firm may take the form of joint ventures, licensing, franchising, and subcontracting agreements. However, the most common form of partnerships with Western companies is subcontracting arrangements. A number of Western apparel firms have contracts with major Turkish apparel firms [5].

Yesim Tekstil has the greater part of its production for export markets beyond Turkey. The company is progressively increasing its market share in export markets by providing the highest quality of services and products to its customers. The countries to which Yesim Tekstil exports its products include the United States of America, Germany, Britain, Holland, Spain, France, Italy, Russia - amongst many others. Yesim Tekstil manufactures for renowned brands including Nike, Gap, Banana Republic, Old Navy, Zara, Pull&Bear, Massimo Dutti, Esprit, Hugo Boss, Lands' End, Tchibo and Schlafgut [19].

The story of Boyner holding dates back to 1952, the year when the prominent textile manufacturer Altınyıldız was founded. Today the holding ranks among the top holdings in Turkey, operating in a wide range of fields in addition to retail. In addition to its Altinyildiz brand fabric in textile sector, it has the brands "Network" and "Fabrika",launched in 1997 and 2000 and its new brand Que established in 2007. Boyner, the biggest department store chain, is home to investments in cosmetics,hometextile and sportswear.Since 1971 Turkey's prestigious garment brand Beymen presents its customers not only Beymen and Beymen Club products but also products by numerous world renowned brands. Turkey operates on a 50%-50% joint venture structure with Benetton, Sisley and 012 brands. Boyner group's total turnover in 2007 amounts to 853 million USD and 360 stores [20].

Founded in Istanbul in 1991, Mavi Jeans designs a full collection of jeans-wear, for young women and men. Turkey's first fashion brand to become global, Mavi has been the leading jeans brand in Turkey since the last 14 years. Mavi is now sold at over, 4000 specialty stores, better department stores and specialty chains in 50 countries including the US, Canada, Turkey, Australia, Germany, Denmark, Netherlands and Russia.

Mavi has over 260 retail stores with flagships in New York, Vancouver, Montreal, Istanbul, Berlin and Frankfurt[21].

YKM is the first department store in Turkey opened in 1950 in Istanbul. YKM offers all products a family needs from women's, men's and children's wear to cosmetics and personal care products, communications and technology products to electric home appliances and home decoration.YKM developed its own brands Men, Bruno Ferrini, Volt in menswear, Agenda and Loox in womenswear, Multi-Colore in children's wear, Tulip in home textile Home in home accessories and introduced such world famous brands as Desigual, Jack&Jones, Only, Carling, Pieces to its customers [22].

Vakko Turkey's leading fashion house, started out as a small hat shop(Merry Hats), that Vitali Hakko founded in 1934. Soon "Merry Hat" turned into Vakko and started producing scarves in the latest fashion, using Turkish silk, cotton and wool. The first Vakko fashion store opened in 1962 in Beyoglu provided a new brand concept for the Turkish clothing industry. Today products which are send to the Vakko warehouses with extreme care are seperated into two groups as shelf and hanging garments and according to their group each product's quality is controlled one last time by superior technology and an expert team. Products which pass quality control based on their brand and gender take their places in the warehouse. They are packaged and shifted to all Vakko stores around Turkey and the world. Vakko manufacturing center-Esenyurt logistics department offer its services in a 5976 m^2 area [23].

Ayaydın Miroglio Group, with the women's textile brands Ipekyol, Machka and Twist, operating under its roof states its vision as being a multinational brand. It has many shops in Turkey (78) and also in foreign countries Romania, Russia and England [24].

Orka Group was established under the name of ORKA Tekstil Sanayi ve Tic. A.Ş. in 2001. There are three main brands under the umbrella of ORKA Damat, Tween and ADV. Damat Tween ADV has 78 concept stores and 111 sales pointsin Turkey and there are 44 concept stores and 179 sales points , total 223 points in 37 different countries [25].

Koton was founded in 1988 and it has more than 346 stores in 25 different countries. Koton offers a variety of garments and accessories at affordable price, for men , women and teenagers. The brand focuses on designing a wide range of products to enable customers to create their own style in-line with their identity. Koton has design team more than 2000 employees (including franchises). Koton is able to offer 10000 different styles each year. New items delivered to stores at least twice a week in order to always offer new products[26].

LC Waikiki, which was bought in 1997 by the Tema Group and has operated as a Turkish brand for 14 years, was first born in France, as a French brand. As a Turkish brand, the Tema Group has transformed LC Waikiki into a market leader, both in terms of its collection as well as its approach to retail. With a history that reaches back to 1985, LC Waikiki continues as a successful brand today. Today, the Tema Group manages a leading chain in the sector, serving millions of people with 335,000 m^2 of sales area and over 330 LC Waikiki stores in 67 Turkish provinces. In 2000 it offered the Southblue and XSIDE brands to the Turkish public. In 2009, beginning its foreign investments, the Tema Group opened its first stores in Romania. Today, the Tema Group carries out the manufacture of the products, it sells through its LC Waikiki stores through a global supply chain. Since the year 2000, the Taha Group has adopted a policy of growth by manufacturing for the leading world brands, independently of LC Waikiki. Having taken its place among world famous brands such as Marks & Spencer, Top Shop, Decathlon and Tommy Hilfiger, the Taha Group decided in 2006 to make foreign investments in order to increase its competitive strength, and has now opened its first production facilities in Egypt and Bangladesh. It has supply chain department and warehouses (open quantity and returns warehouse, promotions warehouse and shipment warehouse [27].

SARAR Apparel has 5 big factories, over 4800 employees, 45 retail stores which are outspread to inland, over 300 selling points and 150 million $ annual turnover. SARAR has a wide business network with its concept stores and dealerships in Europe, USA, Japan, China, Russia, India and the Middle East- Inlet Countries. Sarar Group try to make its brands strong, dominate the technology, protect the quality and image, increase productivity and customer satisfaction. The strategic development planned country-wide and world-wide may be achieved with wide product range of complementary Sarar-labeled goods [28].

Colins has 670 stores in 32 countries, 3000 employees on a total space of 170,000 m^2[29]. Collezione began its journey with the objective to become a world brand by opening its first store in 1987 in Istanbul. It now has 128 stores, 102 corner stores and 13 franchised stores and outlets within the country and abroad with its 32 stores in 18 different countries[30].

Turkish retail clothing industry must have higher performance compared to the retail sector in the world. Downward pressure on price and upward pressure on rents and rates, changing customer requirements and consumption patterns, international competition and e-commerce make Turkish companies to follow some strategies in the global competitive environment. Excellent retail supply chain management revolves around understanding and balancing three key dimensions of availability, inventory and cost. Managing these trade-offs efficiently can result in supply chains that improve business performance and drive competitive adv antage. One example: Spanish retail giant Zara. In the world there are main players department stores (like Debenhams, Lewis), individual stores (Next, GAP, H&M, Zara), variety stores (M&S, BHS etc.), supermarkets (like Tesco) and internet sales.

HOW TO CREATE BEST PRACTICES FOR STRONG COLLABARATIVE LOGISTICS

In a physical product setting, the different types of chains can be explained in the following way. A **supply chain** focuses upon a product and extends back over the different actors, activities and resources required for making it available at the place of consumption. It encompasses a set of logistics and transport chains linking activities from basic extraction of raw materials to retailing (final consumption). A **logistics chain** focuses upon an item part of an inventory and extends from when the item number is created (manufactured or received from a supplier) until it is dissolved (item consumed, becoming a part of another item or being split into several items). For instance, a logistics chain could include a product that has been assembled into a final good, brought to a distribution center to be sorted and temporarily stored and delivered to a retail store. A **transport chain** focuses upon a consignment and extends over movement, physical handling and activities directly related to transport such as dispatch, reception, transport planning and control. For long distance logistics chains, a transport chain can involve a sequence of modes and terminals. Containerization and intermodalism have helped improved the efficiency of transport chains and consequently of supply chains [31](Figure 2).

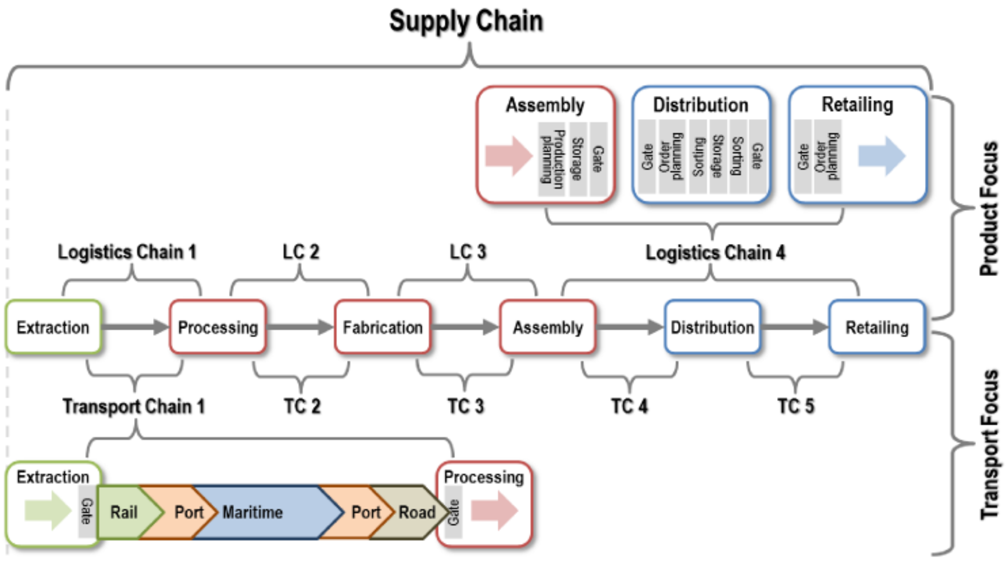

FIGURE 2
The Scope of a Supply Chain, Logistics Chains and Transport Chains[31,32]

All operations related to logistics aim at insuring that a demand is satisfied, let it be a part made available to a manufacturer or a good be present on a store's shelf. There are three major categories of logistics operations. First one is purchase orders processing including operations related to the transactional procurement of goods. Stock management includes operations related to the physical procurement of goods. Transportation involves operations related to the physical distribution of goods [33](Figure 3). Efficient logistics contributes to added-value in four major interrelated ways. **Production** is derived from the improved efficiency of manufacturing with appropriate shipment size, packaging and inventory levels. Thus, logistics contributes to the reduction of production costs by streamlining the supply chain. **Location** is derived from taking better advantage of various locations, implying expanded markets and lower distribution costs. **Time** derived from having goods and services available when required along the supply chain with better inventory and transportation management, and the strategic location of goods and services. **Control** is derived from controlling most, if not all, the stages along the supply chain, from production to distribution. This enables better marketing and demand response, thus anticipating flows and allocating distribution resources accordingly(Figure 3)[34].

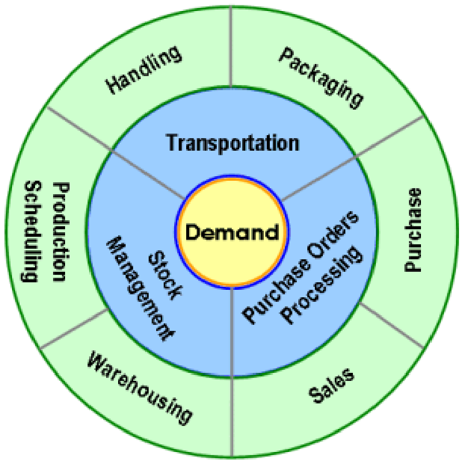

FIGURE 3
Logistics Operations [33]

A well-structured supply chain is of key importance in achieving efficient operations among suppliers, producers, distribution facilities and retailers that constitute the supply chain. The competitive environment makes industries to redesign their existing production and distribution network to meet customer service levels at lowest cost. Globalization of business, better logistics facilities and their management are bound to assume important roles in international business. Improving logistics and SCM in developing countries, some essential infrastructures are required; including (a) legal infrastructure, (b) hardware infrastructure, and (c) software infrastructure. Legal infrastructure could be export/import policies and appropriate custom tariff specification/definition, procedures' stability and capital risc reduction, a reasonable interest rate definition in bank, third party logistics support and national quality standards'definition for logistics and SCM. Hardware infrastuructures could be augmenting new roads and improving the existant ones,augmenting new warehouses and mechanizing the existing ones,reducing custom affairs cycle time and lead-times of releasing goods from custom and improving ICT infrastructure in order to smooth information sharing and financial transactions. Software infrastructures could be encouraging insurance organizations for supporting third party logistics and enhancing the variety of insurances, defining appropriate monitoring procedures, defining effective roadmap for modernizing and implementing logistics and SCM, increasing integration culture within partners, training and improving leaders' and experts' knowledge on logistics and supply chain, enhancing research and development, development commitment to research and learning, improving international partnership and encouraging competitiveness[4].

Just-in-time inventories and just-in-time production schedules start working to optimize the logistics cost while maintaining high levels of customer service. Such IT has reduced the inventory levels of customers practically to nothing, lowering inventory related costs substantially. The textile and apparel industries in Turkey have not yet adopted information technology as a strategic tool at this level of sophistication. This can be attributed to the small to medium size of the firms in the sector, and a general lack of understanding and appreciation of strategic management and marketing. Whether they pursue mass or target marketing, low cost leadership and differentiation remain as two fundamental strategies. The move to a more robust strategic marketing management should incorporate the following: 1) bring a new level of sophistication to marketing and production management, 2) help develop a critical mass of knowledge and capital, and 3) lead to a better understanding of the importance of using technology in the apparel industry [5].

Analysis of the best practice winners found that greater process automation, improved technologies, and increased reliance on logistics partners were instrumental in driving their successes. Companies seeking to improve their international logistics performance should consider these best practice tenets as they construct their transformation roadmap [35]. Envision the future is important and logistics excellence is a journey. Visibility, trade compliance, and transportation contract management are some of the most common cornerstones. Find partner for success and new ways to synchronize activities and increase process visibility and control with customs brokers, freight forwarders, ocean carriers, logistics service providers, and others are also very important decisions. Choose partners that provide the best value, not the lowest contract cost is also very important. Automate with Internet-based technology is an obligation today. International logistics is all about managing a network of third-party providers. Companies with strong Six Sigma heritage are using that discipline to create improved international logistics reliability. Companies must use inventory more effectively and create better in-transit visibility so they can redirect inventory around port congestion or other bottlenecks or to higher points of demand. Also they should implement transportation spend management, manage streamline customs processes, maximize trade agreements and focusing not just on logistics-related savings.

Logisticians perceived four uncertainty dimensions. One of them is customer demands and expectations.Customer demands on logistics had increased and involved several factors such as: shrinking time-windows for deliveries, customized order bookings, increased number of packaging types, customized labeling, variations in number of products per pallet and per order, increased frequency of deliveries, JIT demands, increased product variants, and less volume per order, demands on delivery precision, on-time-in-full.The second one is internal processes which includes importance of functional integration, integration of sales/marketing and logistics, relationship between IT departments and logistics.Third dimension is human factors. Human related uncertainty emerged, such as power, hidden truths, and protectionism. Power hampered decision processes and made communication more difficult.The last one is general trends[36].

In addition to offering standard transportation services to its customers, such a transportation and warehousing, third party logistics providers are delving into value added activities within commodity chains (Figure 4). More advanced services involve performing added value functions on the cargo itself, such as packaging and labeling. A step further would involve a complete management of the concerned supply chains, namely financial transactions and the management of information and communication technologies. Fourth party logistics providers focus upon an integrated view of the supply chain and in which way changes in production planning, sourcing and routing (the usage of a series of 3PL) can help reduce costs and improve the reliability of the supply chains of their customers [37].

3PL >			< 4PL
Standard	**Advanced**	**Complete**	**Integrated**
Transportation services Carrier selection Rate negotiation Fleet management Warehousing Cross docking Pick and Pack Distribution (direct to store/home) Dispatching Delivery documentation Shipment consolidation	Vendor managed inventories Stock accounting Customs clearance and documentation Assembly Packaging Labeling Managing product returns Financing Retail delivery, set up and on site training Inventory tracking	Order planning and processing Information and Communications Technologies (ICT) management Single invoice Landed duty paid cost (per piece) Payment collection Real time inventory updates Just in Time (JIT) inventory management	Production planning Sourcing Routing transit times air vs. ocean Supply chain consulting Real time supply chain monitoring and adjustment

FIGURE 4
Logistics Operations [38]

As a strategic building, H&M builds distribution centers in their international locations in order to cut down lead times and potential logistical costs. Zara has the opportunity to be one of the trendiest/low priced retailers. One of the market opportunities for Zara is to invest in internet retailing especially directed toward the U.S. market. Their European strategy includes, having a strong production and distribution facility in their home country in order to have short production and lead times. The Gap is one of these competitors because they are also international and sell the same range of merchandise with a less trendy style. GAP sells casual apparel, accessories, and personal care products for men, women and children under the Gap, Old Navy, Banana Republic, and Piperlime brands. Zara owns much of its production and most of its stores, the Gap and H&M, which were the two largest specialist apparel retailers in the world, ahead of Inditex, own most of their stores but outsource all production. Benetton, in contrast, has invested relatively heavily in production, but licensees ran its stores. Inditex has it's unique management model based on innovation, flexibility and with an integrated business model. Their fashion philosophy based on creativity, quality design, rapid response to market demand, strategic growth: Fast international expansion, excellent response to sales concepts, compelling mix of latest fashions and quality at affordable prices, customer interaction, attractive stores in prime locations, effective distribution and logistics structure, central distribution, shipment to all stores twice a week and orders to stores in 24-48 hours [1].

In order to convert their current situation into a competitive advantage, global companies are searching for ways by spreading their activities among nations to serve to the world market and this obligates them to have the ability to coordinate among those dispersed activities. Today, big clothing companies in Turkey have started to use logistics as a globalization strategy and outsource their some operations such as sourcing, inbound logistics, manufacturing that can be performed anywhere. Some clothing manufacturing facilities (after assembling and before distribution) such as stock and inventory management, first control, repairing, stain removing, quality control, repressing, counting, barcoding, labeling, packaging, placement of accessories, manuals and warranty documents, product separation and classification, order management and creating sets of products are provided by the lead firms in the logistics sector or independent service providers. Clothing companies get important advantages like time and cost as a result and they focus on their strategic activities more professionally [14].

One of the big logistic companies KARINCA, started giving textile logistics services in 1999, since then, it has continued to extend its services in this field. In 2003, KARINCA acquired the Turkey operations of Meyer & Meyer as well as added some well known and important brands of Europe to its client list. Currently, KARINCA is one of the biggest logistics service provider in Turkey in terms of hanging logistics system capacity. KARINCA is providing services in many fields from warehousing to value added logistics services both for hanging goods as well as flat packed, boxed and palletized merchandise. KARINCA has found the opportunity to share some IT solutions and products in textile logistics with its customers in Turkey. It includes the following Service Fields: Follow-up of the orders quality control of the manufactured textile products in accordance with the international standards, re-finishing services (repairs, removal of stains, washing, ironing...), labeling, bar-coding, pick & pack services, assembling the product, stock control and warehouse management for hanging and packed goods, transportation and distribution of hanging and packed goods to the stores, information technology services designed for textile[39].

Balnak Çatalca Logistics Base has 2.000 m^2 dynamic and 2.000 m^2 stable hanging garments conveyor and stocking system that is suitable for all handling and stocking activities. The total capacity is 250.000 – 300.00 pcs of garments. Detailed inventory, quality control, labeling, barcoding, alarming, long-short term stocking, product pick-up on shop basis services are provided to its clients. Domestic distribution on shop basis, reverse logistics (pick-up and take back out season products to warehouse and distribute them to outlet shops), export operations are also supported with ironing and packing services. The retail process that begins with international transport is concluded by the collection and return to the Logistic Center of the stocks collected at the said locations upon product acceptance by bonded warehouse [40].

Act-logistics ensures the complete follow-up from the production line until final delivery. Fashion retailers will be able to concentrate on their core business by outsourcing logistics activities, transport and storage, labeling and packaging, distribution to the stores throughout the country with accurate information about the terms and quantity. Services provided by the team of professionals are inventory control systems, storage of both palletized and non palletized loads, express delivery to the client, storage of textile products on hangers and in cartons, quality control, packing, sorting, labeling and expedition[41]. In Turkey also there are many other big successful professional logistics firms like Ekol Logistics, Omsan Logistics, Mars Logistics,Gefco, IBA, Kuhne&Nagel, Borusan Logistics, Reysaş Logistics, Schenker Arkas, Horoz Logistics etc.

As a strategic solution, Eryuruk aimed to evaluate a logistic center as a competitive strategy to get advantages like time, cost and customer satisfaction for the Turkish clothing producers in Istanbul, Turkey. In her study, a logistics center design and site selection for the Turkish clothing industry was studied to ensure fast and effective flow of products and to reduce costs. The required activities, services, ownership and management structures and the corresponding size of the areas of a logistics center for Turkish Clothing Industry were determined using data obtained by means of in-depth interviews [42].

In Turkey, there are three types of clothing firms considering logistics activities. First type of clothing organizations only considers transport chains. After the production of clothing products, they try to send them to the customers by using 3PL logistics providers. These types of firms generally do not have logistics departments inside their firms. The second type of clothing firms has logistics departments in their firms and they are conducting logistics operations more professionally. These firms focus on not only transport chains but also logistics chain. Big clothing retailers in Turkey like Mavi Jeans, Vakko, Altinyildiz and LCWaikiki have logistics departments inside their firms. Some of these clothing firms also invest in establishing their logistics centers in strategic points in Turkey to manage and control logistics operations and benefit from these operations. The third type of clothing organizations uses services offered by fourth party logistics providers. This type of clothing companies work with big logistics service providers. For example, Ekol logistics designs all logistics activities in the process starting from the raw material picking to the department of the store according to the requirement and expectations of the customer and develops boutique solutions. Ekol plays an import role in transforming the effort of the customer from logistics into sales with the high standard solutions developed in return product management and other reverse logistics activities[43].

CONCLUSIONS

The aim of this study was to analyze the current structure of clothing industry and retail logistics in Turkey and search new strategies and frameworks to satisfy local and European retailers and to be competitive for Turkish clothing industry.

The competitive environment makes industries to redesign their existing production and distribution network to meet customer service levels at lowest cost. Excellent retail supply chain management revolves around understanding and balancing three key dimensions of availability, inventory and cost. Managing these trade-offs efficiently can result in supply chains that improve business performance and drive competitive adv antage. Analysis of the best practice winners found that greater process automation, improved technologies, and increased reliance on logistics partners were instrumental in driving their successes. In order to convert their current situation into a competitive advantage, global companies are searching for ways by spreading their activities among nations to serve to the world market and this obligates them to have the ability to coordinate among those dispersed activities. Today, big clothing companies in Turkey have started to use logistics as a globalization strategy and outsource their some operations such as sourcing, inbound logistics, manufacturing that can be performed anywhere.

REFERENCES

[1] Palladin A., 2010, "Zara and Benetton: Comparison of two business models", master of science thesis,

[2] Nobukaza, J.A., Fernie, J. And Higashi, T.,2010, "Market orientation and supply chain management in the fashion industry", Logistics and Retail Management, ISBN 978 0 7494 5407 4, 83-101.

[3] Christopher, M., Lowson, B. And Peck H., 2010, "Fashion logistics and Quick Response", Logistics and Retail Management, ISBN 978 0 7494 5407 4, 102-120.

[4] Farahani, R, Z., Asgari,N. And Davarzani, H., 2009,"Supply Chain and Logistics in National, International and Govermental Environment", Physica-Verlag, 179-181.

[5] Culpan, R., Ekin, C., Kumbaracı, M., 2007, "A Critical Assessment of the Turkish Apparel Industry and Firms", Journal of Global Strategic Management, 1, 44-55.

[6] ITKIB (Representation of Turkish Textile and Ready-made Garment Exporters Association), "Tekstil Sektörünün İhracat Performansı Yıllık Değerlendirme 2008", ITKIB Genel Sekreterliği, AR&GE ve Mevzuat Şubesi.

[7]Turkish Statistical Institute, www.tuik.gov.tr

[8] Horizon 2015, http://www.tgsd.org.tr/en/index.php?option=com_content&view=article&id=5&Itemid=58

[9] Nebahat Tokatli* and Ömür Kızılgün, 2010, "Coping with the changing rules of the game in the global textiles and apparel industries: evidence from Turkey and Morocco", Journal of Economic Geography, 10, pp. 209–229

[10] ITKIB, 2010. Tekstil Sektörünün İhracat Performansı Yıllık Değerlendirme 2008, ITKIB Genel Sekreterliği, AR&GE ve Mevzuat Şubesi.

[11] http://www.just-style.com/analysis/turkeys-clothing-and-textile-sector-rebounds_id109102.aspx

[12] http://www.utikad.org.tr/srapor.asp, Türkiye Uluslararsı Taşımacılık ve Lojistik, (2008).

[13] http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/LPI.html

[14] Memedovic, O., L. Ojala, J-P Rodrigue and T. Naula, 2008, "Fuelling the Global Value Chains: What Role for Logistics Capabilities?", International Journal of Technological Learning, Innovation and Development, Vol. 1, No. 3, pp. 353-374.

[15] http://www.utikad.org.tr/srapor.asp, TSKB Lojistik Sektör Raporu, 2008.

[16] Eryuruk, S.H., Kalaoglu, F. and Baskak M.,01/2011, "Logistics as a competitive strategy: The analysis of the Turkish clothing industry in terms of logistics", Fibers and Textiles in Eastern Europe, Vol 19, No 1(84), 12-17.

[17] Abernathy, F.H., Dunlop, J.T., Hammond, J.H. and Weil, D, 1999, "Lean Retailing and the Transformation of Manufacturing – Lessons from the Textile and Apparel Industries", Oxford: Oxford University Press.

[18] http://www.msxlabs.org/forum/moda/26209-modanin-turk-markalari.html#ixzz1OP0zRw00

[19] http://www.yesim.com/anasayfa/

[20] http://www.boynerholding.com/index_en.html#/profile/our-background/

[21] http://www.shopmavi.us/about_mavi.html

[22] http://www.ykmden.com/ContentView.aspx?langId=1&contentId=31

[23] http://www.vakko.com.tr/

[24] http://www.ipekyol.com.tr/en/#/Ayaydin

[25] http://www.orkagroup.com/

[26] http://www.koton.com.tr/EN/

[27] http://corporate.lcwaikiki.com/Page.aspx?id=history

[28] http://www.sarar.com.tr/en/corporate_profile/#chairmans_message

[29] http://www.colins.com.tr/2011/#/New/4

[30] http://www.collezione.com/eng/index.html

[31] http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/scope_supply_chain.html

[32] Woxenius, J. and J-P Rodrigue,2011, "Detours in Supply, Logistics and Freight Transport Chains", submitted for publication to the Journal of Transport Geography.

[33]. http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/logisticsoperations.html

[34] http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/logisticsaddedvalue.html

[35] "Best Practices in International Logistics", 2006. Manhattan Associates Business Value Research Series. Atlanta

[36] Nilsson, F., 2006, "Logistics Management in Practice – Towards Theories of Complex Logistics", The International Journal of Logistics Management, 17, 38-54.

[37] http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/table_services3pl.html

[38] OECD, Logistics Integration in the Asia-Pacific Region, 2000, CPCS Transcom.

[39] http://www.karincalogistics.com/eng/1_2_9.asp?link=15

[40] http://www.balnak.com.tr/En/default.aspx

[41] http://www.act-logistics.com/textile_logistics.php?lg=en

[42] Eryuruk, S.H., 2010, "In order to achieve effective logistics activities between textile and clothing sectors site selection and design of a logistics center", Istanbul Technical University, Institute of Science and Technology, Textile Engineering Department, Ph.D. Thesis.

[43] http://www.ekol.com/en/supply-chain-solutions

THE IMPORTANCE OF FREIGHT VILLAGES:THE APLICATION IN TCDD

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Abstract — *In this paper, emphasized the decision that the freight villages to be set or not while considering the importance of TCDD freight services. Thus, concept of freight village and the planning of instalment of TCDD freight villages in 12 different locations in Turkey and possible contributions of these villages to TCDD freight service is considered. The current situation, freight profile, distribution network of TCDD is observed, transportations from the 7 regions of Turkey to these freight centers are determined and using lineer programming and 0-1 integer programming a distribution network is designed. The created model is solved by using LINDO Software Solver and the results are interpreted.*

Keywords — *Freight Village, TCDD, Freight Service, Lineer Programming, 0-1 Integer Programming*

1. INTRODUCTION

Logistics villages are known by different names such as logistics village, freight village, logistics center, logistics site in literature. Significance of freight villages in Turkey is better comprehended in the most recent years. Particularly, when being considered over railways systems, the significance of freight villages can not be denied. Freight villages allow for interaction between highways and railways and using railways at long-distance, highways at short-distances thicken railway traffic provide reducing noise and environmental pollution and also allow easing highways freight traffic.

TCDD[32] aims to set twelve freight villages at different sizes. These centers specified as Halkalı/Ispartakule (İstanbul), Köseköy (İzmit), Gelemen (Samsun), Hasanbey (Eskişehir), Boğazköprü (Kayseri), Gökköy (Balıkesir), Yenice (Mersin), Uşak, Palandöken (Erzurum), Kayacık (Konya), Kaklık(Denizli) ve Bozüyük(Bilecik). (Doğaner , 2010)

Some works in literature related to freight villages and logistics systems are mentioned below

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[3]TCDD: Turkish State Railways.

TABLE 1
Literature Review

Workers	Study	Year
T.C. Miller, T.L. Friesz, R.L. Tobin	A review of various location models on networks.	1996
F. Barahona, D. Jensen	Plant location with minimum inventory	1998
G. Zhou, H. Min, M. Gen	A genetic algorithm approach to the bi-criteria allocation of customers to warehouses	2002
Huijun Sun, Ziyou Gao, Jianjun Wu	A bi-level programming model and solution algorithm for the location of logistics distribution centers	2008
Yasanur Kayikci	A conceptual model for intermodal freight logistics centre location decisions	2010
Huanjia Yang, Lili Yang, Shuang-Hua Yang	A Multi-Criteria Decision Making Approach for Location Planning for Urban Distribution Centers under Uncertainty	2010
Ye Li, Xiaodong Liu, Yan Chen	Selection of logistics center location using Axiomatic Fuzzy Set and TOPSIS methodology in logistics management	2010
Ishfaq & Charles	Hub location allocation in intermodal logistic networks	2011
Liu, Chan, & Chung	A Study of Distribution Center Location Based on the Rough Sets and Interactive Multi-Objective Fuzzy Decision Theory	2011

2. FREIGHT VILLAGE LOCATION CHOICE IN TCDD

In this paper firstly handles seven geographical regions of Turkey. These seven geographical regions are classified in itself, load-carrying capacities (tons per year), distances traveled are analyzed therefore starting and distribution points are detemined. In first place freights come from different points in railway network of Turkey later freights collected at starting points in every region after that move from these starting points to distribution points which are the sub-points in the regions; finally, the procedure is completed after the transports from distribution points to freight villages.

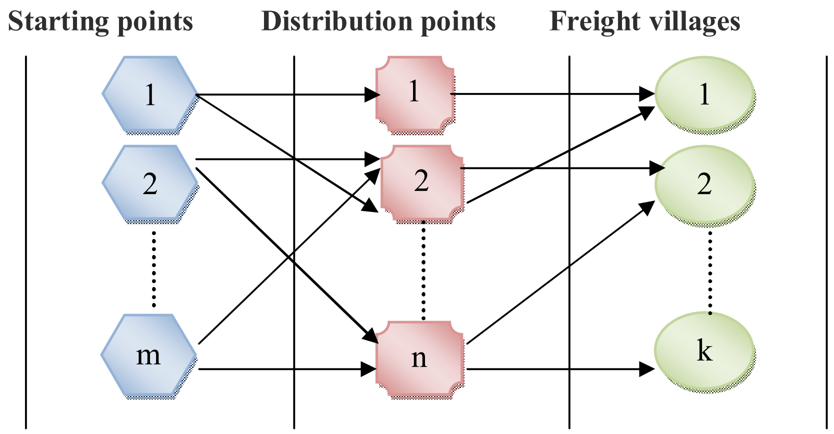

FIGURE 1
Freight Transfer Points

The datas used in this study are annual datas determined as 4 months and 3 periods. Three periods are determined for every transportation during the year and this reflects to the mathematical model. This distribution network which obtained as a result of solution includes transportations to the freight villages which take place in the next step.

2.1. Developed Model

While using the amounts of transport existing in TCDD freight profile, capacities are determined for the starting points, distribution points and freight villages. Distances values per kilometer are used instead of costs.

2.1.1. Notations

In the model expressed, $t \in T$ periods; $a \in A$ regions; $i \in I$ starting points; $j \in J$ distribution points; $k \in K$ freight villages.

X_{aijt} : amount of transport in the period "t" from starting point "i" to distribution point "j" in the region "a"

Y_{ajkt} : amount of transport in the period "t" from distribution point "j" to freight village "k"in the region "a"

W_k : 1, if freight village "k" is opened
0, if freight village "k" is not opened

m_{at} : capacity limit of starting points in the period "t" in the region "a"

p_{at} : lower bound of capacity of starting points in the period "t" in the region "a"

n_{at} : capacity limit of distribution points in the period "t" in the region "a"

r_{at} : lower bound of capacity of distribution points in the period "t" in the region "a"

C_{aijt} : transportation cost per km in the period "t" from starting point "i" to distribution point "j" in the region "a"

C_{ajkt} : transportation cost per km in the period "t" from distribution point "j" to freight village "k" in the region "a"

α_k : set up cost of freight village "k"

c_k : capacity of freight village "k"

$$MinZ \sum_{t=1}^{T}\left[\sum_{a=1}^{A}\sum_{i=1}^{m}\sum_{j=1}^{n} C_{aijt}X_{aijt} + \sum_{a=1}^{A}\sum_{j=1}^{n}\sum_{k=1}^{K} C_{ajkt}Y_{ajkt}\right] + \sum_{k=1}^{K}\alpha_k W_k$$
$$(t=1,2,3; a=1,....,7; i=1,....,5; j=1,...,9; k=1,....,12) \qquad (1)$$

$s.t.$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} X_{aijt} \le \sum_{t=1}^{T} m_{at} \qquad (a=1,....,7; i=1,....,5; j=1,....,9; t=1,2,3) \qquad (2)$$

$$\sum_{j=1}^{n}\sum_{k=1}^{K} Y_{ajkt} \le \sum_{t=1}^{T} n_{at} \qquad (a=1,....,7; j=1,....,9; k=1,....,12; t=1,2,3) \qquad (3)$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} X_{aijt} \ge \sum_{t=1}^{T} p_{at} \qquad (a=1,....,7; i=1,....,5; j=1,....,9; t=1,2,3) \qquad (4)$$

$$\sum_{j=1}^{n}\sum_{k=1}^{K} Y_{ajkt} \ge \sum_{t=1}^{T} r_{at} \qquad (a=1,....,7; j=1,....,9; k=1,....,12; t=1,2,3) \qquad (5)$$

$$\sum_{j=1}^{n}\sum_{i=1}^{m} Y_{ajkt} - \sum_{i=1}^{m}\sum_{j=1}^{n} X_{aijt} \ge 0 \quad (t=1,2,3; a=1,....,7; i=1,....,5; j=1,...,9; k=1,....,12) \qquad (6)$$

$$\sum_{k=1}^{K} W_k \le D \qquad (k=1,....,12) \qquad (7)$$

$$a\sum_{k=1}^{K} W_k + b\sum_{k=1}^{K} W_k \ge E \qquad (k=1,....,12) \qquad (8)$$

$$\sum_{j=1}^{n}\sum_{k=1}^{K} Y_{ajkt} \ge \sum_{k=1}^{K} c_k W_k \quad (a=1,....,7; j=1,....,9; k=1,....,12; t=1,2,3) \qquad (9)$$

$$X_{aijt}, Y_{ajkt} \ge 0$$
$$W_k = 0,1 \qquad (10)$$

2.1.2. Constraints

Equation (1) expresses the minimization of transportation cost from starting points to distribution points and from distribution points to freight villages and minimization of set up costs of freight villages.

Equation (2) expresses the limiting of transportation capacities (tons/year) in the period “t” from starting point “i” to distribution point “j” in the region “a”.

Equation (3) expresses the limiting of transportation capacities in the period “t” from distribution point “j” to freight village “k”in the region “a”.

Equation (4) determines lower bound of capacity of starting points (tons/year) in the period “t” in the region “a”.

Equation (5) determines lower bound of capacity of distribution points (tons/year) in the period “t” in the region “a”.

Equation (6) includes both starting points and distribution points. In this equation amount of transport at least in the period “t” from distribution point “j” to freight village “k”in the region “a” equal or greater than the amount of transport in the period “t” from starting point “i” to distribution point “j” in the region “a”.

Equation (7) limits the number of freight villages to be established.

Equation (8) mentions a lower bound for the number of freight villages to be established.

Equation (9) expresses the capacity of freight villages can not exceed amount of transport in the period “t” from distribution point “j” to freight village “k”in the region “a”.

Equation (10) defines the sign constraints. Amount of transports are non-negative. This constraint also expresses that the 0-1 integer variables wihich related to freight villages to be established or not.

2.1.3. Solution

According to the final solution report the model includes 444 constraints, 1230 variables and 12, 0-1 integer variables. When analyzing the solution where to set up freight villages the decision is İstanbul, Bilecik, Kayseri, Mersin ve Samsun. Total transport performed by TCDD is 9 308 077 920 ton- kilometers. The value of objective function is found 1 063 120 000 ton-kilometers. In this regard, optimal solution has a reduction of 8 billion ton-kilometers compare to the current situation.

The transportations formed from four months periods for the periods t=1,2,3 have a value of tons from starting points to distribution points and from distribution points to the freight villages is in the solution report. For example; when X_{1233} variable is handled with care, transportation in 3rd period performed from Tekirdağ to Edirne in Marmara region is 416 tons. For the Y_{7112} , transportation in 2nd period performed from Gaziantep in southeastern region to İstanbul is 1750 tons. Reducing X_{1233}, 1 ton, considers reducing an amount of 60 ton-kilometers in costs. In the same way, Reducing Y_{7112}, 1 ton, considers reducing an amount of 280 ton-kilometers in costs. When reduced costs are considered, for integer variable W_1 of freight village 1 which thought to be opened there will be an amount of 25 960 ton-kilometers savings if this freight village is not opened.

According to the solution, margin of load density in three centers which Kayseri, Mersin, Samsun is very high therefore this presents how important to set up a freight village in these three centers. Thus, the solution of the model represents us to set up five freight villages. Kayseri, Mersin and Samsun are three of these five freight villages.

Interpreting the solution shows us that Marmara region with the amount of 434 369 tons is one of the regions which have least rail freight mobility. İstanbul is not efficient in rail transit. There is a result according to the solution to be set up a freight village in İstanbul and Bilecik in the region. Considering geopolitical position of Marmara region with an important international trade capacity is a region needed to be set up freight villages.

Aegean region has an amount of 1 472 647 tons of freight mobility. Handling optimal mathematical model, freight villages are not necessary for the region, but considering the freight mobility around the region there may be a necessity for opening a freight village. When analyzing the current situation of TCDD freight transport, Kütahya is the most important freight transfer station. Thus, there is likely to be an interaction with the cities Balıkesir and Bilecik located in Southern Marmara.

Central Anatolia with 1 975 938 tons of freight capacity is one of the regions where transport activities performed most often. Thus, solution reports show us to set up a freight village in Kayseri in Central Anatolia region. Mediterranean region has 780 855 tons of freight capacity. Mersin meets high majority of that capacity. In this paper, also there is a result points to open a freight village in Mersin. Black Sea region and Samsun in this region is the most active area of Turkey in terms of freight transport activities. A very large amount of freight transport provided by Samsun. This presents necessity of opening a freight village in Samsun.

Eastern Anatolia region with 377 995 tons of freight capacity is one of two regions where transport activities least performed. Also the solution shows that not to be set a freight village in this region. Southeastern Anatolia region with 292 172 tons of freight capacity is one of two regions with Eastern Anatolia where transport activities least performed. However, the solution shows that not to be set a freight village in this region.

3. CONCLUSION

In this paper, concept of freight village and the planning of instalment of TCDD freight villages in 12 different locations in Turkey and possible contributions of these villages to TCDD freight service is considered. As first deal with 7 geographical regions of Turkey. These 7 regions are classified in itself and the current situation, freight profile, distribution network of TCDD is observed, transportations from the 7 regions of Turkey through the freight centers are determined. In first place freights come from different points in railway network of Turkey later freights collected at starting points in every region after that move from these starting points to distribution points which are the sub-points in the regions; finally, the procedure is completed after the transports from distribution points to freight villages. The created mathematical model reaches an optimal solution and presents a solution 5 of 12 freight villages might be opened in İstanbul, Bilecik, Kayseri, Mersin and Samsun.

REFERENCES

[1] LTD.ŞTİ., A. U. (Dü.). "Demiryolu Teknolojileri-TCDD Hareket Dairesi TCDD Lojistik Köyler Projesi Bildirisi", ***2. Demiryolu Sempozyumu***, İstanbul (2008).

[2] Awasthi, A., Chauhan, S., & Goyal , S. A Multi-Criteria Decision Making Approach for Location Planning for Urban Distribution Centers under Uncertainty. ***Mathematical and Computer Modelling,*** Volume 53 (Issues 1-2): 98-109 (2011, January).

[3] Aydın, G. T., & Öğüt, K. S. "Lojistik Köy Nedir?" ***2. Uluslararası Demiryolu Sempozyumu***, *2.Cilt*: 1439-1448 (2008).

[4] Barahona, F., & Jensen, D., "Plant Location with Minimum Inventory", ***Math. Program. , Volume 83***, 101-111 (1998).

[5] Cheng, Y., & Yeh, Y. "Exploring Radio Frequency Identification Technology's Application in International Distribution Centers and Adoption Rate Forecasting", ***Technological Forecasting and Social Change,*** Volume 78(Issue 4): 661-673 (2011, May).

[6] Doğaner, Ö., http://www.denizhaber.com/, (2010, Haziran 26).

[7] (DPT), "Sekizinci Beş Yıllık Kalkınma Planı: Ulaştırma Özel İhtisas Komisyonu Raporu: Demiryolu Ulaştırması Alt Komisyonu Raporu", ***DPT, Ankara,*** 42 (2001).

[8] Erel, A., "Türkiye'de Ulaştırma Sektöründe Sorunlar ve Eğitim", ***Ulaştırma Ekonomisi, Türkiye'de ve Dünya'da Ulaştırma Eğitimi,*** ODTÜ(Dü.), Ankara (2002).

[9] Holmberg, K., "Exact solution methods for uncapacitated location problem with convex transportation costs", ***Eur. J. Oper. Res.,*** Volume 114(1): 127–140(14) (1999, April 1).

[10] Ishfaq, R., & Charles, R. "Hub Location–Allocation in Intermodal Logistic Networks", ***European Journal of Operational Research,*** Volume 210(Issue 2): 213-230 (2011, April 16).

[11] Kaya, S., "Türkiye'de Ulaştırma Sektörünün Genel Görünümü ve Sorunları", ***AR-GE Bülten*** (2008, Şubat).

[12] Kayikci, Y., "A Conceptual Model for Intermodal Freight Logistics Centre Location Decisions", ***Procedia - Social***

and Behavioral Sciences, Volume 2 (Issue 3): 6297-6311(2010).
[13] Kılıç, Y., Karaatlı, M. A., Demiral , M. F., & Pala, Y., "Gelişmekte Olan Ülkelerde Sürdürülebilir Kalkınma Açısından Lojistik Köyler: Türkiye Örneği", ***Uluslararası Davraz Kongresi***, Isparta (2009).
[14] Kuo, M., "Optimal Location Selection for An International Distribution Center by Using A New Hybrid Method", ***Expert Systems with Applications,*** Volume 38(Issue 6): 7208-7221 (2011, June, Available Online 13 December 2010).
[15] Li, Y., Liu, X., & Chen, Y., "Selection of Logistics Center Location Using Axiomatic Fuzzy Set and TOPSIS Methodology in Logistics Management", ***Expert Systems with Applications***, Volume 38(Issue 6): 7901-7908 (2010, December 21).
[16] Liu, S., Chan, F., & Chung, S., "A Study of Distribution Center Location Based on the Rough Sets and Interactive Multi-Objective Fuzzy Decision Theory", ***Robotics and Computer-Integrated Manufacturing,*** Volume 27(Issue 2): 426-433 (2011, April).
[17] Lu, Z., & Bostel, N., "A Facility Location Model for Logistics Systems Including Reverse Flows: The Case of Remanufacturing Activities", ***Comput. Oper. Res.*** , Volume 34: 299–323 (2007).
[18] Miller, T., Friesz, T., & Tobin, R., "Equilibrium Facility Location on Networks". ***Springer*** (1996).
[19] Paksoy, T., & Chang, C. T., "Revised Multi-Choice Goal Programming for Multi-Period, Multi Stage Inventory Controlled Supply Chain Model with Popup Stores in Guerilla Marketing", ***Applied Mathematical Modelling,*** Volume 34(Issue 11): 3586-3598 (2010, November)..
[20] Sun, H., Gao, Z., & Wu, J., "A Bi-Level Programming Model and Solution Algorithm for the Location of Logistics Distribution Centers", ***Applied Mathematical Modelling,*** Volume 32(Issue 4): 610-616 (2008, April).
[21] Syam, S. S., "A Model and Methodologies for the Location Problem with Logistical Components", ***Comput. Oper. Res.,*** Volume 29: 1173-1193 (2002).
[22] Taniguchi, E., "Optimal Size and Location Planning of Public Logistics Terminals", ***Transportation Research Part E: Logistics and Transportation Review,*** Volume 35(Issue 3): 207-222 (1999, September).
[23] Topoyan, M., "Lojistik Yönetimi", Mart 10, 2011 tarihinde www.deu.edu.tr: http://kisi.deu.edu.tr/mert.topoyan/ adresinden alındı, (2010).
[24] UTA Lojistik., "İntermodal Taşımacılık Köyünü Buldu", ***UTA Lojistik (Uluslarası Taşımacılık Haber Dergisi)***, (Sayı 9): (2007, Eylül).
[25] Üzülmez, H., "Sadece Sanayiciye Değil, Şehrimize Katkı Sağlaya ©International Logistics and Supply Chain Congress' 2011 October 27-29, 2011, Izmir, TURKEY cak", ***Lonca Dergisi*** (Sayı 30): (2008).
[26] Valentin , R., Han, N., Han, L., & Willem Jan van, S., "A Multi-Agent Platform for Auction-Based Allocation of Loads in Transportation Logistics", ***Expert Systems with Applications,*** Volume 38(Issue 4): 3483-3491 (2011, April).
[27]Wang, B., & He, S., "Robust Optimization Model and Algorithm for Logistics Center Location and Allocation under Uncertain Environment", ***Journal of Transportation Systems Engineering and Information Technology,*** Volume 9(Issue 2): 69-74 (2009, April).
[28] Yang, H., Yang, L., & Yang, S. H., "Hybrid Zigbee RFID Sensor Network for Humanitarian Logistics Centre Management", ***Journal of Network and Computer Applications,*** Volume 34(Issue 3): 938-948 (2010, May 11).
[29] Yıldırım, B., "Lojistik Organize Sanayi Bölgeleri", ***Lonca Dergisi*** (Sayı 30): (2008).
[30] Zhou, G., Min, H., & Gen, M., "The Balanced Allocation of Customers to Multiple Distribution Centers in the Supply Chain Network: A Genetic Algorithm Approach", ***Comput. Ind. Eng.,*** Volume 43: 251–261 (2002).

REVERSE LOGISTICS PROCESSES IN CITY LOGISTICS SYSTEM[1]

Krzysztof Witkowski[2], Sebastian Saniuk[3],

Abstract *— Article presents the problems of solid waste management in city logistics. The subject of research of city logistics is the issues of intentionally organized and integrated flow of materials, people and information in an agglomeration. These problems include among others: the issue of the city communication accessibility, supplying the commercial objects, supply of water and energy, sewage disposal, waste utilization, construction and maintenance of telecommunication networks and environmental protection – ecological aspects. Important areas of city logistics are the activities of gathering, disposal, storage or distribution of municipal and industrial waste. The processes connected with waste management have become part of the city logistics together with the rising amount of waste, by-products and useless consumer articles after expiry date generated by urban agglomerations. This article is a part of research, which is considered to the problem of management (economy) of the infrastructure in city logistics.*

Keywords — city logistics, reverse logistics, waste management.

INTRODUCTION

The implementation of the concept of sustainable development into business practice and the need to meet the challenges of the twenty-first century, at the root of which lies the widespread awareness of the profound global ecological crisis, are now causing particular attention to be given to issues related to environmental quality and cost-effective exploitation of resources [12].

The assumptions of sustainable development clearly indicate that the search for new solutions to technical, technological and logistical resources, and rationalization of the economy, energy and waste should be a priority for all business sectors and services. The definition contained in Article. 3 of the Act of 27 April 2001 on waste should be noted- "waste is all articles or substances which the holder discards, intends to dispose of or is required to dispose of."

In waste management, it must be recognized that the "substance", which for one holder is waste, for another, or even the same operator, at another place and another time can be a useful raw material or intermediate, and this means that waste should be recovered and used effectively, in accordance with the philosophy contained in both Polish legislation and in the framework of the European Council Directive on waste 75/442/EEC of 15 July 1975. The process of waste disposal can be significantly boosted by logistics, and especially by the logistics of recovery, which is "fixed" in traditional logistics and yet is representative of the ecological orientation of logistics and therefore very well suited to the imperative of sustainable development. Reverse logistics enables the realization of the idea of a circular economy, which is a departure from the linear model of raw material flow, to a model of closed material-energy cycles, which significantly reduces the high entropy of the modern economy while enhancing the overall utility rate.

[1] This Paper is granted as research project from grants for science 2010 – 2013.

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CITY LOGISTICS

Logistics covers the planning, coordination and control both in the aspect of time and space, the course of actual processes in the realization of which organization is a participant, for the purpose of efficient and effective goal achievement by an organization [3], [7], [13]. It particularly concerns spatial and timely arrangement (where?), state (how much and in what configuration?) and flow (where from, where to and by what means of transmission?) of goods constituting the components of these processes, i.e. people, material goods, information and funds [6].

Institute of City Logistics defines the city logistics as a process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy [14].

City logistics in many urban areas has been playing an ever increasing role. The number of cars has grown so visibly that urban agglomerations now have to face up to the movement of humans and resources. In western civilization the problem surfaced much earlier, hence many countries introduced various solutions to curb traffic congestion [11].

The subject of research of city logistics is the issues of intentionally organized and integrated flow of materials, people and information in an agglomeration. These problems include among others: the issue of the city communication accessibility, supplying the commercial objects, supply of water and energy, sewage disposal, waste utilization, construction and maintenance of telecommunication networks and environmental protection – ecological aspects.

City logistics is a particular type of logistics service, and is confronted with particular problems, due to the concentration of activities on a limited geographical scale, and the combination with many other activities going on in cities.

City logistics is directed at solving the problems of functioning of highly urbanized areas of microregions. Due to the implementation of its accomplishments, the often non-coordinated system of transport streams conditioned by the historic development of cities is substituted by new streams enclosed by the local logistic system [1].

City logistics is a set of processes of managing the flow of people, loads and information inside the city logistic system according to the city developmental needs and goals, in consideration of natural environment protection and taking into account the fact that a city is a social organization the superior goal of which is to satisfy the needs of its users [9].

The aim of the city logistics is therefore the connection of all business entities acting in a city into a single controllable whole and the management of this network in a manner providing the desired level of life quality and managing the city at a minimum cost level, whilst considering ecological standards [5].

Important areas of city logistics are the activities of gathering, disposal, storage or distribution of municipal and industrial waste. The processes connected with waste management have become part of the city logistics together with the rising amount of waste, by-products and useless consumer articles after expiry date generated by urban agglomerations [4]. Waste disposal and transport is also a vital aspect of city logistics influencing the quality of life of the inhabitants. This applies both, to urban waste and to seasonal waste, such as the disposal of leaves in autumn or snow in winter. It is important to build pro-ecological attitudes among local inhabitants which also has significant impact on the quality of life in the city [11].

REVERSE LOGISTICS

The problems of waste management are increasingly falling into the field of logistics – this is reflected in the growth of reverse logistics.

City logistics systems activities require the assurance of adequate economical and environmental efficiency level on the demand of sustainable development. Reverse logistics – because of the complexity and increasing importance in city logistics processes – has become one of the most important areas of the eco-efficiency rise. New system solutions are observed as essential to increase the eco-efficiency level of reverse management.

Reverse logistics is defined as the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal [16].

More precisely, reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal.

Remanufacturing and refurbishing activities also may be included in the definition of reverse logistics. Reverse logistics is more than reusing containers and recycling packaging materials. Redesigning packaging to use less material, or reducing the energy and pollution from transportation are important activities, but they might be better placed in the realm of “green” logistics. If no goods or materials are being sent “backward,” the activity probably is not a reverse logistics activity.

Reverse logistics also includes processing returned merchandise due to damage, seasonal inventory, restock, salvage, recalls, and excess inventory. It also includes recycling programs, hazardous material programs, obsolete equipment disposition, and asset recovery [8].

WASTE MANAGEMENT

Maintaining cleanliness and order in the city is a mandatory task for which local authorities are responsible. Town councils provide cleanliness and order in their area and create the conditions necessary for their maintenance.

An important task of local authorities is to prevent pollution of the streets, squares and open spaces. This mainly involves collecting and disposing of mud, snow, ice, leaves and other dirt cleared from sidewalks by property owners, and provision of equipment in order to collect waste from the sidewalk.

An important element associated with good waste management is the determination of the frequency and method of disposal of municipal waste, both from the areas of private property, as well as from areas intended for public use. Household waste should be collected and received in a selective manner.

For waste management regions covering at least 300,000 inhabitants, thermal transformation has been established as the preferred method for management of mixed municipal waste. In smaller regions mechanical-biological treatment as the main method of mixed municipal waste management has been adopted. Municipal waste management systems should be based on several principles [2]:

- selective collection of waste segregated "at source" of its generation,
- treatment of waste through: sorting, packing, compaction, baling, etc.
- sale of recyclable materials obtained as a result of segregation,
- separate processing of the waste stream for economically useful raw materials
- sales of processed, economically useful materials (compost, fuel)
- storing the remainder of the waste stream in landfill.

Disposal of waste involves processes of biological, physical or chemical transformation. According to the law, waste disposal also includes landfill. This is the most popular method of waste disposal, in areas specifically designed for this purpose. In addition, the following disposal methods are available [2]:

- composting
- incineration
- gasification and pyrolysis (degassing)
- solid-fuel reprocessing
- Methane fermentation tanks
- energy piles

Selective collection of organic waste allows for the production of high quality compost.

OBJECT OF THE RESEARCH

In the city of Zielona Gora, over 150 000 m3 or 1.2 m3 of waste per person is produced annually. For orientation, this is 370 kg per person. People are generally unaware of how many tonnes of waste per year are thrown away unsegregated. About half of this, if segregated, would be recycled and reused, and as a result the environment would be protected. The municipal council is involved in the disposal of the following waste[10]:

- unsegregated communal waste,
- reusable waste: waste paper, plastics, glass, textiles,
- large-scale waste
- construction waste
- hazardous chemicals,
- bacteriologically dangerous waste.

In Zielona Gora, there is a system of segregation of waste and containers, which makes the process easier:

- Blue containers – paper. This is intended to include books, notebooks, cartons, cardboard and paper bags,
- Yellow containers - suitable for plastics and metals such as plastic beverage bottles, bottles, containers from household chemicals, plastic shopping bags (non-biodegradable), packaging films, plastic household articles, aluminum beverage cans and tins.
- White and green bell-shaped containers - intended for clear and coloured glass. Clear glass should be thrown into the white containers, and coloured glass into the green. Beverage bottles, jars, cups and drinking glasses are suitable for such containers .
- Green household containers: Here should be placed leftover food, bones, ash, foil wrappers from butter, etc.
- Purple containers suitable for textiles
- Silver containers for scrap metal
- Black containers for rubber

Remember that red bags are intended for medical and veterinary waste. Besides this, used batteries that are toxic can be disposed of in red-outlined boxes, which are located in supermarkets or at ZGKiM's facility. Individual household residents can also receive free waste bags. If inhabitants have a signed contract and lease a "green" container, also available free of charge are:

- blue bags with a capacity of 90 litres – for paper;
- white bags with a capacity of 70 litres - for glass (clear and coloured).
- yellow bags with a capacity of 90 litres - for plastics and metals;

The waste is then collected according to a fixed schedule. The next step is the disposal of waste in landfill. Landfill is the last element of waste management. This follows the possibilities for recycling and composting of waste which have been offered. Only waste which does not decompose or decomposes very little should be deposited in the landfill site. Also in this location are facilities for composted waste or those materials that have already been recycled.

The plant is equipped with a waste management system composing of the following facilities [10]:

- waste acceptance system, with weighing equipment;
- commercial waste sorting station;
- municipal waste composting plant - l technological line, compost warehouse;
- landfill with degassing;
- temporary collection point for hazardous waste;
- administrative and social buildings, workshop facilities; ;
- garage space for compactors and storage for lubricants and fuel

MUNICIPAL SOLID WASTE MANAGEMENT

In the European Union in 2009, an average of 513 kg of municipal waste was produced per person. This amount ranged from 316 kg in Poland and the Czech Republic to 833 kg in Denmark – as given by the EU statistical office, Eurostat. An average of 504 kg of waste was received per capita. Of this, 38% went to landfill, 20% to incineration, 24% was recycled and 18% composted. An average of less than 400 kg of waste per person was calculated for Poland, Czech, Latvia, Slovakia, Estonia and Romania. Exact figures are shown in the table (also including the non-EU countries Iceland, Norway and Switzerland). There are also large differences between Member States in the method of waste disposal. The highest percentage of disposal by landfill in 2009 was for Bulgaria (100% of incoming waste) In Poland, the rate was 78%. For incineration as a method of disposal of municipal waste, the most significant figure is Sweden (49%); in 10 countries - including Poland - no more than 1% of the waste gets incinerated. Recycling is most prevalent in Germany (48% of waste collected), in Poland - only 14%. While composting is the most important form of disposal in Austria (40%), in Poland, only 7% of communal waste is used in this way [15]

TABLE 1
Municipal Waste Produced in Different Countries. As in 2009

	Municipal waste generated, kg per person	Municipal Waste collected, kg per person	Method of disposal of municipal waste (%)			
			Landfill	Incineration	recycling	Composting
EU	513	504	38	20	24	18
Belgium	491	486	5	35	36	24
Bulgaria	468	450	100	-	-	-
Czech	316	274	83	12	2	2
Denmark	833	833	4	48	34	14
Germany	587	564	0	34	48	18
Estonia	346	285	75	0	14	11
Ireland	742	730	62	3	32	4
Greece	478	474	82	-	17	2
Spain	547	547	52	9	15	24
France	536	536	32	34	18	16
Italy	541	594	45	12	11	32
Cyprus	778	778	86	-	14	-
Latvia	333	333	92	0	7	0
Lithuania	360	342	95	-	3	1
Luxemburg	707	707	17	36	27	20
Hungary	430	427	75	10	13	2
Malta	647	643	96	-	4	-
Holland	616	520	1	39	32	28
Austria	591	591	1	29	30	40
Poland	**316**	**264**	**78**	**1**	**14**	**7**
Portugal	488	488	62	19	8	12
Romania	396	308	99	-	1	0
Slovenia	449	495	62	1	34	2
Slovakia	339	311	82	10	2	6
Finland	481	481	46	18	24	12
Sweden	485	480	1	49	36	14
Great Britain	529	538	48	11	26	14
Island	554	520	73	11	14	2
Norwegian	473	467	14	42	28	16
Suisse	706	706	-	49	34	17

(Source: www.administrator24.info.pl)

Municipal waste management has the following specific objectives [10]:

1. reducing the amount of biodegradable municipal waste going to landfills; to be deposited:
   - in 2010, not more than 75%,
   - in 2013 not more than 50%,
   - in 2020 not more than 35%

of the weight of the waste produced in 1995,

2. weight of municipal waste sent to landfill to a maximum of 85% of the waste produced by 2014

The specific objective for hazardous waste is to maintain the level of recovery at 50% and recycling at 35%. As for spent batteries and accumulators, objectives are based on expansion of the system for recovery and disposal. Ultimately, the aim is to achieve 100% cessation of disposal of such waste. The same is true of waste electronic equipment. By 2018 the level of recovery of used tires is expected to be 100%, and recycling 20%. For comparison, the 2010 level is 75% recovery and 15% recycling. The strategy also seeks to extend the system of selective collection of waste from renovation, construction and demolition of buildings and achieve a level of 80% in terms of recovery. The main objectives of municipal sewage sludge are [10]:

- reducing total storage of sewage sludge
- increasing the amount of municipal sewage sludge processed before the introduction of sediment - into the environment and transformed by thermal methods,
- maximizing the utilization of nutrients contained in sediment while meeting all health and chemical safety requirements.

The strategic objective of waste management planning is the handling of waste in accordance with the principles of the waste management hierarchy, ie firstly the prevention and minimization of waste generation and to reduce their hazardous properties and, secondly, maximum utilization of material and energy components of the waste, and where waste cannot be subjected to recovery processes, to be neutralised.

REFERENCES

[1] Abt S., 2001, Logistyka w teorii i praktyce, Poznań University of Economics Press

[2] Bendkowski J., Wengierek M., Logistyka odpadów. Obiekty gospodarki odpadami, Politechnika Śląska Press , Gliwice 2004

[3] Čambál M., Cibulka V., Logistika výrobného podniku, Bratislava: STU v Bratislave, 2008. s. 198, ISBN 978-80-227-2904-8

[4] Dżbik E. (Ed.), 1995, Gospodarka miejska, Warsaw

[5] Gołembska E., 2001, Kompendium wiedzy o logistyce, PWN Press, Warsaw

[6] Krawczyk S., 2001, Zarządzanie procesami logistycznymi, PWE Press, Warsaw

[7] Lenort R., Feliks J., 2010, Operational production logistics in metallurgical company, XIV Konferencja Logistyki Stosowanej „Total Logistic Management", Zakopane, 2-4 grudnia 2010

[8] Rogers D. S., Tibben-Lembke R. S., 1998, Going Backwards: Reverse Logistics Trends and Practices, Reverse Logistics Executive Council

[9] Szołtysek J., 2007, Podstawy Logistyki Miejskiej, Katowice University of Economics Press

[10] Waste management plan 2008-2012 for the city of Zielona Góra, Zielona Góra 2007

[11] Witkowski J., Kiba-Janiak M., Correlation between city logistics and quality of life as an assumption for a referential model, The 7th International Conference on City Logistics, 7th June - 9th June 2011 in Mallorca Island, Spain

[12] Witkowski K., Saniuk S., Logistics management aspects of the city infrastructure, International Logistics and Supply Chain Congress 2010, Logistics Association Publication No: 9, Istanbul, Turkey, 2010

[13] Vidová H., Babčan M., Molnárová D., Logistics and its impacts to the environment. In: Environmental Economics, Policy and International Environmental Relations : Proceedings 12th Annual International Conference of PhD. students, young scientists and researchers. Prague, October 11-12, 2010. - Prague : University of Economics, 2010

[14] Internet source: http://www.citylogistics.org/

[15] Internet source: http://www.administrator24.info.pl/

[16] Internet source: http://www.reverselogisticstrends.com/index.php

THE IMPORTANCE AND EFFECTS OF REVERSE LOGISTICS ACTIVITIES FOR THE RETAIL COMPANIES

Kenan DİNÇ [1]

Abstract *– Sustainable and profitable use of resources, social responsibilities, environmental concerns, economic benefits, customer awareness and legislations are pressing retail industry as well as others to provide environmentally conscious products and take back them in case of needs. Although reverse logistics is an emerging field of logistics in practice, it is anticipated that it will be one of the most important in the next decade. In conformity with the legislations of European Union, there is a need of taking a step forward for practical implementation within the optimized boundaries of time and cost. The aim in this paper is to help due diligence by describing improvements, importance and effects of reverse logistics, the level of activities in the retail companies and a useful to-do lists.*

Keywords – Retailing, Reverse Logistics, Logistics.

INTRODUCTION

Beginning from the era of mass production, industrialized countries produce goods relatively larger in amount and cheaper. As a consequence of high level of income, consumption increases the amount of disposal. In the developed countries, metropolitan municipalities are suffering to provide enough disposal areas. Scarce resources make individuals and governments become environmentally conscious. Economically, reusing some of the returned/used products is more convenient than disposing. Reuse of products like paper, glass, and tire has been well known ways of reuse for years. Waste reduction provides to incline from the one-way economy to the idea of recycling the products [1].

Retail organizations have been facing high volume of product returns through the supply chain. Range estimations of product returns are from 15% for mass merchandisers to 35% for e-commerce retailers. Processing delay avoids recovering only a portion of returned products though product returns accounts for a large proportion of reverse logistics activities. Organizations are more likely to perceive the product returns function as an additional cost to be incurred in their normal business practices although an efficient management of reverse logistics can provide them with a competitive advantage [2].

From a supply chain partners' perspective, products can be returned to deal with market situations such as stock balancing, reverse marketing or end of life/season. From the customer perspective products can be returned based on defective/unwanted products, warranties, recalls or environmental disposal [3].

REVERSE LOGISTICS

Logistics is the part of the supply chain process that plans, applies and controls effectively and efficiently the flow and the stock of goods, services and their information from the production site to the consumption site to satisfy the need of customers [4]. Reverse logistics manages used products return from the customers to the producers for the purpose of creating or recapturing value or for proper disposal [5]. There are two major supply chains to be concerned within any distribution system: the forward chain and the reverse supply chain (reverse logistics system). The forward chain is a well-researched field where the strategy is to distribute the products from manufacturing plants or plants to customer outlet zones. The reverse chain is when a product or component returns to the production chain after its use, either for purposes of repair, recycling, or remanufacturing [6]. The reverse supply chain process can be organized sequentially by five key steps: product acquisition, reverse logistics, inspection and disposition, reconditioning, and distribution and sales [7].

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Reverse logistics is the process of planning, implementing and controlling flows of raw materials, in process inventory, and finished goods, from the point of use back to a point of recovery or point of proper disposal [8]. In this process a manufacturer systematically accepts previously shipped products or parts from the point for consumption for possible recycling, remanufacturing, or disposal. Strategic factors in reverse logistics systems consist of strategic costs, overall quality, customer service, environmental concerns, and legislative concerns. Operational factors of reverse logistics systems are the cost-benefit analysis, transportation, warehousing, supply management, remanufacturing and recycling and packaging [9]. The most intuitively related notion with such reverse activities involves the physical transportation of used products from the end user back to the producer [6].

Reverse logistics encompasses logistics activities such as network design, information flow, transportation, inventory, warehousing, material handling, and packaging all the way from products no longer required by the last user to products again usable in a market [10]. From design through manufacture to consumer, firms should explore and integrate reverse logistics as a viable business option in the product life cycle [9]. A study by the Council of Logistics Management reported that there are three key issues affecting reverse logistics: (1) the structure of network: (2) the planning for the material flows: and (3) the classification and the routing of materials [11]. A key aspect to recognize reverse flows is that the collection of goods from the marketplace is a supply-driven flow, rather than demand-driven flows seen in forward flows logistics systems. A supply-driven flow is outside of direct control by a company [11].

Reverse distribution is the collection and transportation of used products and packages. Reverse distribution can take place through the original forward channel, through a separate reverse channel, or through combinations of the forward and the reverse channel (Fig. 1).

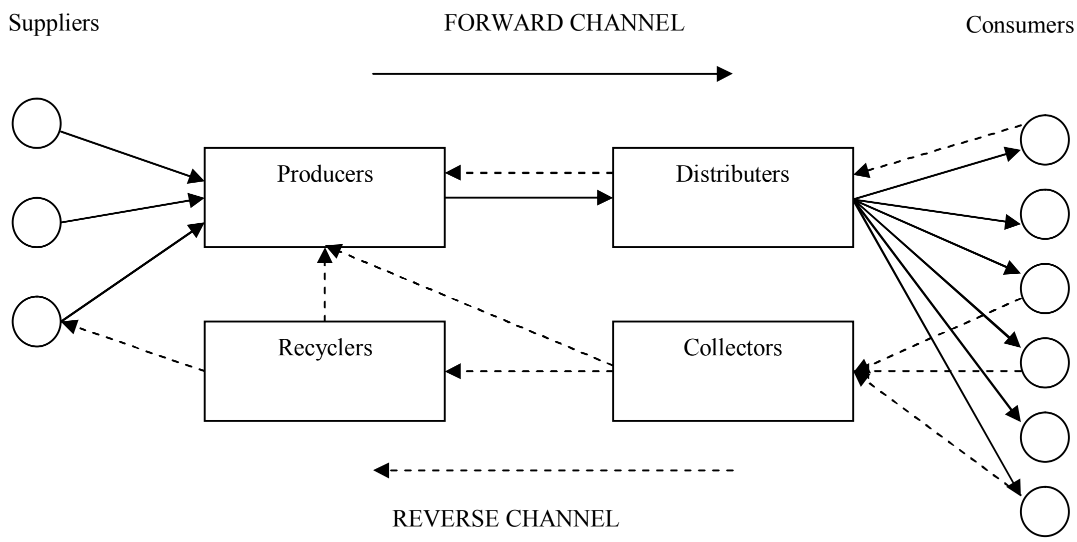

FIGURE 1
Framework Reverse Distribution [10].

The integration of forward and reverse channels is a major issue in reverse distribution channels. The level of integration between the forward and reverse logistics systems depends on the product's disposition [12].

Among the solution techniques proposed in literature, a generic model can be drawn as in Fig.2 and minimum necessary entities are modeled in Fig.3.

When a product arrives to CRC or DC employees assess the condition of the item and determine the best place the product should be sent regarding to the process. Commonly practiced processes are:

- Repackage,
- Refurbish,
- Renew,
- Reuse,
- Repair,
- Remanufacture,
- Recycle,
- Disposal/Discard

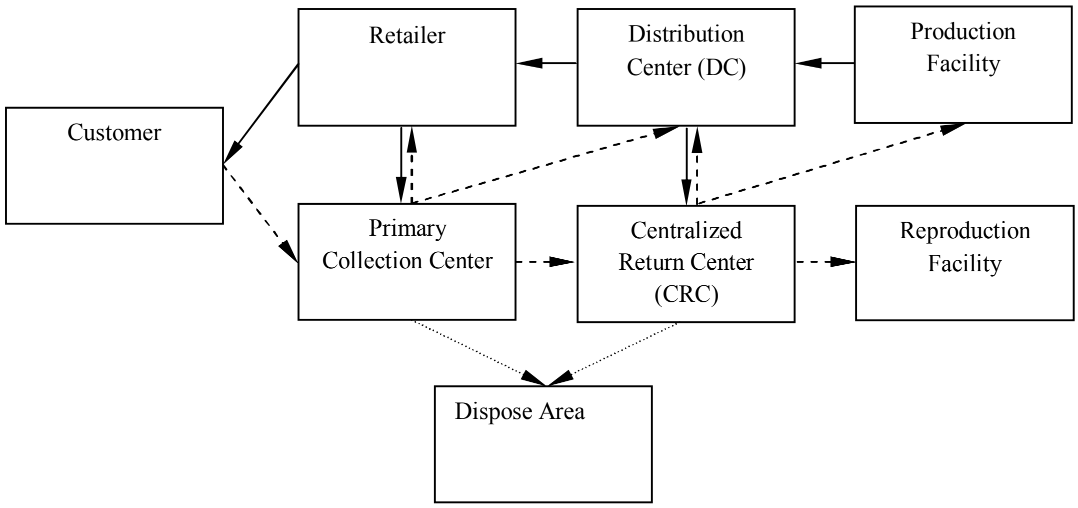

FIGURE 2
Generic Forward and Reverse Distribution Flows

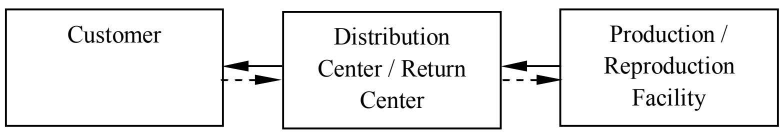

FIGURE 3
Simple Forward and Reverse Distribution Flows

Major differences that exist between forward and reverse retail logistics are:

Forecast: In the forward logistics production is planned according to the demand. However in the reverse logistics, the customers initiate the activities. Observations on sales give clues on trends to facilitate returns estimation. Large volume of sale indicates a large volume of return after a period.

Damaged package: Except the unsold products that have the original package, most of the time returns travels through backward chain without proper package. Transportation, customers or store employees might damage the package.

Transportation and Handling: In reverse logistics, goods usually do not suit pallets as required and take more space than the products in forward logistics. Since the direction is reverse, there is a movement from many locations to a few, contrary to forward logistics. Nearly all the times, in multiple stops routings are different because of the difficulty of loading and unloading goods in the same stop without switching the place of next stop's deliverables.

Cost: Reverse operations per product require more manpower to handle, unclear destinations, costly transportation, more time to examine and classification, collection efforts. It makes reverse logistics more costly than the forward logistics which is well defined and accountable.

Inventory: In the forward logistics, there are inventory parameters (e.g. reorder points, demand, lead time) and there are models starting from basic economic order quantity. Traditional inventory management models do not apply to reverse logistics due to the uncertainty of product returns.

Marketing: Retailers and customers feel concerned in the reverse logistics market. Retailers hesitate on the consumers' acceptance of used item when compared with the new items. It takes time for the customers to have confidence on the firms that sale used products.

CONCLUSION

Percentage of product returns is growing rapidly and presents a potential to enable firms in having advantage in competition if they take precautions. In a well managed reverse logistics activity several key issues are emerging. As a "to-do" list practical activities are listed below:

Analyze business processes: Unfortunately, in reverse logistics "one size fits all" rule does not suit. Flow in the reverse channel needs to be analyzed for the products, collection points, damaged and packaged products, destination, possible facility locations, workforce requirement, marketing options, customer behavior

Decide to form open loop or closed loop supply chain: If the reverse channel uses the forward channel than it is a closed loop. Otherwise, it is called as open loop supply chain.

Dedicate enough workforces for classification of returns: Reverse logistics is labor intensive. In the facility each returned product is evaluated by trained personnel who decide the returns to be repackaged, refurbished, renewed, reused, repaired, remanufactured, recycled, disposed or added value by other means. In a collection point (e.g. retail store), damaged products has the most time consuming process. After examination, either each product is labeled separately, or a box of damaged products is labeled as a whole. Integrated with the IS, UPC coded returns are shipped to DC or CRC according to the structure of the chain.

Optimize DC/CRC locations and capacities (if it is a large organization use Decision Support Tools): Return flow uncertainty extends the holding duration of the returns in the inventory and increase the costs. The more the returns are held in inventory, the less the product value will be.

Plan the transportation and handling: Transportation in reverse logistics is costly due to the unpredictability of returns. Although, returns can be hold in inventory for a long period, the season effect, product life cycle and process times are urging to transport them without waiting long time to accumulate for full load. Contrary to the forward logistics it is a many-to-one network and the number of collection sites is usually high.

Use information technology: From the classification of the returns to the destination facility, information on product, location, physical status, marketing value, legal status, and processes' dates need to be followed by using a sort of UPC.

REFERENCES

[1] Dinç, K., 2010, "Üç aşamalı tersine dağıtım sistemleri için bir model ve ayrıştırmalı çözümü", Unpublished PhD Dissertation, Gazi University Ind.Eng.

[2] Stock, J. R., Mulki, J.P., 2009, "Product returns processing: An examination of practices of manufacturers, wholesalers/distributors, and retailers", Journal of Business Logistics, 30(1)

[3] Hsu, S.H., Alexander, C.A., Zhu, Z., 2009, "Understanding the reverse logistics operations of a retailer: a pilot study", Industrial Management and Data Systems, 109(4)

[4] SCL, Supply Chain & Logistics Institute, Georgia Institute of Technology , http://www.scl.gatech.edu/apps/glossary, 2006.

[5] Tibben-Lembke, R.S., Rogers, D.S., 2002, "Differences between forward and reverse logistics in a retail environment", Supply Chain Management, 7(5)

[6] Jayaraman, V., Patterson, R.A., Rolland, E. , 2003, "The design of reverse distribution networks: models and solution procedures", European Journal of Operational Research, 150(2):128–149.

[7] Prahinski, C., Kocabasoglu, C., 2006, "Empirical research opportunities in reverse supply chains", Omega, 34(6):519-532.

[8] REVLOG;http://www.fbk.eur.nl/OZ/REVLOG/PROJECTS/TERMINOLOGY/Definitions.html, 2011)
[9] Dowlatshahi, S., 2000, "Developing a theory of reverse logistics", Interfaces, 30(3):143–154.
[10] Fleischmann. M., Boemhof-Ruwaard, J.M., Dekker, R., van der Laan, E., van Nunen J.A.E.E., Van Wassenhove, L.N., 1997, "Quantitative models for reverse logistics: a review", European Journal of Operational Research, 103:1-17.
[11] Jayaraman, V., Guide, V.D.R., Srivastava, R. , 1999, "A closed-loop logistics model for remanufacturing", The Journal of the Operational Research Society, 50(5):497–508.
[12] Ferguson, N., Browne, J., 2001, "Issues in EOL product recovery and reverse logistics", Production Planning and Control, 12(5):534–547.

A METHODOLOGICAL FRAMEWORK FOR REVERSE LOGISTICS NETWORK DESIGN COMBINING INTELLIGENT SYSTEM AND OPTIMIZATION MODEL

Gül T. Temur[1], Bersam Bolat[2]

Abstract **—** *In relation to increase in environmental consciousness and legal arrangements, firms have begun to focus on Reverse Logistics (RL) which is the driving force of putting recovery activities in action effectively. One of the major drawbacks of current studies on this topic is that; they usually do not address the uncertainty of product returns. In order to fill this gap in the literature, a methodological framework for reverse RL network design (RLND) models which includes product return amount forecasting by Artificial Neural Network (ANN) is proposed. A two stage approach is followed for the study. In the first stage, ANN forecasting approach on product return amount that is related to the number of containers is proposed. In the second stage, it is determined that how the RL model can be designed and optimized by considering forecasted values at first stage.*

Keywords **—** *Artificial Neural Networks (ANNs)***,** *Product Return Forecasting, Reverse Logistics*

INTRODUCTION

In recent years, increased concern for the environment protection has become a matter of an important priority in the world and companies have been trying to get their business strategies more sustainable. The factors such as regulation pressure, profit margin, need to strengthen green image and social responsibility make firms attach more importance to the return of used or scrapped products. The return of products is controlled by Reverse Logistics (RL) management approach which is defined by The European Working Group on Reverse Logistics (REVLOG) as the following [1];

'The process of planning, implementing and controlling backward flows of raw materials, in process inventory, packaging and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal'.

The most important reasons of growing interest to RL is environmental protection and its regulations. Many regulatory initiatives have been developed imposing certain responsibilities and environmental obligations on original equipment manufacturers, suppliers, municipalities and customers. For instance, the European Union with its Directives 2002/96/EC and 2002/95/EC regarding the waste electrical and electronic equipment (WEEE) has imposed strict obligations in order to increase the recycling of electrical and electronic equipments by enforcing producers to be responsible for taking back the products and reprocessing them. Although the importance of reverse logistics has been widely recognized in many developed countries, it is a fairly new challenging area for developing countries such as Turkey. Especially during the adaptation process to European Union standards, environmental legislations have been regulated and the importance of sustainability has became more apparent in both academic and business environments.

In the process of backward flows of products, there are many recovery options. Reference [2] states that activity groups of product recovery networks can be collected into five parts:

- Collection: It refers to make used products' 'takeback' possible and move them in fixed collection points.
- Inspection/Separation: It refers to indicate necessary operations for each product according to their ability to reprocess.
- Re-processing: It refers to transfer reusable products to usable products by activities such as remanufacturing, recycling and repair.
- Disposal: It refers to dissolve products that can not be reused.
- Re-distribution: It refers to orient reusable products to the possible markets.

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Looking at all problem areas available in the literature, it is seen that the topics range from strategic decisions to tactical and operational decisions. Reference [3] summarizes the most important modeling approaches related with product recovery as; ‘forecasting returns’, ‘reverse logistics network design’, ‘vehicle routing’, ‘return handling and warehousing’, ‘lot sizing’, ‘stochastic inventory control’, ‘dynamic product recovery’, ‘production planning’, ‘inventory valuation’, ‘coordination in closed loop supply chains’, ‘long term analysis of closed loop supply chains’, ‘environmental management’, ‘economic and environmental performance’ and ‘information technology’. Optimization of logistic networks by minimizing costs directly or indirectly related with these options is one of the most commonly studied topics in reverse logistics network design (RLND) problem area. The solution of optimization models mostly becomes optimal for any particular scenario or real condition that all parameters are known or assumed as known. However in real, the complexity of these kinds of problems increases due to high uncertainty in quantity, quality and time parameters of product returns. In order to deal with uncertainty parameters, stochastic programming which addresses the unknown parameters following a particular probability function, is used. There are some studies presenting stochastic approaches to RLND models. Some researchers proposed mathematical model that set the quantity of demand and supply/return of materials as stochastic parameters [4-11]. Reference [12] and [13] model the return quantity as a stochastic parameter. Reference [14] proposes a SMILP model addressing two more different stochastic parameters: return quality and variable cost, besides return quantity. Reference [15] proposes a mathematical programming addressing three uncertain parameters: the customer demand, the recovery rate of return products and the remanufacturing lead time are the main uncertain factors.

While high uncertainty is an important characteristic of reverse logistics, the available literature and theory on uncertainty decision making in this area are limited. Because of this reason, this study draws attention to develop a hybrid structure that integrates two of the topics listed by reference [3]: ‘forecasting returns (FR)’ and ‘reverse logistics network design (RLND)’.

This paper presents a simplified methodological framework structured in two stages. In the first stage, decision making approach for product return uncertainty is proposed. In the second stage, an optimization model that considers the results of first stage is developed.

METHODOLOGICAL FRAMEWORK

Scope

The complexity of reverse logistics networks may increase due to high uncertainty in relation to amount of product returns. Therefore it becomes critical to develop a decision making approach for forecasting product return amount which is used in the optimization model as a parameter. This methodological framework focuses on the way of building a quantitative optimization model as well as decreasing uncertainty of product return amount by using intelligent system approach as a decision making tool.

Overview

Parallel with the scope of the study, the proposed hybrid system comprises following two main stages:

Stage 1 - Decision Making Approach: Firstly, this stage goals to define factors that have impact on return amount of products. Then, it aims to gather the historical data for defined factors in the selected logistics network in order to develop a forecasting approach for product return amount. An intelligent system is used as a decision making tool. It is assumed that product return is directly related with the amount of collected containers. Therefore, in this stage the number of collected containers is forecasted.

Stage 2 - Optimization Model: This stage mainly goals to create a mathematical model that decides on the number of centers and allocation of products between centers by aiming the minimization of the total cost of the system. It begins with definition of general structure of the network and determination of assumptions, indices, parameters, variables, constraints and objective function. Then, related and available data regarding the proposed network is collected. In the proposed model, one of important parameters is total return amount (quantity of collected containers) that is forecasted at the first stage.

Analysis of Stages

Stage 1 - Decision Making Approach

In today's business environment, most of products that are manufactured in sectors such as electronics, food, automotive, chemical home products are given back because of some reasons such as calling the products by manufacturers, price advantage for buying new ones, collecting harmful goods, etc. Firms call this activity as a 'product return' and they mostly calculate the amount of returned products by multiplying a rate with sales amount of the product. For instance for magazines this rate is 50%, for wholesale products 4-15%, for catalogue products 18-35%, for electronics 10-12% and for automobile parts it is 4-6% [16].

Product return amount forecasting is an economically important and a complex decision because it changes depending on many variables that make the generation process of an effective decision making approach hard. Actually, many forecasting methods may be used for this study. Intelligent systems are useful for hard forecasting processes. As an intelligent decision making support system, Artificial Neural Network (ANN) that has a high success percentage on obtaining the forecasted values as close as the real ones is chosen for the methodology. ANN is a system that learns from historical data. This working principle of ANN is very similar with human brains. The operation occurs by connections between many different processing elements called as *neurons*. Each neuron receives many input signals, and then produces an output signal that is directly sent as input to another neuron. The connections of neurons between layers are named as *weights*. The forecasting success of system is founded on these weights. The sum of weighted inputs in each neuron is entered to the activation function in order to get an output from the neuron [17, 18]. The weights are repeatedly changed depending on the results of learning rules in order to modify the connections until the best loads are gained [19].

One of the most commonly used types of ANNs is Multi Layered Perceptron (MLP) which has three different layers: input, hidden and output. Each layer has different number of neurons. Input layer is the receiver of the network, hidden layer is the negotiator and output layer is transmitter of the system. Hidden layer provides generalization of the output when linkage between inputs and outputs is nonlinear [20]. Different numbers of neurons operates in each layer and they are internally connected each other with weights. Development of an ANN model may be analyzed into four main steps: *definition of input and output parameters, design of network, train and test of network, evaluation of implementation results.*

Definition of input and output parameters: The ANN methodology begins with definition of parameters. There are qualitative (e.g.,demographic structure, legal requirements, etc) as well as quantitative (e.g., population, distance,etc) factors that have impact on the product return.

The proposed model considers factors as input parameters that affect the product return amount. For collection container location, some qualitative and quantitative input parameters that are mostly compiled from different studies in the literature are listed at Table 1.

TABLE 1
Input Parameters

Qualitative Parameters	
Governmental regulations [21]	Giving information to customers about product returns [22]
Legal inducements [21]	Development of second hand sector of product [27]
Product category [22]	Segment of customers [27]
Life cycle point of product [23]	Identity of firms which have return responsibilities [30]
Complexity of product modularity [24]	Resources of recycling [1]
Seasonality of product [23]	Easiness of product returns [26]
Discount strategy of firms for giving back [25]	Strategy of firm on product returns [26]
Advertisements [26]	
Quantitative Parameters	
Price of products [22]	Sales distribution features of product [28]
Economic life of product [24]	Warranty period [30]
Sales amount for past terms [29]	Rate of defects [29]
Distance between centers and municipalities	Surface area of selected location
Population of selected location	Education level of selected location

Design of network: Factors which are found important by company managers are tagged as inputs of the system. Meanwhile, containers' return amount is tagged to the ANN system as output parameter. To choose the number of hidden layers and each node numbers of them, the neural network software is run for different nodes combinations. These tries successively include 1 to 6 nodes for all hidden layers, therefore there exist 36 trials that begin with 1 node in first hidden layer and 1 node in second, ends with 6 nodes in first hidden layer and 6 nodes in second. Trial error results that are evaluated by mean square error value (MSE) show us the most acceptable node number.

On the other hand, although output parameter that shows the amount of container is numeric, there are some non numeric parameters such as qualitative input parameters. These kinds of parameters are taken into consideration by entering their symbolic measurements. When entering non numeric data of a location into the ANN system, short expressions are used. For example if the existing of governmental regulations are taken into consideration, 'yes' is used if there is a governmental regulation at considered location. If not, 'no' is used as a symbolic measurement. Parallel with that, if resources of recycling are considered, types of resources are written into the system by using brief expressions. At the end, the software automatically turns non numeric values to numeric by converting symbolic expressions to the 0 or 1 values. Because ANN models are run by using numeric data.

The advantage of ANN is; the system can run by using limited number of data. There is not any lower limit for data set. However, it is required to highlight that large data sets give researchers more satisfying results in shorter time. In this study, the elements of the data set are the locations where containers are put in. For each location, all values of input and output values are entered into the system. For training process, nearly 75% of total data is randomly chosen as a training set. Rest of the data is set apart to be used for testing.

Train and test of network: For deciding on the best loads, many trials are run in order to get minimum MSE value. After training the network according to randomly selected node and layer numbers, when MSE gives minimum value, it is assumed that this trained system's output scores have the nearest value to the experts' suggestions. If a built structure has MSE value less than 0,01; it is mostly considered as highly reasonable. Then testing process is started by running rest of data.

During testing process, the answers of network are checked to identify if they are closer to the output value defined by history data or not. If outputs of network are found closer, it is possible to say that the network is ready to use. That means, if data about input parameters of alternative collection locations are entered to the ANN system, the decision maker becomes able to have an idea about how many containers should be put on this place. In other words, decision makers can have idea about return amount of products by looking at the container amount output of selected ANN system.

Evaluation of implementation results: At the end of ANN implementation, it is shown that how much percent of test data gets closer value and discussed if return amount of test sample is successfully found by using improved ANN structure. If model has output values same as real output, it becomes clear that the network is ready to be used by decision makers on product return forecasting. That means decision makers can benefit from this system as a support tool during forecasting return amount of products. If input parameter information of a new returned product is entered to the system, the decision maker can have an idea about how much product will be collected by looking at the output value that is given by network.

Stage 2 – Optimization Model

In the optimization stage, a mathematical model that decides on the number of centers and allocation of products between centers is proposed. For the creation of proposed model, a general open loop logistics network is taken into consideration. In this network, it is assumed that containers (CO) in original equipment manufacturers (OEMs), municipalities and/or distributors full of end-of-life products are collected at each month. Then they are sent to collection centers (CC). At collection centers, products are controlled and if there are any products that cannot be reprocessed, they are directly sent to refineries (R) or disposal centers (DC). The rest of them are sent to recovery center (RC) for reprocessing operations. By the help of recovery options such as remanufacturing, recycling and repair, the products are separated and converted into materials that can be sent to material suppliers (M) in order to use in new product manufacturing in the market. After reprocessing options, it is also possible to have materials that cannot be sent to suppliers. These materials should be sent to refineries and disposal centers. General open loop network of assumed model in this study is represented in Figure 1.

As literature review shows, there are many optimization approaches for RLND modeling. In this study mixed integer linear programming (MILP) which is the most commonly used modeling approach to RLND is used. The objective function optimizes variables for profit maximization. The model is one product, capacity constrained model and based on a single period of time. It is deterministic. That means all locations and capacities are known. Demand related to container quantity is also known after developing forecasting approach at Stage 1. Inventory costs are ignored. There is not any safety stocks in the centers. Variable costs of full trucks are considered which are same at each route. Rate of distribution of products from one center to other is known (α: rate of materials sent from collection center to disposal center; β: rate of materials sent from collection center to refinery, μ: rate of materials sent from recovery center to material supplier, λ: rate of materials sent from recovery center to refinery). Existing centers can be closed or expanded. Refineries and material suppliers pay money when they get products/materials. On the other side, money is paid to customers (container owners) for serving products to collection centers and to disposal centers for incineration or burning operations.

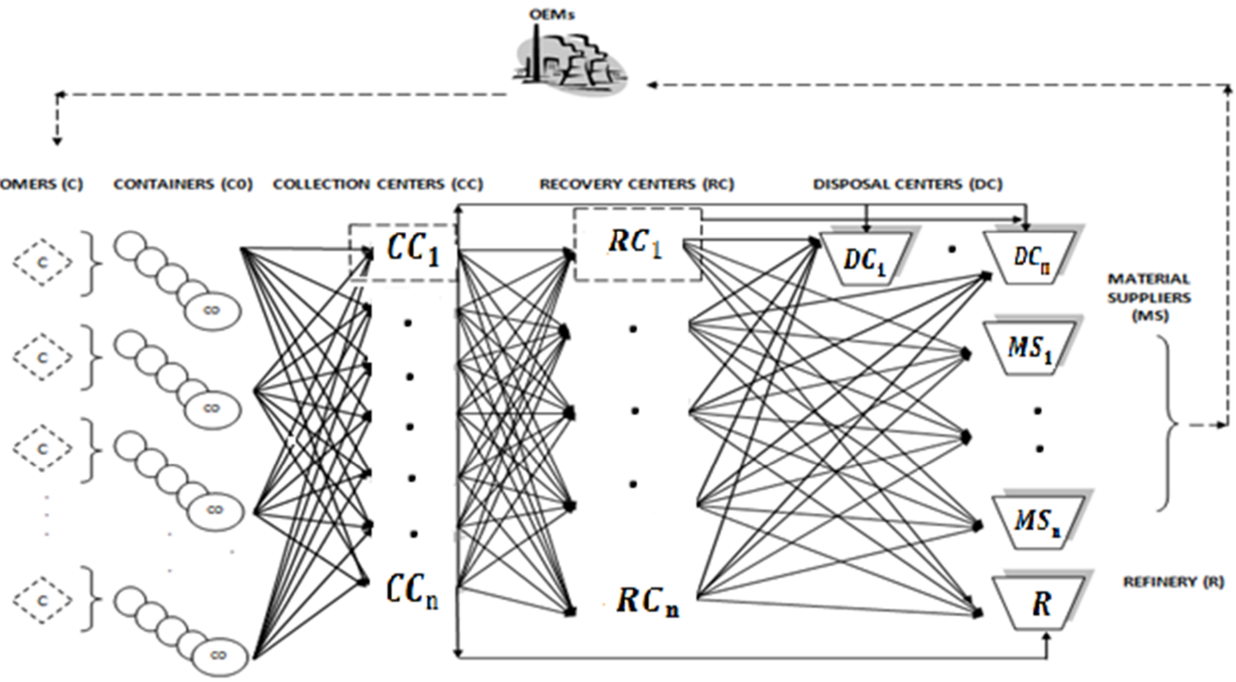

FIGURE 1
Open Loop Network

Parallel with these assumptions, the general structure of the model is shown below (M is a very large number):

Max =

$\sum$ earned money from selling recovered materials to the material suppliers and refineries -
$\sum$ transportation variable costs - $\sum$ processing costs – $\sum$ annualized fixed costs -
$\sum$ paid money for serving products to collection centers and disposal centers

subject to

balance constraints:

$\sum$ collected containers at collection center = total return amount

$\sum$ containers served from customers to collection center $\leq$ M * Indicator of opening potential collection center

$\sum$ containers served from customers to collection center $\leq$ M * (1- Indicator of closing existing collection center)

$\sum$ containers served from collection center to recovery center $\leq$ M * Indicator of opening potential recovery center
$\sum$ containers served from collection center to recovery center $\leq$ M * (1- Indicator of closing existing recovery center)
Indicator of expansing existing collection center + Indicator of closing existing collection center ≤ 1
Indicator of expansing existing recovery center + Indicator of closing existing recovery center ≤ 1
$\sum$ containers served from customers to collection center = $\sum$ containers served from collection center to other centers
$\sum$ containers served from collection center to recovery center = $\sum$ containers served from recovery centers to other centers

capacity constraints:
$\sum$ containers served from customers to collection center $\leq$ annual capacity of potential collection center * indicator of opening potential collection center
$\sum$ containers served from customers to collection center $\leq$ annual expansion capacity of existing collection center * indicator expansing existing collection center + annual capacity of existing collection center
$\sum$ containers served from customers to collection center $\leq$ annual capacity of existing collection center * (1 - indicator closing existing collection center)
$\sum$ containers served from collection center to recovery center $\leq$ annual capacity of potential recovery center * indicator of opening potential recovery center
$\sum$ containers served from collection center to recovery center $\leq$ annual expansion capacity of existing recovery center * indicator expansing existing recovery center + annual capacity of existing recovery center
$\sum$ containers served from collection center to recovery center $\leq$ annual capacity of existing recovery center * (1 - indicator closing existing recovery center)

rate equations:

$\sum$ containers served from collection centers to recovery centers = $(1-\alpha-\beta)$ * $\sum$ containers served from customers to collection center
$\sum$ containers served from recovery centers to material suppliers = $\mu * (1-\alpha-\beta)$ * $\sum$ containers served from customers to collection center
$\sum$ containers served from recovery centers to disposal centers = $(1-\mu-\lambda)* (1-\alpha-\beta)$* $\sum$ containers served from customers to collection center
$\sum$ containers served from recovery centers to refineries = $\lambda * (1-\alpha-\beta)$* $\sum$ containers served from customers to collection center
$\sum$ containers served from collection centers to disposals = α* $\sum$ containers served from customers to collection center
$\sum$ containers served from collection centers to refineries = β * $\sum$ containers served from customers to collection center

center quantity constraints:
$\sum$ indicator opening potential collection center - $\sum$ indicator closing existing collection center + quantity of existing collection center $\leq$ defined number of total collection center
$\sum$ indicator opening potential recovery center - $\sum$ indicator closing existing recovery center + quantity of existing recovery center $\leq$ defined number of total recovery center
all variables ≥ 0 and integer; all indicators $\in \{0,1\}$

After development of the model, it is necessary to gather available data regarding the existing and potential centers and their locations, number of product types, opening/closing/expanding costs, variable costs, capacity of centers, capacity of expansion, distribution rates of materials, quantity of existing centers, distance between centers and total product return amount for generation a real case based application or numerical study. Needless to repeat that total return amount is forecasted according to decision approach method stated at Stage 1. At the end of gathering data, the model is optimized and sensitivity analysis is done.

Graphical representation of steps of hybrid methodological framework for RLND can be seen at Figure 2.

CONCLUSION AND FUTURE WORKS

The design process of a reverse logistics network has hard nature. It requires solution of problems which are mostly based on uncertainty of the network. Therefore, many uncertain parameters such as quantity, quality and time of product returns have to be defined and made as more certain. In the mixed integer network design, uncertainty is commonly considered by scenario analysis. It is also clear from the literature that besides scenario analysis, stochastic programming is used for dealing with uncertainty and no attempt was made for solving uncertainty problems by using decision making approaches. One of the major drawbacks of these kind of studies is that they do not adequately address the uncertainty directly. Discovering methodology that combines RLND models and decision making on product return uncertainty becomes a daunting task. This paper is prepared for developing a framework including forecasting total product return as close as real, and optimizing the model that considers forecasted value.

The benefit of this framework is providing time advantage to firm managers and researchers at planning phase of a reverse logistics network design. Besides, conducting this type of analysis provides a new viewpoint different from scenario analysis/stochastic programming and a holistic approach for network designing in reverse logistics and being alert in identifying and resolving problems before they happen. In the future, we aim to conduct this model in a real case. Furthermore, other forecasting methods can be used and compared with ANN.

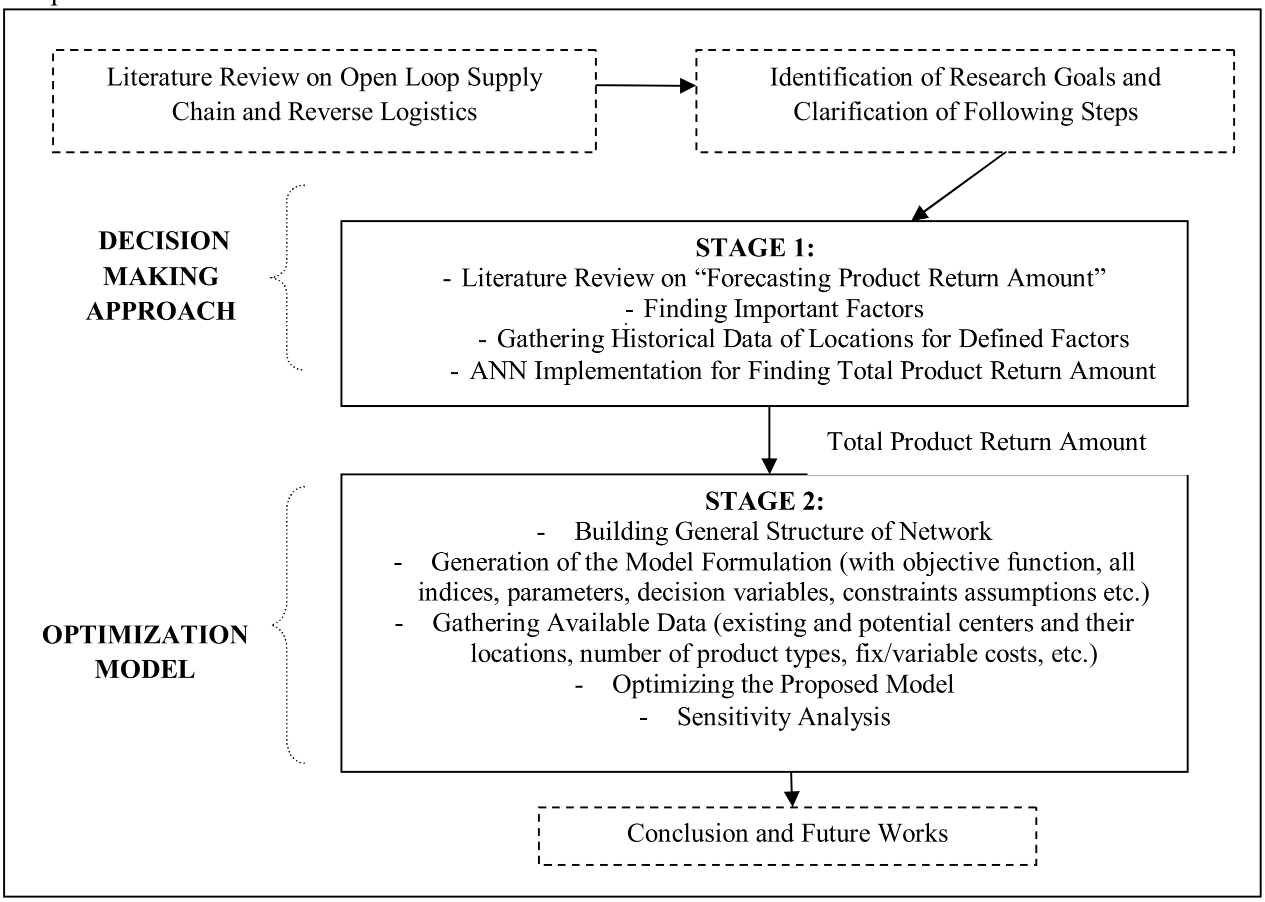

FIGURE 2
Steps of Hybrid Methodological Framework For RLND

REFERENCES

[1] De Brito, M.P. and Dekker, R., 2004. “A Framework for Reverse Logistics”. In: Dekker, R., Inderfurth, K., van Wassenhove, L.N., Fleischmann, M. (eds), “Reverse Logistics: Quantitative Models for Closed-Loop Supply Chains”. Springer-Verlag. Berlin Heidelberg New York

[2] Fleischmann, M., Krikke, H.R., Dekker, R. and Flapper, S.D.P., 2000, “A characterisation of logistics networks for product recovery”, Omega, 28-6, 653-666

[3] Dekker, R., Inderfurth, K., van Wassenhove, L.N. and Fleischmann, M., 2004. “Quantitative Models for Reverse Logistics Decision Making”. In: Dekker, R., Inderfurth, K., van Wassenhove, L.N., Fleischmann, M. (eds), “Reverse Logistics: Quantitative Models for Closed-Loop Supply Chains”. Springer-Verlag. Berlin Heidelberg New York

[4] Kusumastuti, R.D., Piplani, R.and Lim, G.H., 2004. “An Approach to Design Reverse Logistics Networks for Product Recovery”, Proceedings of International Engineering Management Conference, 1239-1243

[5] Zhou, G., Cao, Z., Cao, J. and Meng, Z., 2005. “A Genetic Algorithm Approach on Reverse Logistics Optimization for Product Return Distribution Network”, Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 267-272

[6] Listeş, O. and Dekker, R., 2005, “A stochastic approach to a case study for product recovery network design”, European Journal of Operational Research, 160, 268-87

[7] Salema, M.I.G., Barbosa-Povoa, A.P. and Novais, A.Q., 2007, “An optimization model for the design of a capacitated multi-product reverse logistics network with uncertainty”, European Journal of Operational Research, 179, 1063-1077

[8] Listeş, O., 2007, “A generic stochastic model for supply-and-return network design”, Computers & Operations Research, 34, 417-442

[9] Wang, X. and Zhao, L., 2009. “Network Design of Reverse Logistics Intergrated With Forward Logictics”, Proceedings of Asia-Pacific Power and Energy Engineering Conference

[10] Lee, D.H. and Dong, M., 2009, “Dynamic network design for reverse logistics operations under uncertainty”, Transportation Research, Part E, 45, 61-71

[11] El Sayed, M., Afia, N. and El-Kharbotly, A., 2010, “A stochastic model for forward-reverse logistics network design under risk”, Computers & Industrial Engineering, 58, 423-431

[12] Chen,Q. and Gu, Q., 2007. “Analysis of Quantity Uncertainty of Returns on Remufacturing Logistic Network Using a Stochastic Programming Model”, Proceedings of IEEE International Conference on Control and Automation, 3073-3077

[13] Chu, L.K., Shi, Y., Lin, S., Sculli, D., Ni, J., 2010, “Fuzzy chance-constrained programming model for a multi-echelon reverse logistics network for household appliances”, Journal of the Operational Research Society, 61, 551 - 560

[14] Pishvaee, M.S., Jolai, F. and Razmi, J., 2010, “A stochastic optimization model for integrated forward/reverse logistics network design”, Journal of Manufacturing Systems, 28(4), 107-114

[15] Chen, Y., Liu, D., Mao, H. and Tian, Y., 2008. “Uncertain Programming of the Distribution/Recovery Center in Forward/Reverse Hybrid Logistics System”, Proceedings of IEEE International Conference on Service Operations and Logistics, and Informatics, 3057-3062

[16] Rogers, D.S., and Tibben-Lembke, R.S., 1999. “Going Backwards: Reverse Logistics Trends and Practices”. Reverse Logistics Executive Council. Pittsburgh, PA

[17] Kahraman S., Gunaydin O., Alber M. and Fener M., 2009, “Evaluating the strength and deformability properties of misis fault breccia using artificial neural networks”, Expert Systems with Applications, 36, 6874–6878

[18] Gupta, P. and Sinha, N. K., 1999, “An improved approach for nonlinear system identification using neural networks”, Journal of the Franklin Institute, 336(4), 721-734

[19] Johnson, J. and Picton, P., 1995, “Mechatronics: Designing Intelligent Machines, Concepts in Artificial Intelligence’, Vol 2, Butterworth-Heinemann

[20] Koskivaara E., 2004, “Neural networks in analytical review procedures”, Managerial Auditing Journal,19(2), 191–223

[21] Koster, R., De Brito, M., and Van de Vandel, M., 2002, “Return handling: an exploratory study with nine retailer warehouses”, International Journal of Retail & Distribution Management, 30(8), 407- 421

[22] Hess, J.D. and Mayhew, G.E., 1997, “Modeling Merchandise return in direct marketing”, Journal of Direct Marketing, 11(2), 20– 35

[23] Tibben-Lembke, R. S., 2002, “Life after death: reverse logistics and the product life-cyle”, International Journal of Physical Distribution & Logistics Management, 32(3), 223-244

[24] Östlin, J., Sundin E., and Björkman M., 2009, “Product life-cycle implications for remanufacturing strategies”, Journal of Cleaner Production, 17,999–1009

[25] Mukhopadhyay, S. K., and Setoputro, R., 2004, “Reverse logistics in e-business optimal price and return policy”, International Journal of Physical Distribution & Logistics Management, 34(1), 70-88

[26] Klausner, M. and Hendrickson, C., 2000, “Reverse-logistics strategy for product take-back”, Interfaces, 30(3), 156–165

[27] De Brito, M.P., 2004, "Managing Reverse Logistics or Reversing Logistics Management?". Erasmus University Lecture Notes, Rotterdam
[28] Vlachos, D. and Dekker, R., 2003, "Return handling options and order quantities for single period products", European Journal of Operational Research , 151, 38–52
[29] Marx-Gomez, J., Rautenstrauch, C., Nürnberger, A., and Kruse, R., 2002, "Neuro fuzzy approach to forecast returns of scrapped products recycling and remanufacturing", Knowledge Based Systems, 15,119-128
[30] Thierry, M.; Salomon, M., Van Nunen, J. and Van Wassenhove, L., 1995, "Strategic issues in product recovery management", California Management Review- ABI/INFORM Global, 37, 2, 114.

REVERSE LOGISTICS NETWORK DESIGN MODEL FOR RECYCLING AND RETREADING PROCESS OF USED TIRES

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Abstract — *Significant environmental problems have been experienced due to the growth in the amount of used tires every year. In addition, both remanufacturing and recycling options for end of life tires have becoming crucial issues nowadays because of the difficulty related to the dissociation of these tires in the environment and the economic benefits of material and energy recycling. In this respect, effective collection, storage, recycle and proper disposal of these end of life tires without damaging the environment require designing an efficient reverse logistics network. Based on this motivation, a mixed integer linear programming model is developed for a closed loop supply chain of end of life tires. Alternative recovery options such as remanufacturing and recycling are considered simultaneously in the model. The main objective of the model is developing a multi-echelon, multi-period, multi-product logistics network design model in order to decide the physical locations of distribution centers, centralized return points and the retreading companies. The model is applied to an illustrative case and solved using LINGO 9.0 optimization solver. In order to obtain the optimum profit values that is targeted, major factors such as unit selling price of the retreated tires, probability of the entrance of worn tires to retreading process and the other factors within the profit function etc. are examined with the help of Taguchi design of experiment technique.*

Keywords **—** *Network design, recycling, reverse logistics, tire retreading*

INTRODUCTION

Since the high amounts of used tires are disposed all over the world, several recovery alternatives have become vital issues. Thus in this paper, we examined different recovery options such as remanufacturing and recycling simultaneously to recover the value in the scrap tire. Whitin the scope of remanufacturing, tire retreading process is discussed. As a result of a specified using period of a tire, the tread become useless. On the other hand, the casing may be available for reusing. So, tire retreading can be performed and defined as follows: process of replacing the worn rubber outer layer of a tire with a new rubber layer. Retreading process provides saving up to %80 of the material cost of a tire [1]. Moreover, tire manufacturers may increase the volume of retreadable tires by incresing the amount of steel cord in the casing [2].

According to [3], scrap tires can be used in four alternative ways: direct reuse, retreading, recycling, and energy recovery. A small fraction of the used tires can be resold in the secondary markets. When the used tire is in a good condition, retreading process usually can be performed more than once. Although, the retreaded tires produce almost the same mileage as compared with newly produced tires, they are sold for %30 to %50 discounts in the secondary markets [2-4]. Since, tires have a high energy content compared to other types of solid waste and fossil fuel, they can be used for electricity generation by incineration and as a fuel substitute in thermoelectric plants and cement plants [2-4].

Rubber, steel and fibers are all separated in the material recycling phase and tire granulate can be reused in the new tire production or other applications such as in road paving, sports fields, roofing materials, footwear, automobile parts, etc. [3].

Sasikumar et al. [2] formulated a mixed integer nonlinear programming model for maximizing the profit of a multi-echelon, multi-period reverse logistics network with a real life case of truck tire remanufacturing.

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At the end of their study, it is emphasized that although the remanufactured tires are sold with %30 to %50 discounts, profit improvements can be obtained both for customers and remanufactured companies.

Demirel and Gokcen [5] developed a mixed integer linear programming model for a multi-echelon, multi-product closed-loop supply chain considering remanufacturing case.

Subulan and Tasan [6] proposed a medium-term planning model for a lead/acid battery closed loop supply chain considered recycling as a recovery alternative.

In this study, we developed a mixed integer linear programming model for a closed loop supply chain of end of life tires while taken into account different recovery alternatives based on [2]. The purpose of this study is to develop a multi-echelon, multi-product, multi-material and multi-period network design model for an end-of-life tire closed-loop supply chain to maximize the profit of the overall system.

PROBLEM DESCRIPTION AND MODEL DEVELOPMENT

In the forward supply chain, different types of newly produced tires are transported to the distribution centers to meet the tire dealers' demands. Also, retreaded tires are shipped from the several retreading companies to distribution centers to meet the secondary market requirements. Storage of the both newly produced and retreaded tires are allowed in the distribution centers.

In the reverse supply chain, used tires are collected from the end users at their end of life while the end user replace it by a new one in the tire dealer. On the other hand, there is a reverse flow of used tires through initial collection centers. All of the returned tires are consolidated at the centralized return points. Used tires which are in appropriate condition for retreading process are transported to retreading companies directly and the other tires can be evaluated by different alternatives such as energy recovery, material recycling, landfilling and incineration according to specified rates.

There are two different options for the new tire plants to supply materials such as rubber, steel and fiber. One is purchasing them from external suppliers and the other one is the acquiring them by recycling way from the recycling facilities. Shortages are not allowable and cost parameters at all stages of the closed-loop supply chain network do not change throughout the time periods. Transportation times between the stages are not taken into account. The tire dealers' demands are known and deterministic over the time periods. Quantity of returned tires from a given tire dealer is the fraction of total demand of that tire dealer and amounts of used tires returned via initial collection centers in each time periods are also known. The configuration of the system discussed above can be shown as in the fig. 1.

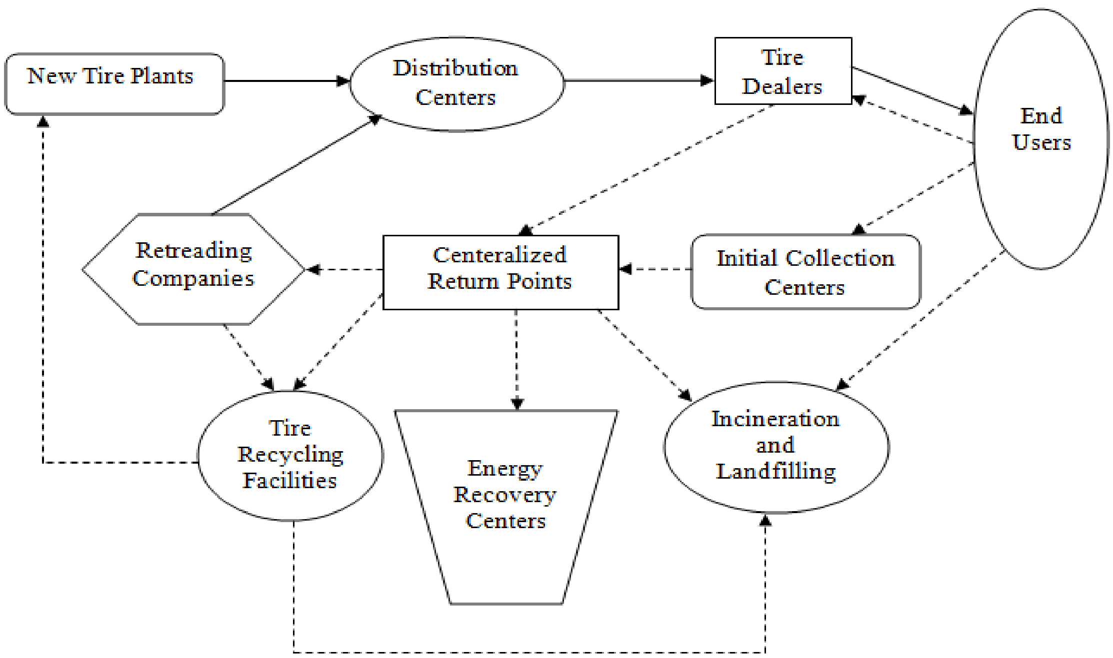

FIGURE. 1
Closed-loop Supply Chain Network Representation of End of Life Tires

Indices and Sets

The notation used in the model are as follows. *p,* index for tire type (such as car tire, truck tire), *p'* index for retreaded tire type, *c* index for material type, *i* index for new tire plants, *d* index for distribution centers, *r* index for tire dealers, *j* index for initial collection centers, *k* index for centralized return points, *l* index for tire retreading companies, *n* index for tire recycling facilities, *m* index for cement plants or thermoelectric plants as energy recovery centers, *t* index for time periods**.**

Model Parameters and Decision Variables

Parameters;

SL_p	unit selling price of the newly produced *p*-type tire to a tire dealer
$SL_{p'}$	unit selling price of the retreaded *p*-type tire to a tire dealer for secondary markets
SSL_p	unit selling price of used *p*-type tire to the recycling facilities
$SSLL_p$	unit selling price of used p-type tire to the cement or thermoelectric plants
F_l	fixed set-up cost of the retreading company *l*
F_d	fixed set-up cost of the distribution center *d*
F_k	fixed set-up cost of the centralized return point *k*
PC_{pi}	production cost of per unit of tire type-*p* in new tire plant *i*
TC_p	transportation cost of one unit of tire type-*p* per kilometer
$TC_{p'}$	transportation cost of one unit of retreaded tire type- *p'* per kilometer
TC_c	transportation cost of one kg. of material *c* per kilometer
α_p	returned fraction of the demand from tire dealers for tire type-*p*
B_p	fraction of used tire type-*p* satisfying the quality specifications for retreading process
B	fraction of used tires shipped from centralized return points to the cement plants
γ	fraction of used tires shipped from centralized return points to the recycling plants
δ	fraction of used tires shipped from centralized return points to the disposal sites
θ_{pl}	recovery fraction for tire type-*p* at retreading company *l*
REC_{pl}	remanufacturing cost per unit of used tire type-p in retreading company l
REC_{pn}	recycling cost per unit of used tire type-*p* in recycling facility *n*
PUC_{ci}	purchasing cost per kg of material *c* for new tire plant *i*
CC_p	collection cost per unit of tire type-*p* through the initial collection points
D_{prt}	demand of tire dealer *r* for newly produced tire type- *p* in period *t*
$D_{p'rt}$	demand of tire dealer *r* for retreaded tire type-*p'* in period *t*
R_{pjt}	returned volume of each type of used tires to the initial collection center *j* in time period *t*
IC_{pi}	inventory holding cost of per unit of newly produced tire type-*p* in new tire plant *i*
IC_{pi}	inventory holding cost of per unit of both newly produced and retreaded tire type-*p* in distribution center *d*
IC_{pk}	inventory holding cost of per unit of scrap tire type-*p* in centralized return point *k*
IC_{ci}	inventory holding cost of per kg of material *c* in new tire plant *i*
$DISC_p$	disposal cost per unit of used tire type-*p*
W_p	weight of the used tire type-*p*
a_{cp}	percentage of contribution of material type-*c* for the used tire type-*p*
CAP_{pi}	production capacity of tire type-*p* in new tire plant *i*
CAP_d	capacity of distribution center *d* for both newly produced and retreaded tires
CAP_{pk}	capacity of centralized return point *k* for used tire type-*p*
CAP_{pn}	recycling capacity of recycling facility *n* for used tire type-*p*
CAP_{pl}	remanufacturing capacity of retreading company *l* for used tire type-*p*
d_{xy}	the distance between the point *x* and point *y* in the network

Decision variables;

y_l	the indicator of opening retreading company *l*
y_d	the indicator of opening distribution center *d*
y_k	the indicator of opening centralized return point *k*
y_{jkt}	1, if initial collection center *j* is allocated to centralized return point *k* in period *t*; 0, otherwise

Q_{pit}	number of units of newly produced tire type-p manufactured in new tire plant i during period t
Q_{cit}	amounts of material type-c purchased from an external supplier to new tire plant i in time period t
x_{pidt}	quantity of tire type-p shipped to distribution center d from new tire plant i in period t
x_{pdrt}	quantity of newly produced tire type-p shipped to tire dealer r from distribution center d in period t
$x_{p'drt}$	quantity of retreaded tire type-p' shipped to tire dealer r from distribution center d in period t
x_{pdrt}	quantity of newly produced tire type-p shipped to tire dealer r from distribution center d in period t
x_{prkt}	quantity of used tire type-p shipped to centralized return point k from tire dealer r in period t
x_{pkmt}	quantity of used tire type-p shipped to cement plant m from centralized return point k in period t
x_{pknt}	quantity of used tire type-p shipped to tire recycling facility n from centralized return point k in period t
x_{pklt}	quantity of used tire type-p shipped to retreading company l for remanufacturing option from centralized return point k in period t
$x_{p'ldt}$	quantity of retreaded tire type-p' shipped to distribution center d from retreading company l to meet secondary market's demand in period t
x_{plnt}	quantity of used tire type-p shipped to tire recycling facility n from retreading company l for recycling option in period t
x_{cnit}	quantity of material type-c shipped to new tire plant i from tire recycling facility n in period t
I_{pit}	inventory level of newly produced tire type-p at new tire plant i in time period t
I_{cit}	inventory level of material type-c at new tire plant i in time period t
I_{pdt}	inventory level of newly produced tire type-p at distribution center d in time period t
$I_{p'dt}$	inventory level of retreaded tire type-p' at distribution center d in time period t
I_{pkt}	inventory level of used tire type-p at centralized return point k in time period t

Mathematical Formulation

By using the indices, parameters and decision variables defined above, the objective function of the multi-echelon, multi product, multi-material and multi-period reverse logistics network design problem which considers recovery options such as remanufacturing and recycling is given by the following equation. Maximization of the total profit of the overall closed-loop supply chain network ;

Maximize R-C (1)

(i) Revenue;

$$R=\sum_{p}^{P}\sum_{d}^{D}\sum_{r}^{R}\sum_{t}^{T}x_{pdrt}\,.\,SL_p+\sum_{p'}^{P'}\sum_{d}^{D}\sum_{r}^{R}\sum_{t}^{T}x_{p'drt}\,.\,SL_{p'}+\sum_{p}^{P}\sum_{l}^{L}\sum_{n}^{N}\sum_{k}^{K}\sum_{t}^{T}(x_{pknt}+x_{plnt}).SSL_p$$
$$+\sum_{p}^{P}\sum_{k}^{K}\sum_{m}^{M}\sum_{t}^{T}x_{pkmt}\,.\,SSLL_p \qquad (2)$$

(ii) Cost;

$$C=\sum_{l}^{L}F_l\,.\,y_l+\sum_{d}^{D}F_d\,.\,y_d+\sum_{k}^{K}F_k.\,y_k+\sum_{p}^{P}\sum_{i}^{I}\sum_{t}^{T}Q_{pit}\,.\,PC_{pi}+\sum_{p}^{P}\sum_{i}^{I}\sum_{d}^{D}\sum_{t}^{T}TC_p\,.\,x_{pidt}.\,d_{id}$$
$$+\sum_{p}^{P}\sum_{d}^{D}\sum_{r}^{R}\sum_{t}^{T}TC_p\,.\,x_{pdrt}.\,d_{dr}+\sum_{p'}^{P'}\sum_{d}^{D}\sum_{r}^{R}\sum_{t}^{T}TC_{p'}\,.\,x_{p'drt}.\,d_{id}+\sum_{p}^{P}\sum_{r}^{R}\sum_{k}^{K}\sum_{t}^{T}TC_p\,.\,x_{prkt}.\,d_{rk}$$
$$+\sum_{p}^{P}\sum_{j}^{J}\sum_{k}^{K}\sum_{t}^{T}TC_p\,.\,R_{pjt}.\,y_{jkt}d_{jk}+\sum_{p}^{P}\sum_{k}^{K}\sum_{m}^{M}\sum_{t}^{T}TC_p\,.\,x_{pkmt}.\,d_{km}$$
$$+\sum_{p}^{P}\sum_{k}^{K}\sum_{n}^{N}\sum_{t}^{T}TC_p\,.\,x_{pknt}.\,d_{kn}+\sum_{p}^{P}\sum_{k}^{K}\sum_{l}^{L}\sum_{t}^{T}TC_p\,.\,x_{pklt}.\,d_{kl}+\sum_{p'}^{P'}\sum_{l}^{L}\sum_{d}^{D}\sum_{t}^{T}TC_{p'}\,.\,x_{p'ldt}.\,d_{ld}$$
$$+\sum_{p}^{P}\sum_{l}^{L}\sum_{n}^{N}\sum_{t}^{T}TC_p\,.\,x_{plnt}.\,d_{ln}+\sum_{c}^{C}\sum_{n}^{N}\sum_{i}^{I}\sum_{t}^{T}TC_c\,.\,x_{cnit}.\,d_{ni}$$

$$+\sum_{p}^{P}\sum_{k}^{K}\sum_{l}^{L}\sum_{t}^{T}\theta_{pl}\,.\,x_{pklt}.REC_{pl}+\sum_{p}^{P}\sum_{k}^{K}\sum_{l}^{L}\sum_{n}^{N}\sum_{t}^{T}(x_{pknt}+x_{plnt}).B_p.REC_{pn}+\sum_{c}^{C}\sum_{i}^{I}\sum_{t}^{T}Q_{cit}.PUC_{ci}$$
$$+\sum_{p}^{P}\sum_{j}^{J}\sum_{t}^{T}R_{pjt}\,.\,CC_p+\sum_{p}^{P}\sum_{i}^{I}\sum_{t}^{T}I_{pit}\,.\,IC_{pi}+\sum_{p}^{P}\sum_{p'}^{P'}\sum_{d}^{D}\sum_{t}^{T}(I_{pdt}+I_{p'dt}).IC_{pd}$$
$$+\sum_{p}^{P}\sum_{k}^{K}\sum_{t}^{T}I_{pkt}\,.\,IC_{pk}+\sum_{c}^{C}\sum_{i}^{I}\sum_{t}^{T}I_{cit}\,.\,IC_{ci}+\sum_{p}^{P}\sum_{d}^{D}\sum_{r}^{R}\sum_{t}^{T}(1-\alpha_p).x_{pdrt}.DISC_p$$
$$+\sum_{p}^{P}\sum_{k}^{K}\sum_{l}^{L}\sum_{n}^{N}\sum_{t}^{T}(x_{pknt}+x_{plnt}).\left(1-B_p\right).DISC_p+\sum_{p}^{P}\sum_{r}^{R}\sum_{j}^{J}\sum_{k}^{K}\sum_{t}^{T}(x_{prkt}+R_{pjt}.y_{jkt}).\delta.DISC_p \qquad (3)$$

Subject to;

$$Q_{pit}\leq Cap_{pi} \qquad \forall p,\forall i,\forall t \qquad (4)$$

$$I_{pit}=I_{pit-1}+Q_{pit}-\sum_{d}^{D}x_{pidt} \qquad \forall p,\forall i,\forall t \qquad (5)$$

$$I_{cit}=I_{cit-1}+Q_{cit}+\sum_{n}^{N}x_{cnit}-\sum_{p}^{P}Q_{pit}\,.\,W_p.a_{cp} \qquad \forall c,\forall i,\forall t \qquad (6)$$

$$\sum_{d}^{D}x_{pdrt}=D_{prt} \qquad \forall p,\forall r,\forall t \qquad (7)$$

$$\sum_{d}^{D}x_{p\prime drt}=D_{p\prime rt} \qquad \forall p',\forall r,\forall t \qquad (8)$$

$$I_{pdt}=I_{pdt-1}+\sum_{i}^{I}x_{pidt}-\sum_{r}^{R}x_{pdrt} \qquad \forall p,\forall d,\forall t \qquad (9)$$

$$I_{p\prime dt}=I_{p'dt-1}+\sum_{l}^{L}x_{p\prime ldt}-\sum_{r}^{R}x_{p\prime drt} \qquad \forall p',\forall d,\forall t \qquad (10)$$

$$\sum_{k}^{K}x_{prkt}=\ \alpha_p.\sum_{d}^{D}x_{pdrt} \qquad \forall p,\forall r,\forall t \qquad (11)$$

$$\sum_{k}^{K}y_{jkt}=1 \qquad \forall j,\forall t \qquad (12)$$

$$\left\{\sum_{r}^{R}x_{prkt}+\sum_{j}^{J}R_{pjt}.y_{jkt}\right\}.\beta=\sum_{m}^{M}x_{pkmt} \qquad \forall p,\forall k,\forall t \qquad (13)$$

$$\left\{\sum_{r}^{R}x_{prkt}+\sum_{j}^{J}R_{pjt}.y_{jkt}\right\}.\gamma=\sum_{n}^{N}x_{pknt} \qquad \forall p,\forall k,\forall t \qquad (14)$$

$$I_{pkt}=I_{pkt-1}+\sum_{r}^{R}x_{prkt}+\sum_{j}^{J}R_{pjt}.y_{jkt}-\sum_{l}^{L}x_{pklt}$$
$$-(\delta+\beta+\gamma).\left\{\sum_{r}^{R}x_{prkt}+\sum_{j}^{J}R_{pjt}.y_{jkt}\right\} \quad \forall p,\forall k,\forall t \qquad (15)$$

$$\sum_{d}^{D}x_{p\prime ldt}=\ \theta_{pl}.\sum_{k}^{K}x_{pklt} \qquad \forall p,\forall p',\forall l,\forall t \qquad (16)$$

$$\sum_{n}^{N}x_{plnt}=\left(1-\theta_{pl}\right).\sum_{k}^{K}x_{pklt} \qquad \forall p,\forall l,\forall t \qquad (17)$$

$$\sum_{k}^{K} x_{pklt} \le Cap_{pl}.y_l \qquad \forall p, \forall l, \forall t \tag{18}$$

$$\sum_{p}^{P}\sum_{i}^{I} x_{pidt} + \sum_{p'}^{P'}\sum_{l}^{L} x_{p'ldt} \le Cap_d.y_d \qquad \forall d, \forall t \tag{19}$$

$$\sum_{r}^{R} x_{prkt} + \sum_{j}^{J} R_{pjt}.y_{jkt} \le Cap_{pk}.y_k \qquad \forall p, \forall k, \forall t \tag{20}$$

$$\sum_{k}^{K} x_{pknt} + \sum_{l}^{L} x_{plnt} \le Cap_{pn} \qquad \forall p, \forall n, \forall t \tag{21}$$

$$\sum_{i}^{I} x_{cnit} = \sum_{p}^{P}\sum_{k}^{K} x_{pknt}.B_p.W_p.a_{cp} + \sum_{p}^{P}\sum_{l}^{L} x_{plnt}.B_p.W_p.a_{cp} \qquad \forall c, \forall n, \forall t \tag{22}$$

$$Q_{cit} + \sum_{n}^{N} x_{cnit} \le Cap_{ci} \qquad \forall c, \forall i, \forall t \tag{23}$$

$$x_{prkt} + R_{pjt}.y_{jkt} \le M.y_k \qquad \forall p, \forall r, \forall j, \forall k, \forall t \tag{24}$$

$$x_{pklt} \le M.y_l \qquad \forall p, \forall k, \forall l, \forall t \tag{25}$$

$$x_{pidt} + x_{p'ldt} \le M.y_d \qquad \forall p, \forall p', \forall i, \forall d, \forall l, \forall t \tag{26}$$

$$Q_{pit},\ x_{pidt}, x_{pdrt},\ x_{pklt}, x_{p'ldt},\ x_{p'drt},\ x_{plnt},\ Q_{cit}\ \ \textit{are integer} \tag{27}$$

$$y_l,\ y_d, y_k, y_{jkt} \ \in (0,1)$$

$$\textit{All other variables are continuous.} \tag{28}$$

The objective of the model shown in (1) is to maximize the total profit of the system. Constraint (4) ensures that the production quantity of each tire type during each time period must not exceed the production capacity of the new tire plant. According to constraints (5) and (6), one can calculate the inventory levels of each newly produced tire type-p and each material type-c at each new tire plant in each time period, respectively. The beginning inventory levels are assumed to be zero. Constraints (7) and (8) ensures that demands for each newly produced tire type and retreaded tire type of each tire dealer in each time period must fully be met. According to the constraints (9) and (10), one can calculate the inventory level of each newly produced tire type-p and retreaded tire type-p' at each distribution center in each time period. The beginning inventory levels are assumed to be zero. Constraint (11) is the flow constraint balancing the quantities of returned tire. Constraint (12) ensures that an initial collection center is assigned to a single centralized return point in each time period. Constraints (13) and (14) represent the amounts of shipments from the centralized return points for recycling and energy recovery. Constraint (15) is inventory equation for used tires in centralized return points. Constraints (16) and (17) are conservation of flow constraints for retreading companies. Constraints (18), (19), (20) and (21) are capacity constraints for retreading companies, distribution centers, centralized return points and tire recycling facilities, respectively. Constraint (22) is the conservation of flowconstraint for the tire recycling facilities. Constraint (23) is the existing capacity constraint of new tire plants for each material type. Constraints (24), (25) and (26) make sure that a centralized return point, retrading company and distribution center can be established if there is an incoming flow to these candidate locations. Constraint (27) maintains the non-negativity of decision variables. Constraint (28) represents the binary variables.

APPLICATION OF THE MODEL TO AN ILLUSTRATIVE EXAMPLE

Some of the used datas for testing the validation of the model are as follows:

- Number of new and retreaded tire types = 2
- Number of material types = 3
- Number of new tire plants = 2
- Number of distribution centers = 3
- Number of tire dealers = 4
- Number of initial collection centers = 2
- Number of centralized return points = 3
- Number of tire retreading companies = 2
- Number of tire recyclig facilities = 2
- Number of energy recovery centers such as cement plants or thermoelectric plants = 3
- Number of time periods = 4

Opening cost of potential retreading companies are determined as $20000, $25000 respectively. Fixed set up costs for distribution centers and centralized return centers are set to be $10000, $7500, $9000 and $8000, $6000, $10000, respectively. Other used datas are as seen in table 1 and 2.

TABLE 1
Average of some important ratios used in the model

Return rate (α_p)	**Acception Rate (B_P)**	**Energy recovery (β)**	**Recycling rate (γ)**	**Disposal rate (δ)**	**Recovery fraction (θ)**
0.8	0.7	0.4	0.15	0.05	0.65

TABLE 2
Demand information for newly produced and retreaded tires

Demand of tire dealers in each time period for new car tires	**Demand of tire dealers in each time period for retreaded car tires**	**Demand of tire dealers in each time period for new truck tires**	**Demand of tire dealers in each time period for retreaded truck tires**
7500	500	14500	1000
10000	750	12000	500
14500	1000	7000	450
10000	600	10000	680
15000	400	13500	720
12000	650	11500	750
8000	400	15000	830
9500	570	11500	860
15000	900	10000	680
10000	250	9500	700
14000	650	17000	400
12500	680	9500	500
7500	750	13000	550
9500	720	15000	680
14000	850	12500	720
11000	900	8500	750

EXPERIMENTAL DESIGN AND ANALYSIS

Since the sensitivity analysis can not not applied directly to the mixed integer programming models and the results are not significant, Taguchi design of experiment approach is used in order to reach the optimum profit values that is targeted and examine the effects of some parameters' values on the total revenue.

TABLE 3
Parameter Levels Used in The Taguchi Design

	Return rate	**Unit selling price of the retreated tires**	**Acception rate**	**Retreading capacity**
Level 1 (min)	0.6	$20	0.5	35000 units
Level 2 (max)	0.9	$60	0.75	60000 units

Because of the total degrees of freedom is equal to 4, we can use the L8 orthogonal design matrix which has least experiment number for 4-factors, 2-levels Taguchi design. Total revenue is determined as response variable for the Taguchi technique. Experimental results (value of response variable) obtained for each run were shown in the table 4.

TABLE 4
Controllable Parameters

Exp. no	**Return rate**	**Unit selling price of the retreated tires**	**Acception rate**	**Retreading capacity**	**Total profit**
1	0.6	20	0.5	35000	90061690
2	0.6	20	0.75	60000	89047590
3	0.6	60	0.5	60000	93471480
4	0.6	60	0.75	35000	92198670
5	0.9	20	0.5	60000	89816470
6	0.9	20	0.75	35000	88234530
7	0.9	60	0.5	35000	94527990
8	0.9	60	0.75	60000	92171270

Experiments are carried out using parameters defined at different levels and solution model generated in LINGO 9.0 program. For the evaluation of experiment results and effects of related factors, Taguchi's signal/noise ratios,analysis of means graphs and interaction graphs are used and the experiments are carried out in MINITAB 14 according to Taguchi L8 scheme.

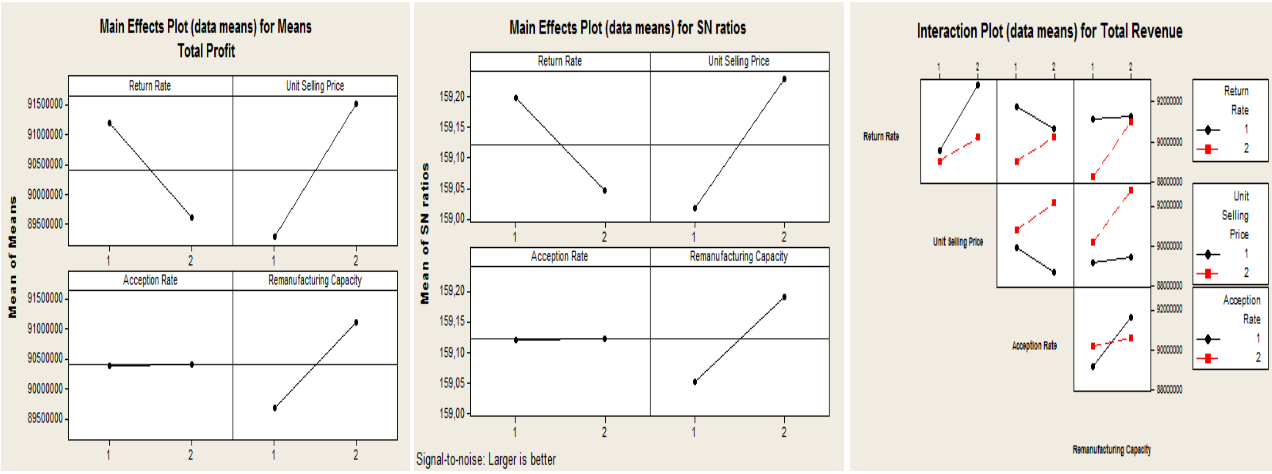

FIGURE. 4, 5 and 6
The Main Factor Effects Obtained From Statistical Analysis of Means and Signal to Noise Ratios For Total Profit, Respectively

According to fig. 4 and 5, since the return rate, unit selling price for retreaded tires and remanufacturing capacity of retreading companies cause significant variability on response variable, these factors are important for the performance criterion. For instance, when the returned rate is equal to the minimum level (0.6), unit selling price is equal to the maximum level ($60) and remanufacturing capacity is equal to maximum level (60000 units) the total profit of the closed-loop supply chain will increase. Acception rate has not an important effect on the total profit. In this study, larger is better category was selected while calculating the S/N ratios for total closed-loop supply chain profit. Because, objective of this study is maximizing the total profit value. In the result of all these S/N calculations, the highest signal/value ratio value refers to the best experiment results.

It is obviously seen that, the main factor effects with analysis of means graph and the S/N ratios supported the same optimal factor levels. As a result, main factor levels returned rate-1, unit selling price-2, remanufacturing capacity -2 and acception rate 1 or 2 are observed as the factor levels increasing the total profit of the closed-loop supply chain.

When we examine the interactions between each factor which affect the total profit of the reverse logistics network, there is a strong interaction between acception rate and remanufacturing capacity of the retreading companies. Since the interaction lines do not intersect for the other factors, there is no interaction or weak interaction between these factors.

CONCLUSION AND FUTURE WORKS

In this paper, we developed a multi echelon, multi product and multi period network design model for an end-of-life tire closed-loop supply while taken into account the different recovery alternatives simultaneously, recycling and remanufacturing. The proposed model is illustrated and tested through an example by using a set of fictitious data.

At the end of the study, Taguchi design of experiment technique is used to examine the effects of some parameters on the total profit of the closed-loop supply chain. According to result of experiments, it is determined that return rate, unit selling price of retreaded tires and capacity of retreading companies have important effects on the total profit of the system.

For future research, the multi-objective model which takes into account the environmental aspects of this problem may be developed. Also, the uncertainty related to the demand of new and retreaded tires and return quantities of the end of life tires may be overcome with the scenario based approach.

REFERENCES

[1] Debo, G., Wassenhove, V. 2005, "Tire recovery: the RetreadCo case" Managing Closed-Loop Supply Chains, springer book series, part 5, 119-128.
[2] Sasikumar, P., Kannan, G., Haq, A.N. 2010, "A multi-echelon reverse logistics network design for product recovery – a case of truck tire remanufacturing", The International Journal of Advanced Manufacturing Technology 49: 1223-1234.
[3] Panagiotidou, S., Tagaras, G. 2005, "End-of-life tire recovery: the Thessaloniki initiative", Managing Closed-Loop Supply Chains, springer book series, part 7, 183-193.
[4] Lebreton, B., Tuma, A. 2006, "A quantitative approach to assessing the profitability of car and truck tire remanufacturing", International Journal of Production Economics, 104: 639-652.
[5] Demirel, N.Ö., Gökçen, H. 2008, "A mixed integer programming model for remanufacturing in reverse logistics environment", International Journal of Advanced Manufacturing Technology, 3: 1197–1206.
[6] Subulan, K., Tasan, A.S. 2011, "A Medium Term Planning Model for a Lead/Acid Battery Closed-Loop Supply Chain", 12th International Symposıum on Econometrics Statistics and Operations Research, 229-238.

PRACTICES, POLICIES AND PERCEPTIONS OF VALUE RECOVERY FROM USED PRODUCTS: A COMPARISON BETWEEN SMEs AND LARGE ENTERPRISES

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Abstract *— The objective of this study is to understand if and how small and medium-sized enterprises (SMEs) differ from large enterprises in their perceptions regarding the question "why, how and how much should we engage in product recovery activities?" The main issues that are explored and compared between SMEs and large companies are: the extent of involvement in product recovery activities (PRA), the direct profitability of PRA, the most important specific drivers and barriers to the implementation of PRA and the future prospects of PRA. Data has been collected through a questionnaire-based survey of manufacturing companies in Greece and 327 valid responses were received. We present and discuss the results of the statistical analysis of these responses and arrive at several conclusions about the differences between SMEs and large companies in the implementation of recovery activities, the main drivers and obstacles for further development of such activities and their future prospects.*

Keywords —Business policy, Greece, Reverse logistics, Small and medium-size enterprises.

INTRODUCTION

Although concern for the environment has generated increased interest in product reuse, empirical studies describing the practices and strategies regarding recovery activities are sparse. The management of returned products and value recovery is the focus of the field of Reverse Logistics [1], which includes processes like collection, inspection, testing and recovery of products or components. The focus of this study is on the management of returned products and added value product recovery processes that extend the life span of a product or component, namely remanufacturing, refurbishing, repair, and cannibalization. In the remainder of this paper all these recovery processes will be collectively called Product Recovery Activities (PRA). Operational definitions of all types of PRA and other relevant terms can be found in [2], [3], [4].

The academic interest in PRA has been with steadily increasing in the past 15 years. Rubio et al. [5] note that 121 out of 186 published reverse logistics articles in 1995-2005 are based on the development of mathematical models, while during the same period only 9 of the 186 papers are classified as survey-based research. In one of the first publications shaping the area of Reverse Logistics Carter and Ellram [6] pointed out the lack of empirical studies. In the years that followed many other researchers underscored the need for more empirical research on various issues related to the extent of involvment of manufacturers in PRA, the profitability of PRA, the most important specific drivers, barriers and future prospects to the implementation of PRA. Atasu et al. [7] emphasize the need to go into the field and explore how industry is evolving and what are its pressing problems. Srivastava [8] argues that survey-based research is a necessity as its findings may explain current practices, critical issues and techniques used to manage the reverse logistics activities. Zhu et al. [9] call for survey-based research to explore why organizations do or do not implement typical PRA practices.

The motivation behind the research presented in this paper was to fill some of the existing gaps in the knowledge and understanding of PRA, especially with respect to the differences between small and medium-sized enterprises (SMEs) and large enterprises (LEs). In the rest of the paper we present the research methodology and the research results along with the main conclusions of this research.

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RESEARCH FRAMEWORK

Research Questions

The focus of this research is on the management of return products and value added product activities undertaken by manufacturing SMEs and large enterprises (LEs). This line of enquiry seems particularly relevant for several reasons: i) despite a growing body of literature on reverse logistics management [1], [10], [11], the understanding of PRA remains limited to this day [12]; ii) while from a manufacturing strategy point of view several studies investigate the main differences between SMEs and LEs [13], the differences between SMEs and LEs in the specific context of PRA remain an underinvestigated area of research; iii) size reflects distinctive organizational characteristics; size represents a proxy of slack and of availability of financial and non-financial resources [14]. According to Grando and Belvedere [13] SMEs perform worse than LEs mainly due to the lack of technical superiority, infrastructure and financial recourses. On the other hand, SMEs are known to be more innovative [15] and more flexible than LEs [13]. Hence, SMEs might manage their return products and might implement PRA differently than LEs. Therefore, it is interesting to find out whether and how SMEs and LEs differ in their perceptions and attitudes with respect to PRA. The specific research questions we pose are the following:

RQ1: Are there significant differences between SMEs and LEs with respect to the types of product recovery activities that are engaged in and the organization of returned products collection?

RQ2: Are there significant differences between SMEs and LEs in the factors motivating engagement in PRA?

RQ3: Are there significant differences between SMEs and LEs with respect to the direct profitability of PRA?

RQ4: Are there significant differences between SMEs and LEs in the main barriers and in the future prospects with respect to further development of PRA?

This research aims at obtaining documented answers to the above questions through an extensive questionnaire-based survey in the manufacturing sector. To our knowledge this is the first survey - based research that is reported in the academic literature and explores the differences between SMEs and LEs in the PRA domain. It is part of a larger empirical study of product recovery activities (PRA) in the Greek industry through detailed case studies [16] and questionnaire-based survey [17] and [18].

Research Design and Methodology

The main tool used in this research is a short questionnaire which was developed, tested and used in the first survey in 2004 [17]. The design of the questionnaire, its content validity and comprehensiveness were described in detail in [17]. The same questionnaire was used again following the same procedure in the second survey, which was conducted in 2007. In June 2007 the questionnaire was sent electronically to manufacturing companies that are active in Greece excluding small-size companies (with fewer than 10 employees). The list of companies was obtained from ICAP's Greek Financial Directory 2007 [19] volume 1: industry, which includes detailed listings of Greek manufacturing enterprises. To maximize the response rate one month after the first invitation the questionnaire was e-mailed again to all those companies that had not responded. After the necessary checks for completeness and consistency of the returned questionnaires, the total number of valid and usable responses was 327, representing a response rate of 11.9%, which is within the usual range for that type of survey [20]. Potential non-response bias was addressed indirectly by comparing the early responses (first mailing) to the later ones (second mailing), as suggested by [21] and applied by [22] among others. The results of the appropriate t-tests and X^2-tests show that there are no statistically significant differences between these two groups at significance levels of 0.1 or lower, suggesting that non-response bias is not a problem. The sample was also checked for representativeness with respect to industry sector. The chi-square goodness-of-fit test results show that the sectorial representation of the sample does not differ significantly from that observed in the population.

RESULTS AND DISCUSSION

General Characteristics

Table 1 presents the profile of the respondents with respect to size (number of employees). The total number of companies appearing in table 1 is 311 rather than 327 because 16 of the responses are anonymous. Table 1 shows that 273 out of 311 (87.8%) are SMEs and 38 out of 311 (12.2%) are LEs. Based on the analysis of the exploratory questions in the first part of the questionnaire we identified that 109 out of 311 responses come from manufacturing companies with no engagement in PRA. Thus the companies that are active in value recovery from collected used products are finally 202, representing a proportion of 65% in the sample.

TABLE 1
Sample Characteristics

Number of employees	Number of companies
10 to 49	165
50 to 249	108
250 to 500	21
more than 500	17

We use the notation L0 (PRA level 0) for companies not pursuing any PRA and we denote by L1 those companies that implement at least one product recovery option. Figure 1 shows the profile of the responders from the point of view of the engagement in PRA.

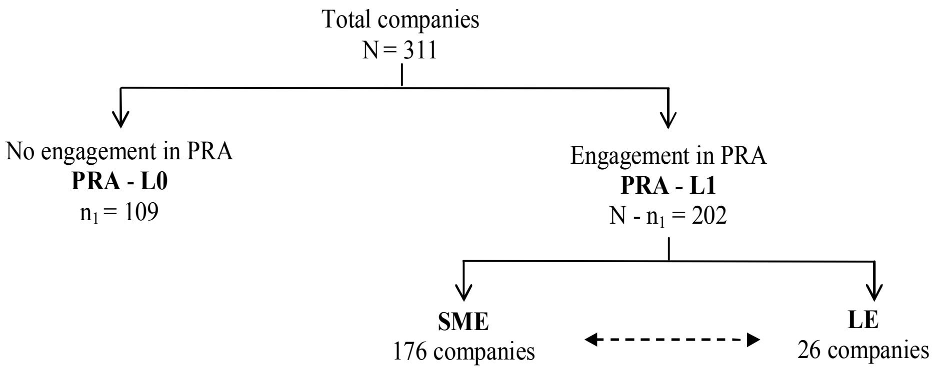

FIGURE 1
Profile of The Respondents With Respect to PRA Level

Since the focus of the study is the assessment of PRA when we make statements about "respondents" in the remainder of the paper we refer to those companies, SMEs and LEs, that are denoted as L1 companies.

Comparisons

The answers to the questions in the present study are expressed as values of 22 variables of categorical or ordinal type. Seven categorical variables record the presence or absence of implementation of specific types of product recovery (direct reuse, resale after repackaging, repair, refurbishing, remanufacturing, cannibalization, recycling), one variable measures the extent of involvement in PRA compared to the company's total production activity (at three levels), two variables describe the organization of returns collection. Five ordinal variables correspond to the importance assigned to five drivers and five ordinal variables correspond to the seriousness assigned to respective specific obstacles to PRA. All these ordinal variables are measured on a 5-point Likert scale. Direct profitability is expressed as a categorical variable with four mutually exclusive alternatives, while future intentions with regard to PRA development are expressed as a categorical variable with two mutually exclusive alternatives. In order to explore the existence of significant differences between

SMEs and LEs for each of the 22 variables of interest, we performed statistical tests on the two respective independent samples. Following the guidelines of [23] the statistical analysis was carried out using X^2 tests for the categorical variables and Mann-Whitney tests, Friedman two-way analysis of variance by ranks and Wilcoxon matched-pairs signed-ranks tests for the ordinal variables.

Management of Collection and Value Recovery (RQ1)

All the types of product recovery activities that were listed in the questionnaire are sizably represented in the sample, with "direct reuse" in first place. Table 2 shows the exact percentages of the respondents that implement each recovery option. The percentages sum up to much more than 100% because most companies use multiple recovery options. In order to investigate differences in the implementation of recovery options we compared the responses through X^2 tests.

TABLE 2
Implementation of Product Recovery Activities

	Percentage of respondents		
Recovery activity	SME	LE	
Direct reuse	56.8%	73.1%	
Resale after repackaging	21.6%	30.8%	
Repair	35.2%	42.3%	
Refurbishing	20.5%	11.5%	
Remanufacturing	19.3%	3.8%	*
Cannibalization	39.8%	30.8%	
Recycling	39.8%	50.0%	

* p-value < 0.1

The results show significant difference in only one variable; remanufacturing (p-value=0.05). In general, though, involvement in PRA is limited; 89% of the SMEs and 92% of the LEs indicate that recovery activities amount to less than 10% of their company's overall production activity.

Table 3 shows that most companies collect returned products, parts and packaging materials directly from their consumers and/or through the company's own collection sites. X^2 tests were performed in order to detect possible statistically significant differences in the organization of the collection process. The results show no significant differences between SMEs and LEs.

TABLE 3
Organization of The Collection of Used Products

Collection of returned products	SME	LE
Directly from the consumer and/or company's collection sites	68.6%	70.8%
Using third parties	45.9%	37.5%

Motivation for PRA - Driving Factors (RQ2)

The motivating factors, which have emerged from the literature review [4], [8], [17] are expressed as shown in Table 4. The respondents indicate their perception about the importance of these drivers by rating them on a five-point Likert scale with 1 = "not at all important" and 5 = "very important." The average ratings for SMEs and LEs are presented in Table 4. Neither SMEs nor LEs mention any other driver although it was allowable to do that in the questionnaire.

TABLE 4
Factors Motivating Engagement in PRA

Drivers	Average rating SME	LE	
Customer service	3.7	3.5	
Green image	2.9	4.2	*
Profitability	2.9	2.8	
Competition	2.8	2.6	
Legislation	1.9	2.3	

* p-value < 0.1

The Friedman two-way analysis of variance by ranks shows that there exist very significant differences in the ratings of the motivating factors (p-value<0.001) not only in SMEs but and in LEs also. In order to investigate more specifically which pairs of drivers differ significantly in their ratings, we carried out the Wilcoxon matched-pairs signed-ranks test for all 10 pairwise combinations of the five drivers in each of those two samples of companies. The p-values of the 10 tests for SMEs are summarized in Table 5 while the corresponding results for the LEs are summarized in Table 6.

Table 5 shows that for SMEs the most important motivating factor for undertaking PRA is customer service as its rating differs significant (p-value<0.001) and is clearly higher than those of the remaining drivers. Green image, competition and profitability are at parity for second place while legislation is the least important factor motivating SMEs in PRA.

TABLE 5
Results (p-values) of Wilcoxon Matched-Pairs Signed-Ranks Tests for SMEs Drivers

Driving factors	Legislation	Profitability	Green image	Customer service	Competition
Legislation	-	<0.001	<0.001	<0.001	<0.001
Profitability		-	0.731	<0.001	0.782
Green image			-	<0.001	0.491
Customer service				-	<0.001
Competition					-

According to Table 6, green image is the most important motivating factor for LEs while customer service is second and competition, profitability and legislation are at parity for third place. Both SMEs and LEs evaluate legislation as the least important driving factor. This finding contradicts the claim of Carter and Ellram [6], who argue that managers perceive that the regulatory sector influences product recovery strategies to a greater extent than customers and competitive factors. Our results about the importance of legislation are similar to those of Rogers and Tibben-Lembke [22], who state that less than 30% of the respondents in their study mention legal restrictions as an important factor.

TABLE 6
Results (p-values) of Wilcoxon Matched-Pairs Signed-Ranks Tests for LEs Drivers

Driving factors	Legislation	Profitability	Green image	Customer service	Competition
Legislation	-	0.466	<0.001	0.018	0.410
Profitability		-	0.007	0.136	0.793
Green image			-	0.098	0.001
Customer service				-	0.010
Competition					-

The Mann-Whitney U test was performed to assess differences between SMEs and LEs with respect to the driving factors. The results presented in Table 4 show significant difference in the rating of one variable; green image (p-value<0.001). Specifically, LEs appear to be more strongly motivated by green image than SMEs.

Direct Profitability of Product Recovery Activities (RQ3)

Many studies, [24], [25] among others, have shown that recovery management can be a source of significant cost savings. The estimate of this research is that 57.7% of SMEs and 66.7% of LEs find recovery activities profitable at a high or at least satisfactory level, (Table 7). At the other end, 36.3% of SMEs and 33.3% of LEs report that product recovery activities are not profitable at all, while for 6% of SMEs the profitability of PRA is not obvious yet. Once again the X^2 test was performed to detect statistically significant difference in the direct profitability of PRA between SMEs and LEs. The test shows that the respective null hypotheses of no difference cannot be rejected at a significance level lower than 10%.

TABLE 7
Actual Direct Profitability of PRA

	Percentage of respondents	
Level of profitability	SME	LE
Profitable at a high/satisfactory level	57.5%	66.7%
Not profitable at all	36.3%	33.3%

Although not directly comparable, these results are in agreement with the findings of Autry et al. [26] in the electronics industry and Daugherty et al. [27] in the automobile aftermarket industry; in both these studies the respondents report moderate success with respect to profitability improvement (between 4 and 5 on a 7-point scale).

Barriers to PRA Development – Future Prospect (RQ4)

The relative importance of the various PRA barriers has been studied systematically through questionnaire-based surveys in [22] and [17]. In Part 3 of the questionnaire respondents were asked to assess the importance of specific obstacles to the development of recovery activities, by rating them on the five-point Likert scale (1 = not at all important, 5 = very important) and to express their intention to further develop recovery activities. The five barriers that were explicitly mentioned in the questionnaire are those that have emerged from the literature review. Table 8 shows the five selected barriers to PRA development along with the average ratings of their perceived seriousness on the 5-point scale.

TABLE 8
Barriers to The Development of PRA

Barriers	Average rating SME	LE	
Complicate the company's operations	2.9	2.4	*
Inconsistent with the company's operations	2.5	2.7	
Not economically justifiable investment	2.5	1.9	*
Investment with high uncertainty	2.2	2.0	
Require specialized know-how and/or staff	2.0	1.8	

* p-value < 0.1

It turns out that for SMEs the greatest impediment to the development of PRA is that such activities complicate the existing mode of operation while LEs evaluate the incompatibility of PRA with the company operation as the greatest impediment to the development of PRA. As a matter of fact an important characteristic of added value recovery is a complex set of interrelated processing steps and options, which may entail a complex structure of the corresponding logistics network between collection and re-distribution [28]. In a case where an original equipment manufacturer (OEM) is involved in remanufacturing activities, remanufacturing operations must be coordinated with normal manufacturing operations and this generates additional complexities [11], [29]. In their survey of logistics managers Rogers and Tibben-Lembke [22] found that 40% of logistic managers consider reverse logistics relatively unimportant compared to other company issues and more than 35% of the respondents believed that company policies negatively impact their reverse logistics management.

The Friedman two-way analysis of variance by ranks confirms that there are not any clearly significant differences in the average ratings of the barriers within LE. On the contrary, in the case of SMEs the Friedman two-way analysis of variance and the Wilcoxon matched-pairs signed-ranks tests for all pairwise combinations of the five barriers show beyond any reasonable doubt that the greatest impediment to the development of PRA is that such activities complicate the existing mode of operation. "Incompatibility of PRA with the company operation" and "economic justification of the necessary investment" share the second place on the five-point seriousness scale as the ratings of them are clearly higher than those of the remaining two which are at parity for third place. The exact p-values of the ten Wilcoxon tests are given in Table 9.

TABLE 9
Results (p-values) of Wilcoxon Matched-Pairs Signed-Ranks Tests for SMEs Barriers

	Inconsistent with the company's operations	Complicate the company's operations	Investment with high uncertainty	Not economically justifiable investment	Require specialized know-how and/or staff
Inconsistent with the company's operations	-	<0.001	0.011	0.881	<0.001
Complicate the company's operations		-	<0.001	0.002	<0.001
Investment with high uncertainty			-	0.002	0.130
Not economically justifiable investment				-	<0.001
Require specialized know-how and/or staff					-

Once again Mann-Whitney *U* tests were performed to assess differences between SMEs and LEs with respect to the seriousness of the impediments to further develop PRA. The results show significant differences in the ratings of two variables; namely, complication of company operation (p-value=0.092) and not economically justifiable investment (p-value=0.027). Specifically, compared to LE, SMEs believe more strongly that the implementation of PRA complicates the existing mode of operation and does not constitute economically justifiable investment. The future prospects of product recovery are not very encouraging, especially in SMEs. Table 10 shows that the majority of SMEs do not intend to further develop recovery activities while the majority of LEs intend to further develop recovery activities. Despite the difference in the precentages, the X^2 test does not show any statistically significant differences between SMEs and LEs with respect to intention to expand PRA (at significance levels of 0.1 or lower).

TABLE 10
Future Prospects of PRA

	SME	LE
Companies intending to expand PRA	44.4%	54.2%

CONCLUSIONS

This paper responds to the repeated calls for more empirical research in reverse logistics. The general finding is that SMEs and LEs differ considerably in their perceptions about PRA, most notably in the perceived importance of the drivers and barriers to the implementation of PRA. Despite the fact that we targeted the Greek industry it is conceivable that the findings may also apply to the manufacturing sectors of other countries with similar economies but this remains to be confirmed through future research.

ACKNOWLEDGMENT

The authors express their appreciation to all the companies that participated in the survey.

REFERENCES

[1] Dekker, R., Fleischmann, M., Inderfurth, K. and Van Wassenhove, L.N., eds, 2004. “Reverse logistics, Quantitative models for closed loop supply chains”. Springer-Verlag, Berlin, Germany.

[2] Thierry, M., Salomon, M., Van Nunen, J., and Van Wassenhove, L.N., 1995. “Strategic issues in product recovery management”, California Management Review, Vol. 37, No. 2. pp. 114-135.

[3] Ferguson, M., and Souza, G.C., 2010. “Commentary on closed-loop supply chains”. In: Ferguson, M.E. and Souza, G.C. (eds.), Closed Loop Supply Chains: New Developments to Improve the Sustainability of Business Practices, pp. 1-6, Taylor and Francis/CRC Press, Boca Raton, FL.

[4] De Brito, M.P., and Dekker, R., 2004. “A framework for reverse logistics”. In: Dekker, R., Fleischmann, M., Inderfurth, K., Van Wassenhove, L.N., (eds), Reverse logistics, Quantitative models for closed-loop supply chains, pp. 3-27, Springer-Verlag, Berlin, Germany.

[5] Rubio, S., Chamorro, A., and Miranda, F.G., 2008. “Characteristics of the research on reverse logistics 1995-2005”, International Journal of Production Research, Vol. 46, No. 4. pp. 1099-1120.

[6] Carter, C.R., and Ellram, L.M., 1998. “Reverse logistics: A review of the literature and framework for future investigation”, Journal of Business Logistics, Vol. 19, No. 1. pp. 85-102.

[7] Atasu, A., Guide, Jr. V.D.R., and Van Wassenhove, L.N., 2008. “Product reuse economics in closed-loop supply chain research”, Production and Operations Management, Vol. 17, No. 2. pp. 483-496.

[8] Srivastava, S.K., 2008. “Network design for reverse logistics”, Omega, Vol. 36, No. 4. pp. 535-548.

[9] Zhu, Q., Sarkis, J., and Lai, K., 2008. “Green supply chain management implications for closing the loop”, Transportation Research Part E, Vol. 44, No. 1. pp. 1-18.

[10] Fleischmann, M., Bloemhof-Ruwaard, J.M., Dekker, R., Van der Laan, E., Van Nunen, J.A.E.E., and Van Wassenhove, L.N., 1997. “Quantitative models for reverse logistics: A review”, European Journal of Operational Research, Vol. 103, No. 1. pp. 1-17.

[11] Guide, Jr., V.D.R., 2000. “Production planning and control for remanufacturing: industry practice and research needs”, Journal of Operations Management, Vol. 18, No. 4. pp. 467-483.

[12] Prahinski, C., and Kocabasoglu, C., 2006. “Empirical research opportunities in reverse supply chains”, Omega, Vol. 34, No. 6. pp. 519-532.

[13] Grando, A., and Belvedere, V., 2006. "District's manufacturing performances: a comparison among large, small-to-medium-sized and district enterprises", International Journal of Production Economics, Vol. 104, No.1. pp. 85-99.

[14] Meredith, J., 1987. "The strategic advantages of new manufacturing technologies for small firms", Strategic Management Journal, Vol. 8, No. 3. pp. 249-258.

[15] Rothwell, R., 1978. "Small and medium-sized manufacturing firms and technological innovation", Management Decision, Vol. 16, No. 6. pp. 362-370.

[16] Kapetanopoulou, P., and Tagaras, G., 2009. "An empirical investigation of value-added product recovery activities in SMEs using multiple case studies of OEMs and independent remanufacturers," Flexible Services and Manufacturing Journal, Vol. 21, No. 3-4. pp. 92-113.

[17] Kapetanopoulou, P., and Tagaras, G., 2011. "Drivers and obstacles of product recovery activities in the Greek industry", International Journal of Operations and Production Management, Vol. 31, No. 2. pp. 148-166.

[18] Kapetanopoulou, P., and Tagaras, G., 2009. "Drivers, obstacles, and future prospects of product recovery in four industrial sectors in Greece". 7th International Logistics and Supply Chain Congress on «Creating Difference in Information Era via Value Chains», Istanbul, Turkey, November 5-6, pp. 513-519.

[19] ICAP's Greek Financial Directory 2007, available at: http://www.icap.gr

[20] Yang, B., Burns, N.D. and Backhouse, C.J., 2005. "An empirical investigation into the barriers to postponement", International Journal of Production Research, Vol. 43, No.5. pp. 991-1005.

[21] Armstrong, J.S. and Overton, T.S., 1977. "Estimating non-response bias in mail surveys", Journal of Marketing Research, Vol. 14, No. 3. pp. 396-402.

[22] Rogers, D.S. and Tibben-Lembke, R.S., 2001. "An examination of reverse logistics practices", Journal of Business Logistics, Vol. 22, No. 2. pp. 129-148.

[23] Sheskin, D., 2007. "Handbook of parametric and nonparametric statistical procedures", 4th ed. Chapman & Hall. New York.

[24] Tibben-Lembke, R.S., 1998. "The impact of reverse logistics on the total cost of ownership", Journal of Marketing Theory and Practice, Vol. 6, No. 4. pp. 51-60.

[25] Meyer, H., 1999. "Many happy returns", The Journal of Business Strategy, Vol. 20, No. 4. pp. 27-31.

[26] Autry, C.W., Daugherty, P.J., and Richey, R.G., 2001. "The challenge of reverse logistics in catalog retailing", International Journal of Physical Distribution and Logistics Management, Vol. 31, No. 1. pp. 26-37.

[27] Daugherty, P.J., Richey, R.G., Genchev, S.E., and Chen, H., 2005. "Reverse logistics: superior performance through focused resource commitments to information technology", Transportation Research Part E, Vol. 41, No. 2. pp. 77-92.

[28] Fleischmann, M., Krikke, H.R., Dekker, R., and Flapper, S.D.P., 2000. "A characterisation of logistics networks for product recovery", Omega, Vol. 28, No. 6. pp. 653-666.

[29] Van der Laan, E., and Teunter, R.H., 2006. "Simple heuristics for push and pull remanufacturing policies", European Journal of Operational Research, Vol. 175, No. 2. pp. 1084-1102.

OUTSOURCING REVERSE LOGISTICS IN CONTEXT

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Abstract − *The purpose of the paper is to present the results of survey investigating outsourcing of reverse logistics activities in the context of their strategic versus operative or ad hoc management of reverse flows and benefits seeking and gaining within reverse logistics management. The exploratory analysis tries to answer the basic research question whether companies strategically managing reverse flows use outsourcing more often compared to companies with ad hoc or operative management and what is the role of costs versus benefits in the context of outsourcing of reverse flows. The survey was realized among 150 Czech small, middle and big companies from several industries and the size and type of industry are two other contextual factors related to outsourcing decisions. The paper contributes to a better understanding of present knowledge targeted at reverse logistics management practices.*

Key words: costs, benefits, outsourcing, strategic management, reverse logistics

INTRODUCTION

Since the seventies of twentieth century the concept of reverse flows (also as RF in the text) as a scientific term emerged in literature [1] although enterprises had to be interested in some aspects of managing any items which 'returns' to the company since the beginning of entrepreneurship. The very much same we can say about outsourcing. For instance Kakabadse and Kakabadse [2] refer history of 'conscious' and documented outsourcing managed processes to Old Romans, however as the theoretic concept it has started to be developed in the late seventieth and beginning of eighties of the twentieth century (for a short discussion of the history of the concept see e.g. Arniti and Wei, 2005) [3].

In this paper we use 'reverse flows' as term of all those flows…*' of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal*'… [4, p. 2]. As the synonymous other concepts in the literature can be found that may be used interchangeable to some extent (returns, backwards flows and for managerial processes the most typical concepts are reverse logistics and supply chain loop. Reverse flows origin both in the internal as well as external environment of the company and they are often subject of interest of logistics or supply chain management.

Any decision to outsource is a long-term strategic decision and this concerns decisions of reverse flows as well [1], so managers should know and understand the benefits or threats or advantages and disadvantages of outsourcing very well. Strategically managed reverse flows can be more effective and can lead to sustainable competitive advantage [5] and outsourcing can be one of enabling factors [6]. Despite this fact many companies still treat reverse flows as non value-generating area of entrepreneurship [7] as well as they connect outsourcing with simple purchasing of just cost-reducing or missing activities [8].

Research on many aspects of reverse flows outsourcing is still limited [6], [9] or [10]. The aim of this paper is therefore to present results of one survey and so to contribute to the knowledge regarding RF outsourcing. We wanted to find answers to three basic questions, namely: 1. Is there any link between level of planning involvement and outsourcing of reverse flows?; 2. Do companies using outsourcing of RF perceive other benefits more intensively compared to those which are less active in RF outsourcing?; and 3. Are there any differences among companies outsourcing more or less RF activities as for the size and type of industry? The country where the survey was realized is the Czech Republic. Only few studies about reverse flows management in this country have been realized until

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now and even less research have been done about reverse flows outsourcing [11]. Therefore survey results enrich the spectrum of knowledge about RF in the context of outsourcing in this country.

The paper proceeds as follows: First, we explain the theoretical underpinnings of the empirical survey. Next the hypotheses, data collection and methods applied are presented. Results and discussion are introduced in following part. The final sections include the limitations of the survey, conclusions and suggestions for future research.

LITERATURE REVIEW

Reverse flows consist mainly of products and packaging [4], together with products and packaging also other flows – e.g. information, know-how, finance etc. return, which are necessary for managing reverse flows. Managerial issues and value capturing or creation are comprehend in the definition of reverse logistics: '*The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal'* [4, p. 2]. There are many reasons why companies take care for RF both voluntary and enforced. They can be divided simply to economic, legal (mostly environmental issues) and commercial [12] and also moral or ethical [13].

There is no standard definition of outsourcing. For instance Barthélemy and Adsit define outsourcing very narrowly and generally as *'turning over all or part of an organizational activity to an outside vendor'* [14]. On the contrary Bardoloi offers rather specified definition: '*Outsourcing is the process of procuring services or products from an external service provider with a view to curb costs, replace in-house capabilities, and thereby reduce the time period of projects. Outsourcing is thus a full transfer or delegation of an organization's facility management functions to an external firm'* [15, p. 1]. For managerial use the best definition is another very simple description – the concept means the abbreviation of three words *'outside resource using'* [16, p. 23]. This definition proceeds from the Resource Based View theory and despite its simplicity it enables to understand many forms of outsourcing. According to this theory, companies search for and keep '*rare, nonsubstitutable, and difficult-to-copy resources and capabilities to earn above-normal rents*' [17, p. 421] and to gain maximum value. Such resources – both tangible and intangible - help companies to get sustainable competitive advantage. If companies do not own such resources for competitive value creation, they have to find external providers [18], in the context of reverse flows termed 3PL or 4PL [e.g.12].

Therefore lack of ownership is one of the reasons why companies outsource, why they outsource in logistics or supply chain and why they in many cases outsource also in reverse flows management. The question to outsource or not to outsource has to be answered within three areas: a) if outsourcing add value (there are hidden costs also in RF) [12], [18], [19]; b) what type of value (financial or nonfinancial, where both can influence each other and this impact can be also hidden in many cases and have long-term character) and c) how much value can be get by the activity outsourced. Simply said, we can cite Vining and Globerman: *'in order to outsource intelligently the firm must know both the benefits and risks of outsourcing and the specific determinants of conflict'* [20, p. 646].

Other potential reasons for outsourcing which can be called as benefits found in literature can be summarized as these: reducing operating costs, cash flow improvement, elimination of infrastructure investments or reduction in capital investments, risk sharing, reduction of risks and liabilities, access to resources not available in company's internal environment and/or to the outputs of such resources if needed (e.g. know-how or best class products, services or processes) or more specified access to advanced technology and/or specialised expertise [21], [22] [23], flexibility improvement in general or operational efficiency improvement, service improvement in general [6], customer service improvement, flexibility increase towards the changing requirements of customers, reduction of capital employed, environmental awareness increase, expansion into unfamiliar (or new) markets, differentiation from competitors [6], in supply chains also reduction in the complexity of logistics operations [22], quality improvement, reduction of transaction time, financial savings in general, strategic focus on core competencies [23]. Kakabadse and Kakabadse point to interesting difference in following the benefits of outsourcing found in Cranfield survey in 2001 in the USA and Europe – in the USA it is cost management and aiming to achieve best practices, in Europe cost discipline and cost reduction [2]. Ordoobadi classifies reasons for outsourcing reverse flows into three categories: strategic, operational and financial [6].

Concentration to only financial measures of outsourcing can be considered as defensive and operational management behaviour [24]. Nevertheless, for companies strictly following cost leadership business strategy, the decision for external provider of activity that would help to improve financial performance and keep minimum level of costs is neither operational nor tactical decision, but the strategic one. Strategic dimension of outsourcing and especially of reverse flows is not always properly understood by management. However, as Quélin and Duhamel citing Grant (2002)stress, *'outsourcing influences the resources allocated to business units as well as the level of vertical specialisation of the firm's activities, both of which are strategic corporate decisions'* [25, p. 648]. In the area of reverse flows, determination of return policy which includes the decision of actors involved in reverse processes, their roles, their share on value creation for company and the potential impact on company competitive advantage must be solved at the strategic level [12].

Any type of reverse flows activity can be outsourced. The list of typical reverse activities is introduced for instance by Rogers and Tibben-Lembke [4], who divide activities into two groups – to product and packaging connected (returns to supplier, resale, sale via outlet, salvage, reconditioning, refurbishing, remanufacturing, reclaiming, recycling, land filling). De Brito and Dekker [26] proposed the pyramid of recovery option which represents options of recapturing or recovery of potential value within given activities. Resale, re-use and re – distribution are at the top of the pyramid enabling to gain highest value followed by repair, refurbishing, remanufacturing, parts retrieval, recycling, incineration and land filling which is at the bottom of pyramid with negative value recovered from reverse flows. Krumwiede and Sheu and Lambert and al. present other list of reverse flows activities – much of them are the same as previous mentioned ones, the rest are synonymous: retrieval or recall (process of collecting and removing products from customers), transport, disposition (inspection, repair, rework, replacement, disassembly, salvage, liquidation sales, landfill disposal) [27], [12].

Concept of value capturing as one of the most important items for outsourcing decision (together with the perception of risk, need of control and investment, extent and character of complexity and/or specificity of process determined for outsourcing etc.) is visible (more or less) also in the activities which companies or their outsourcing partners provide. Activities can be assessed on the base of their position on the continuum from peripheral (or trivial or non core) through core distinct (supporting), core-close to core for business and business success [16], [18], [8]. Although activities within reverse flows are often considered as non-core [9] and non-generating value [7] and as such they are usually typical representatives for outsourcing – e.g. transport, consolidation, warehousing and freight forwarding on tactical decision level [27], the recent trends show the shift from outsourcing of (only) peripheral activities to outsourcing the core ones to 3 PL [29] [22] [6] as well as the whole managerial processes to 4PL in supply chains context [7].

Outsourcing reverse flows have to reflect also some specificities and/or distinct character of these flows management. The most typical ones are: higher complexity of processes that demand higher expertise and specialization compared to forward flows; need for special services (e.g. parts repair and screening for refurbishment/ remanufacturing) beyond core business [30]; uncertain and inconsistent extent, content and quality of flows (that requires '*flexible capacity requirements for storage, processing, and transportation*') [10, p. 1112], timing [6] and dependence on company size and type of industry [30], [13].

METHODOLOGY

Based on literature review three hypotheses were formulated for the survey:

H1: Companies which plan RF strategically, outsource more RF activities compared to those which plan RF only on tactical or operational level or do not plan reverse flows at all (they manage ad hoc)

H2: Companies which plan reverse flows strategically, outsource different reverse flows activities compared to those which do not plan reverse flows at all (they manager ad hoc) or only on tactical, operative level and/or ad hoc.

H3: Companies which outsource more reverse flows activities (3 and more), perceive more often financial benefits than nonfinancial benefits coming from reverse flows.

To examine how outsourcing is connected to some managerial decisions in the companies operating in the Czech Republic structured questionnaire for obtaining the data and information was used. The questionnaire includes 22 questions covering also other issues of reverse flows management beyond the topic of outsourcing. The length of the questionnaire and multiple character of themes has some advantages as well as disadvantages. One of the disadvantages lead to the limitation of survey – the topic of outsourcing could not be in more detail. Answers from 150 representatives from the same number of companies were collected through personal interviews which enabled to get answers also to the most of open questions (which are not always filled in in the case of mail or on-line surveys). Respondents were logistics or supply chain managers, in some cases marketing managers (it means professionals from the middle and the top management as well) of small, middle and big-sized enterprises from various industries and branches (commerce and service, food processing, engineering, chemical and pharmaceutical industries were those with the highest rate of responses). Concrete respondent persons were chosen on the base of previous telephone, e-mail or personal inquiry about the proper and responsible person capable to give right information. List of companies was obtained from the special Czech database Albertina data (from the year 2011 Creditinfo). Survey had an introductory exploratory character being the first existing survey concerning reverse flows outsourcing management in context with other issues of RF management in this country.

Respondents were given this list of 11 activities and they were asked whether they employ or not every individual activity (dichotomy answer). Means, standard deviation, correlation (determined with a Spearman's Rho) between a) variable strategic versus nonstrategic planning and variable number of outsourced activities, b) between variable strategic versus only ad hoc decision and variable number of outsourced activities and c) between variable real reverse flows benefit (where 1 stated for financial and 2 for nonfinancial benefits) and number of outsourced activities was computed. For the same couples of variables also the independent samples tests (Levene´s test for Equality of Variance and t-test for Equality of Means) and ANOVA and ANOVA post hoc Bonferroni were applied. We analysed also the dependency on size of companies (small, middle and big according the number of employees) and type of industry with 4 production industries – chemical, food processing, engineering and one group of other types not ranked into the previous three ones and one 'non production industry' – commerce and services.

Although we asked also for the reasons why company outsources every individual activity, in this paper the analysis concentrates on the link between the activities outsourced and perceived benefits (financial – nonfinancial) of reverse flows management as such. This question was the open one, it means the answers had to be categorised and divided into two groups.

SURVEY FINDINGS

The results for the H1:

H1: Companies which plan RF strategically, outsource more RF activities compared to those which plan RF only on tactical or operational level (or ad hoc) or do not plan reverse flows at all (they manage ad hoc)

show statistically significant relationship (at the 0,05 level) between character of planning hierarchy and number of outsourced activities. The Spearman's rho coeff. is 0,150, mean for number of outsourced activities within strategically planning companies is 2,58 (St. deviation 1,835) whereas mean for companies which do not plan RF on this top level is only 2,17 (with higher St. deviation - 2,156).

When we compare companies which plan RF on strategically level with companies which do not plan RF at all (they plan ad hoc), the results again confirm H1, but relation is not statistically significant. Mean for number of outsourced activities within companies not planning RF at all is 1,81 and Spearman's rho is -0,095, Sig. (1-tailed) is 0,123.

Size of companies correlates with number of activities outsourced (Mean for number of activities outsourced and a) small companies is 2,20, St. dev. is 2,022, for b) middle companies the Mean is 2,34 and St. dev. is 1,881 and for c) big companies is 2,74 and St. dev. is 2,061, but this relation is not statistically significant (Spearman's rho is 0,106, Sig. 1-tailed is 0, 098).

There is also dependence between the number of activities and character of industry – production industries (chemical, engineering, food processing and companies put into the category 'others') outsource more activities (N 106, Mean 2,46, St. dev. 1,948) compared to companies from commerce and services (N 44, Mean 2,25, St. dev. 2,081). Again this relation is not statistically significant – Spearman's rho is 0,70 and Sign. (1-tailed) is 0,197. If we explore individual industries, the Means for activities outsourced are: commerce and services: 2,25, chemical: 3,14, food processing 2,67 and engineering 2,71.

For the H2:

H2: Companies which plan RF strategically, outsource different RF activities compared to those which plan RF only on tactical and operational level or do not plan reverse RF at all (they manager ad hoc)

frequencies, percentage and independent samples test (Levene's Test for Equality of Variance and t-test for Equality of Means) was used. The findings indicate differences as well as statistically significant differences between the two groups of companies.

There are some similarities and differences as well in the type of activities and share of their use between companies planning reverse flows strategically and those who plan only on tactical, operative level or do not plan at all. For both groups outsourcing of transport belongs to the most often outsourced activity just with the difference in share in favour for companies strategically planning (67,1% compared to 56,9%). The second biggest share concerns the same activity for both groups again – destruction, refurbishing. In this case the share is slightly more in favour for the companies which do not plan strategically (the difference is 4,3%). Collection is the third most often used activity by both groups, but in this case companies strategically planning reverse flows outsource this activity more often (difference in shares is 11,3%). The fourth activity ranked same for both groups is the resale of components (or items, materials or packaging). Companies that plan reverse flows strategically apply this activity more frequently, too (with the difference of 12,8%). The share and the rank of the rest of activities differ. Whereas activity selection/sorting for companies that plan reverse flows strategically is on the fifth rank with the share of 24,7%, for the other group it is ranked within one of the three the least used activities. On the contrary, reassembly/rework presents bigger share for companies not planning strategically (difference is 7,2%). The difference of shares within two groups for selection/sorting is 15,5%.

ANOVA analysis also pointed out statistically significant dependence between the variables level of planning involvement and type of activities outsource, namely within three types of activities: selection/sorting/separation (Sig. is 0,014), repackaging and resale (Sig. is 0,021) and resale of components/items/ materials/packaging (Sig. is 0,063).

Statistically significant differences of Means (at 0,05 level) on the basis of ANOVA post hoc Bonferroni test results when analysing the dependence between the size of companies and type of activity outsourced were found in the case of collection, selection and reassembly as can be seen in TABLE 1.

TABLE 1

ANOVA Multiple Comparisons For Type of Activity Outsourced and Size of Company and Share of Companies Within Each Size

dependent variable	(I) company size and share in %	(J) company size	Mean Difference (I-J)	Std. Error	Sig.
collection	1 (12,7%)	2 (20,8%)	-0,080	0,079	0,939
		3 (40,5%)	-0,277*	0,084	0,004
selection/sorting/ separation	1 (7,3%)	2 (17,0%)	-0,097	0,072	0,537
		3 (33,3%)	-0,261*	0,077	0,003
reassembly, rework, disassembly, dismantling	1 (20,0%)	2 (9,4%)	0,106	0,060	0,242
		3 (2,4%)	0,176*	0,064	0,020

The results show that within collection and selection/sorting the share of companies which provide these activities is higher with middle and big companies. On the contrary, the share for the activity of reassembly is higher with middle and small companies.

There are also differences among individual industries and type of activities outsourced. While for instance transport of RF is outsourced by 92,9% of companies from chemical industry, only 56,8% of companies from commerce and services outsource this activity. Collection is outsourced by 33,3% companies from engineering industry, but by no of companies from food processing. The same we can say about selection (also the share is same). Destruction or refurbishing is outsourced mostly by food processing companies (66,7%) and the least by commerce and services (36,4%). Food processing industry has the highest share of companies which outsource charity as RF (33,3) compared to engineering industry with the smallest share (4,4%). Resale of components/items/materials/packaging is outsourced most often by companies from chemical industry (42,9%), while commerce and services do not outsource such activity very often (11,4%).

H3: Companies which outsource more reverse flows activities (3 and more), perceive more financial benefits than nonfinancial benefits.

This hypothesis is based on the presumption that the level of outsourcing involvement is related to the level of resources allocated to the processes connected to outsourcing and working with hard data can be linked to the higher level of understanding which value categories may be inherent in outsourcing. The issue of the character of benefits was examined through one open question asking which value does the company retrieves from reverse flows. All statements were coded into categories of value and after divided into financial benefits, nonfinancial benefits and costs.

The results of the analysis indicate that the H3 must be rejected. The higher number of activities outsourced, the higher number of perceived nonfinancial benefits were introduced by the respondents. 52 companies perceive financial benefits (from 1 to 3 maximum, e.g. higher profit, higher turnover, cost decrease…) and 90 companies perceive nonfinancial benefits (from 1 to 4 maximum - e.g.customer satisfaction, image, information received from RF etc.), 24 companies perceive (also) the sacrifices of RF (in the form of financial costs). Mean for financial benefits perceived by companies that outsource 3 and more activities is 1,27 (St. deviation is 0,533) and Mean for nonfinancial benefits is 1,62 (St. deviation is 0,834). Spearman’s rho for number of outsourced activities and a) number of financial benefits is 0,169 and b) number of nonfinancial benefits is = 0,024 with no statistical significance.

Significant dependence was detected between the size of company and number of both benefits perceived with RF. Sig. of Levene´s Test for Eq. of Var. for number of financial benefits is 0,00, Sig. (2-tailed) with t-test is 0,094 and for number of nonfinancial benefits is Sig. of Levene´s Test 0,024 and Sig. (2-tailed) with t-test is 0,359. Mean for number of financial benefits in the case of small companies is 1,11, for middle companies is 1,22 and for big companies 1,44, Mean for number of nonfinancial benefits in the case of small companies is 1,52, for middle companies is 1,57 and for big companies is 1,70. Managers of big companies are able introduce more categories of both groups of benefits.

The final results concern the analysis of the relation between type of industry and type of value perceived and they imply several differences among industries. Although representatives of all industries introduce most often nonfinancial benefits, the biggest share (if we do omit “other”) can be found within commerce and services (65,7%) and chemical industry (66,7%), the smallest within food processing industry (25,8%). Companies from this industry mentioned slightly more often costs (as the negative side of value) (12,9% compared to 5,0% - engineering, 8,6% commerce and services), whereas no company from chemical industry mentioned costs. Higher share compared to the other industries in the case of only or more given financial benefits can be found with engineering industry (30,0% compared to food processing – 25,8%, chemical – 11,1% or commerce and services – 5,7%).

LIMITATIONS

The survey has several limitations. First the multiple and multi-topics covering questionnaire did not enable to explore the issues of outsourcing deeper (e.g. what exactly mean to manage RF on individual levels of planning hierarchy?; what exactly companies involve into their plans regarding RF?; why some companies do not plan RF at all?). We did not try to identify if companies outsource to 3PL or 4PL that can be interesting issue for managing RF outsourcing. Number of respondents is not enough big to formulate any general conclusions and no generalisation can be done for the findings concerning industries, as well.

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The results of survey confirm and supplement existing empirical knowledge with strategic character of RF outsourcing management. The main findings prove that strategic planning is connected to:

1. outsourcing of more activities (nevertheless there can be dependence with the size of companies);
2. the fact that such companies outsource different activities or the share of different outsourced activities vary;
3. activities that are outsourced distinctly more by the companies planning RF strategically belong to the activities creating higher value for companies (according for instance to De Brito and Dekker pyramid (see Literature Review). This is the case of resale of components, items/parts/packaging and collection and selection/sorting. Final two activities are not covered in the pyramid, but they are precondition for the resale that is at the top of pyramid. From 34 companies which plan RF strategically and resale the parts/items…, 11 outsource collection and 7 sorting/selection.

Findings also discover that companies that are more involved in RF outsourcing perceive more benefits (and less costs) and more nonfinancial benefits compared to financial benefits. In the connection with this result one question can be formulated: Which companies outsource more RF? that can be solved in further research in the context of several potential answers: a) those companies that do not have enough resources (how it is with their competitiveness and quality of planning processes?); b) companies that focus on their core competencies or c) companies that focus on costs and the management expect to save money by outsourcing RF. This is the question of performance management and measurement.

We finish the paper with the conclusions of previous surveys which underline various aspects of effective and efficient outsourcing even of RF. '*If outsourcing is to be fully integrated as a valid and respectable management tool, it must be pursued with a clear sense of where and why it leads to enhanced value*' [31, p. 730], be interesting to know whether outsourcing affects management orientation (e.g. customer or production oriented; vertical or horizontal hierarchy), business relationships (e.g. short or long term; equality regarding risks and rewards), performance measurements (cost, productivity, customer service, asset management, and/or quality), ICT (e.g. large or small systems; standalone or integrated applications), and utilized SC strategies (e.g. time-based solutions, standardization, or postponement) [22].

REFERENCES

[1] de Brito, M.P. 2003, "Managing reverse logistics or reversing logistics management", ERIM Ph.D. Series Research in Management, 35, Erasmus University Rotterdam

[2]Kakabadse, A. and Kakabadse, N., 2002, „Trends in Outsourcing: Contrasting USA and Europe" European Management Journal, Vol. 20, No. 2, 189–198

[3]Amiti, Mary and Shang-Jin Wei, 2006, "Service Offshoring and Productivity: Evidence from the United States," NBER Working Paper no. 11926. Cambridge, MA: National Bureau of Economic Research, 1-24

[4] Rogers, D.S. and Tibben-Lembke R., 1998, "Going backwards: reverse logistics Trends and Practices",University of Nevada, Reno

[5] Mollenkopf D. A. and Closs D.J., 2005, "The hidden value in reverse logistics", Supply Chain Management

Review, Vol. 5, No. 7/8, 34-43
[6] Ordoobadi, S.M., 2009, „Outsourcing reverse logistics and remanufacturing functions: a conceptual strategic model", Management Research News Vol. 32 No. 9, 831-845
[7] Mukhopadhyay, S.K. and Setaputra, R., 2006, „The role of 4PL as the reverse logistics integrator. Optimal pricing and return policies", International Journal of Physical Distribution & Logistics Management, Vol. 36, No. 9, 2006, 716-729
[8] Gilley, K. M. and Rasheed, A., 2000, „Making More by Doing Less: An Analysis of Outsourcing and its Effects on Firm", Journal of Management, Vol. 26, No. 4, 763–790
[9] Serrato, M, Ryan, S.M. and Gaytan, J., 2004: „ Characterization of reverse logistics network for outsourcing decisions", available at: www.public.iastate.edu/~smryan/msrevlog.pdf
[10] Cheng, Y.-H. and Lee, F., 2010. „Outsourcing reverse logistics of high-tech manufacturing firms by using a systematic decision-making approach: TFT-LCD sector in Taiwan", Industrial Marketing Management, No. 39, 1111–1119
[11] Škapa, R. and Klapalová, A., 2009, „Reverse Logistics in the Czech Republic: Outcomes of the Preliminary Research", in ICABR 2009, Brno: MZLU, 2009. 1254-1265.
[12] Lambert, S., Riopel, D and Andul-Kader, W., 2011, „A reverse logistics decisions conceptual framework", Computers & Industrial Engineering, In Press
[13] Presley, A., Meade, L., Sarkis, J., 2007, „A Strategic Sustainability Justification Methodology for Organisational Decisions: A Reverse Logistics Illustration", International Journal of Production Research, Vol. 45, No.18-19, 4595-4620
[14] Barthélemy, J. and Adsit, D., 2003, „The Seven Deadly Sins of Outsourcing [and Executive Commentary]", The Academy of Management Executive (1993-2005), Vol. 17, No. 2, 87-100
[15] Bardoloi, S., 2004, „Outsourcing + Insourcing Key to Smartsourcing", Pinnacle Research Group, Pinnacle Systeme, available at: http://www.a1technology.com/blog/Outsourcing/2004_03_22_outsourcing.htm
[16] Arnold, A. , 2000, „New dimensions of outsourcing: a combination of transaction cost economics and the core competencies concept", European Journal of Purchasing & Supply Management, No. 6, 23-29
[17] Verwaal, E., Commandeur, H. and Verbeke, W., 2009, „Value Creation and Value Claiming in Strategic Outsourcing Decisions: A resource contingency perspective", Journal of Management, Vol. 35, No. 2, 420-444
[18] Logožar, K., 2008, „Outsourcing Reverse Logistics", Zagreb International Review of Economics & Business, Vol. 11, No. 2, 35-45
[19] Pochampally, K.K., Gupta, S.M., Govindan, K., 2009, "Metrics for performance measurement of a reverse/closed-loop supply chain", International Journal of Business Performance and Supply Chain Modelling, Vol. 1, No 1, 8-32.
[20] Vining, A. and Globerman, S., 1999, „A Conceptual Framework for Understanding the Outsourcing Decision", European Management Journal, Vol. 17, No. 6, 645–654
[21] Persson, G. and H. Virum, 2001, "Growth Strategies for Logistics Service Providers: A Case Study", International Journal of Logistics Management, Vol. 12, No 1, 53-64
[22] Hilletofth, P. and Hilmola, O.-P., 2010, „Role of logistics outsourcing on supply chain strategy and management. Survey findings from Northern Europe," , Strategic Outsourcing: An International Journal, Vol. 3, No. 1, 46-61
[23] Belcourt, M., 2006, „Outsourcing — The benefits and the risks", Human Resource Management Review, No. 16, 269–279
[24] Bettis, R.A., Bradley, S.P. and Hamel, G., 1992, „Outsourcing and Industrial Decline", The Executive, Vol. 6, No. 1, 7-22
[25] Quelin, B. and Duhamel, F., 2003, „Bringing Together Strategic Outsourcing and Corporate Strategy: Outsourcing Motives and Risks", European Management Journal, Vol. 21, No. 5, 647–661
[26] de Brito, M.P. and Dekker, R., 2003, "A framework for reverse logistics", ERS-2003_045-LIS, ERIM, Erasmus University Rotterdam
[27] Krumwiede, D.W. and Sheu, C., 2002, "A model of reverse logistics entry by third-party providers", Omega, Vol. 30, No. 5, 325-333.
[28] Butner, K and Moore, D., 2006, „Building value in logistics outsourcing. The future of the logistics provider industry", IBM Global Business Services, IBM Institute for Business Value. IBM Corporation, 1-16
[29] Kara, S.S., 2011, „Evaluation of outsourcing companies of waste electrical and electronic equipment recycling", International Journal of Environmental Science and Technology, Vol. 8, No 2, 291-304
[30] Kumar, S. and Putnam, V., 2008, "Cradle to cradle: Reverse logistics strategies and opportunities across three industry sectors", International Journal of Production Economics, No. 115, 305–315
[31] Alexander, M. and Young, D., 1996, "Outsourcing: Where´s the value?", Long Range Planning, Vol. 29, No. 5, 728 - 730

THE FRAUDULENT RETURNS: THE ADDITIONAL COST FOR REVERSE LOGISTICS

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Abstract *— In the opinion of several academicians and practitioners, reverse logistics can create an additional value for companies. However, for the majority of the companies reverse logistics is still associated with cost only. Therefore the measures that enable companies to decrease the reverse logistics-related cost are highly appreciated. A proper inspection or 'gate-keeping' activity in the beginning of the reverse flow is an example of such a measure. However, its efficiency is harmed due to the return fraud that increases the total cost of reverse logistics. The article identifies the important factors that stimulate/discourage the return fraud in the retail. A model proposed on the basis of the theory of planned behavior was tested on the data of 207 respondents. Our results of structural equation modeling proved that the strict return policy is a significant factor that can partially eliminate such an unethical behavior, or more precisely the intention to it.*

Keywords — Behavior, modeling, return fraud, return policy

INTRODUCTION

In the U.S., the liberal return policy resulted in a dramatic growth in returned goods, because the customers learnt to abuse the system. They returned the goods and claimed the money back even in situations that contradict the legislation or conditions of returns set by the merchandiser [1]., This means additional cost for companies, especially for their reverse logistics systems [2].

In the marketing literature, the abuse of return policy is labeled as deshopping, fraudulent return, boomerang shopping or borrowing. This opportunistic behavior belongs to the same illegal and unethical category as shoplifting, fake insurance claims or intellectual property theft [3]. However, the public condemns the return fraud less compared to other types of illegal activities [4], [1]. What is important, the fraud intention is not always apparent in the moment of purchase, but it can come into existence later on [5].

RETURN FRAUD IN B2C

The Extent of Return Fraud and its Economic Consequences for the Retail

One third of customers were able to recall their intention (within the last six month) to abuse the return policy somehow in an experiment [6]. According to [7], 18 percent of customers had personal experience with return fraud (of apparel). In another research [8], it was 50 percent of women. [9] reported about 90 percent of customers having admitted return fraud.

For retailers, the unpleasant fact is that the return fraud has a growing tendency [8]. According to the survey carried out among 111 retailers in the US, the estimated loss caused by return fraud increased from $9.59 billion to $13.95 billion. The most critical season, when return fraud regularly shoots up, is the holiday: one fourth of annual return frauds happen in this time [10].

Some companies changed their return policies to be more conservative in reaction to the growing tendency of return fraud [11], [12].

The Motivation for Return Fraud

Several researchers tried to identify the motives of return fraud. For example Piron and Young [7] discovered the following broad categories of motives for return fraud of apparel:

- Social – borrowing for special social occasion
- Economic – economic circumstances did not allow a customer to buy the product
- Personal satisfaction of a customer
- Professional – the need for the apparel results from the job position of a customer
- Altruistic needs – return fraud realized in order to please other people.

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The respondents of [13] confirm the above conclusions: the customers justify the return fraud by social and economic needs, or by retailers' high prices and liberal return policies. The return fraud is an accepted norm for some customers; it is a rational and calculated behavior [9].

The customer behavior in favor as well as against return fraud is influenced by other people [13]. The success in fraudulent returning deepens the knowledge of return policy and related procedures, which in turn support the confidence of customers in the further return fraud attempts. In customers' eyes, this leads to a better perceived behavior control over the respective situation [5].

For understanding return fraud, other relevant findings come from service guarantees research: some customers do not seek full compensation and are satisfied with partial compensation only. Due to this decision the customers are able to perceive themselves positively, i.e. to be behaving ethically correctly [14]. For managers, the following finding is of high importance: the customers that achieved higher compensation as a result of a guarantee abuse are not more satisfied. The authors explain this fact by customers' belief that the higher compensation resulted from their effort and not from a company's effort [14].

The Profile of Opportunistic Customers

The demographic characteristics of the customers who abuse the return policy have been the object of research since the middle of 1970s, however, the conclusions are ambiguous. According to recent research [1], women, younger and less educated consumers are more prone to abuse the return policies, which complements the findings of Muncy and Vittel [4] that women, younger and less educated consumers as well as low-income customers see the return fraud to be less ethically problematic. However, the psychographic factors are of higher importance than the demographic ones [1]. The return fraud relates to: the level of public self-consciousness (negative relationship), knowledge of returning rules and regulations, consumption-related, thrill-seeking needs, past experience of fraudulent returning, consumer anomia, social norms, attitude toward complaining, and consumer fraudulent return proclivity.

The Procedures of Abusing Return Policies

A typical example of return fraud is the return of shoplifted goods to the retailer or returning the products bought by means of fraudulent payments. The third most common category is 'borrowing', i.e. returning products that were intentionally bought to be returned later, after a short time of use [10].

Conducted in-depth interviews among 87 retailers and 96 customers found out the general procedures and the measures the customers use successfully when returning a product fraudulently. Customer knowledge of return policies, exploiting relational ties, judicious timing, selection of suitable products, appropriate interaction style or feigning personal connections are the examples of such measures [9].

Apparently, only a small portion of these factors can be affected by retailers themselves [9]. The factors also stress the importance of shop-assistants in the process of a product return. It was confirmed experimentally that in a situation when a customer behaves in a socially acceptable manner shop assistants tend to oversee some rules set by the retailer for product returns and subsequently they sometimes accept the product back groundlessly [15]. Mistakes are made by the responsible shop managers as well, when they revise the rejecting decision of shop assistants to satisfy (e.g. angry, unpleasant) customers. This frustrating experience diminishes the willingness of the shop assistants to adhere to the retailer's return policy strictly [16].

EMPIRICAL SURVEY

Research Aim

The majority of research into fraudulent returns was conducted in the US or the UK [5], therefore it is useful to extend this research to other countries to find out if this opportunistic behavior is globally universal and if it exceeds cultural, legislative and geographic boundaries. Our research follows this way in its first aim, which is to conduct a survey mapping the extent of return fraud in Czech consumers. Secondly, we try to determine and measure the factors stimulating the intention to return fraud.

Model Formulation

The proposed research is based on a model that applies the theory of planned behavior to explain the motives for fraudulent returning.

The theory of planned behavior belongs to the group of theoretical models that try to explain human behavior. The theory assumes the decision on the behavior is a result of balancing the probability of achieving the goal of the behavior and the expected value of the outcome. The individuals prefer the behavior that maximizes the positive and minimizes the negative outcomes [17].

Intentional behavior is predicted by a personal attitude to the behavior and by the opinions of others about the respective behavior (i.e. social norm). The attitude represents the evaluation of behavior and its outcomes. A subjective norm consists of perceived and expected evaluation of the behavior by persons that are able to affect the individual's behavior.

Generally, the people prefer behavior that can be controlled and performed easily. This constitutes a third variable – the perceived behavioral control. The actual control is hard to measure, so the perceived control is used instead in the majority of research [18].

According to the authors of the theory of planned behavior, the predecessor of behavior is an intention that indicates the amount of effort the people are willing to perform to realize the behavior. Thus, the influence of the attitude, subjective norm and perceived behavior control on behavior is mediated by the intention.

The theory of planned behavior is broadly used in many disciplines. Generally, it is able to explain up to 39 percent of the variance in intention and up to 27 percent in behavior. The three exogenous variables (attitude, subjective norm and perceived behavior control) were proved to be related to intention. Intention and perceived behavior control are related to behavior [19]. The theory of planned behavior is useful in designing the measures, whose aim is to change the undesirable behavior to desirable. Therefore this theory is appropriate for studying fraudulent returning [8].

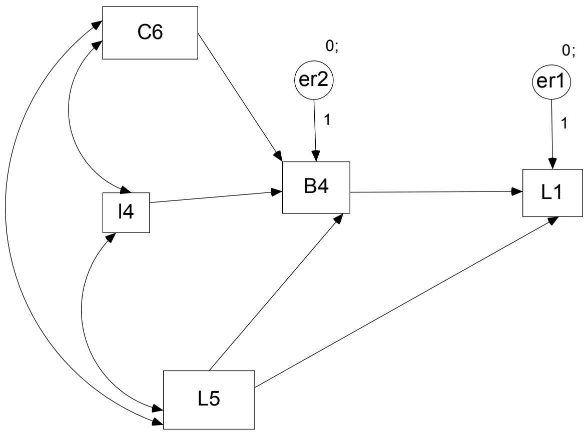
Hypotheses are formally defined as follows:

- H1: Attitude toward fraudulent returning is positively related to intention.
- H2: Subjective norm is positively related to intention.
- H3: Perceived behavior control is positively related to intention.
- H4: Perceived behavior control is positively related to behavior.
- H5: Intention to fraudulent returning is positively related to behavior.

The research objective is closely related to the ethical aspects of behavior. As stated in the literature review section, the customers themselves are aware of the unethical dimension of return fraud [5]. Therefore we have to take this fact into consideration when we formulate and interpret the results of survey among customers. This remark is valid especially for the one ethically sensitive question in the questionnaire (question about the personal experience with return fraud).

TABLE 1
The Variables of The Model

Variable	Variable indication	Wording of questions
Behavior	L1	Have you ever tried to return a product, although you knew it was unjustified? (never – many times)
Intention	B4	In case I do not need an intact product any longer, I will try to return it back to the retailer. (strongly disagree – strongly agree)
Attitude	C6	It is my right to return the product back, although I have used it successfully. (strongly disagree – strongly agree)
Subjective norm	L4	If my friends damaged a product, they would not try to return it back to the retailer and claim compensation. (strongly disagree – strongly agree)
Perceived behavior control	L5	When a product becomes unnecessary, it is difficult to return this used product back to the retailer. (strongly disagree – strongly agree)



The variables of the model:

Number of variables in the model: 7
Observed endogenous variables: B4, L1
Observed exogenous variables: L5, C6, L4
Unobserved exogenous variables: er1, er2

FIGURE 1
Graphical Presentation of The Proposed Model

Pilot Research

Before the questionnaire was formulated and data collected, the pilot research was conducted to roughly estimate the extent of return fraud among Czech customers. A group of twenty randomly selected people was asked three open-ended questions. After simple content coding and frequency count it was found out that respondents had no previous experience with return fraud, more precisely they denied that they had conducted such behavior in the past. None of the respondents tried to abuse the return policy. One respondent admitted that he considered this, but he failed in the course of realization (without stating any reason for that).

The pilot research indicated that return fraud will probably not be wide-spread among Czech customers.

The Collection of the Quantitative Data

The data were collected in May and June 2011 through a printed questionnaire among 250 students in regular- and distance learning. However, the final sample had to be reduced to 207 cases because 43 (18%) respondents did not answer the ethically sensitive question about personal experience with return fraud (L1 – the dependent variable). The imputation of missing values would be very problematic as imputation in case of dependent variable could distort the calculations of the whole model [20].

All the five variables represented the answers to the scale questions, with values -3 to +3. Thus, the outliers' identification was skipped. Unfortunately, the data did not fulfill the requirements of normality, which was tested visually and by means of Shapiro-Wilk test W. The most common problem – the negative skewness of data – was corrected by power and square root transformation as suggested by [21], [20] and [22]. As the results calculated on transformed variables were almost identical to the results based on the original data, we turned away from transformation and all the presented numbers come from non-transformed data. Our case provides further evidence concerning robustness of structural equation modeling (more precisely of the path analysis) when applied on the sufficiently large samples (see [20]).

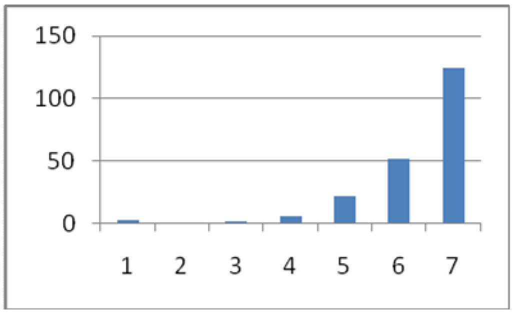
Research Sample Description

In the final research sample, the share of men (54%) slightly outweighed the share of women (46%). The average age was 24.5 years and the respective median achieved 23. The respondents considered their financial situation to be somewhat good; more precisely slightly above the average when compared to their environment.

Czech Customers' Experience in Fraudulent Returning

The most critical question in terms of statistical modeling was represented by the dependent variable L1 – respondents' experience with fraudulent returning. Similarly to other statistical methods, the structural equation modeling requires a sufficient variability in data. In this respect the L1 variable is far from the ideal: 60% of respondents never tried to abuse the return policy. The remaining 40% experienced it inconsiderably. All in all, the variable of L1 enters the calculations with a very low variability, which negatively affects the reliability of results.

Speaking about factual interpretation of this result, Czech consumers seem to be substantially less engaged in fraudulent returning compared to foreign experience of [7] - [9].



Note: 1: many times, 2: 7-9 times, 3: 5-6 times, 4: 3-4 times, 5: twice, 6: once, 7: never

FIGURE 2
Frequencies of Return Fraud Experience

Statistical Test of the Model

The essential indicator of the statistical validity of the path model is $\chi 2$. Its value (2.314; p= 0.314; Df=2) suggests that the model can be accepted, i.e. the proposed relations between variables are supported by the empirical data. The results of other widely-used indicators like Comparative index fit (CIF=0.998) and RMSEA (0.028) are in harmony with the statement. Because several indicators proved the statistical validity, the model as a whole can be accepted and it is sensible to analyze the detailed calculations.

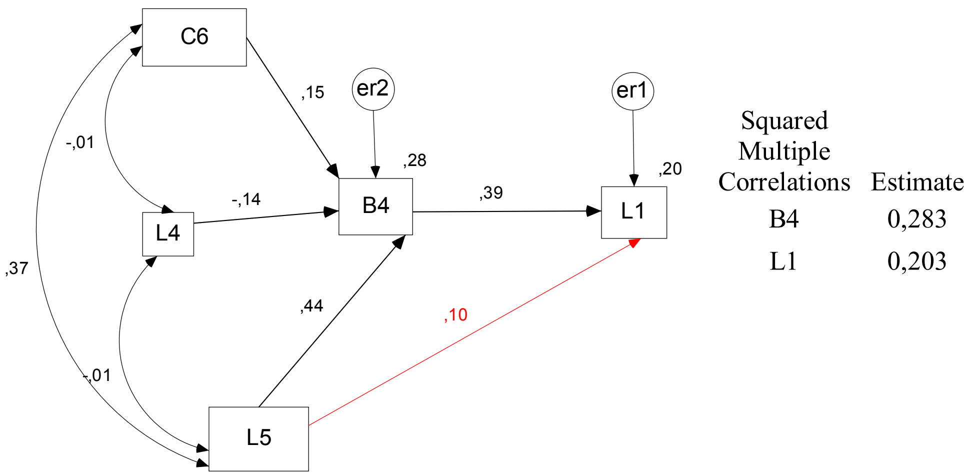
The structural relationships in the model (see Table 1) are statistically significant except for the relation between perceived behavior control and behavior (H4 hypothesis). In other words, the H1, H2, H3 and H5 hypotheses cannot be rejected; therefore they can be accepted temporarily. The standardized regression coefficients supply another piece of information: there is a modest relationship between intention and behavior (0.39). The strongest coefficient was found between perceived behavior control and intention (0.44), which is similar to the findings of [8] and [25] and partially of [9]. Weak relations were identified in attitude (0.15) and subjective norm (-0.14) toward intention, which contradicts to [25], where these relationships were found to be of modest intensity. The negative value of the coefficient in subjective norm reflects the opposite polarity of the respective question about subjective norm and therefore the negative extent was expected. The model explains 28 percent of the variance in intention and 20 percent in behavior.

TABLE 2
Parameter Estimates of The Model

Regression Weights			Estimate	S.E.	C.R.	P	Standardized Regression Weights	Hypothesis testing
B4	<--- (H1)	C6	0.1	0.044	2.291	0.022	0.146	supported
B4	<--- (H2)	L4	-0.02	0.009	-2.291	0.022	-0.136	supported
B4	<--- (H3)	L5	0.056	0.008	6.906	***	0.44	supported
L1	<--- (H4)	L5	0.009	0.007	1.354	0.176	0.097	rejected
L1	<--- (H5)	B4	0.287	0.052	5.493	***	0.394	supported

CONCLUSIONS

The perceived behavior control appears to be the most important variable out of the exogenous variables defined by the model. If customers consider return fraud to be difficult, their intention to abuse the return policy and to take advantage of it is less and the performing this behavior is less frequent. The relative importance of perceived behavior control in comparison to attitude and subjective norm suggests that retailers who are facing the problems of return fraud should modify their return policies in the first place. They have to find out and implement the measures that complicate the opportunistic behavior. And only then they should employ some activities, which will affect a change in customers' beliefs (which in turn change their attitude and subjective norm). A communication campaign pointing out the negative consequences of return fraud and its unethical dimension would be an example.



Note: The red color depicts the statistically unreliable relationship
FIGURE 3
Standardized Regression Coefficients of Model of Fraudulent Returning

If Czech consumers are similar to their foreign counterparts, the success of such a measure could be a big question mark, because the customers are aware of the fact that return fraud is unethical. The communication campaign would not bring new information for them. Probably a better example is given by King at al. (2008), who speaks for rational argumentation in a campaign: return policy is an instrument useful not for a retailer or a customer alone, but for both sides of a contract. In the eye of a customer, the return policy diminishes the risk of a mistaken purchase.

However, the interpretation of the theory of planned behavior is not so straightforward. The behavior can be changed substantially by affecting variables of not only strong, but also weak links to intention [23]. In our model of fraudulent returning, attitude and social norm are such variables that we should focus on in the first place if we accept the importance of weak relationships.

When drawing a conclusion, the suggestions to retailers must be proposed realistically. The retail is able to modify the return policy and in this way to affect the perceived behavior control of customers. On the contrary, the change in attitude and subjective norm would require measures that are more likely unattainable for retail. Next, the problem of ethical behavior is not a problem of a single retailer, but of the whole society. Perhaps this could be the task for retail associations and federation for instance. They could raise money to start a communication campaign, which would be geographically dispersed and long-term running to bring the expected effects.

The proposed findings have to be relativized to a certain extent due to several limitations. First, although the indicators of statistical validity signal that the model is acceptable, both the low variability of dependent variable (L1) and its high non-response rate (18 percent) can affect the results seriously. The low variability itself can simply reflect the fact that Czech customers do not abuse the return policies. However, this could be also a result of bad measurement – bad wording of questions. The validity of this variable could be improved if respondents were given different examples of return fraud because they might not recognize some behavior to be ethically incorrect (i.e. to be return fraud).

This also leads to the second major limitation. The research design was based on a direct measurement of variables, which are typically considered to be latent. Employing more sophisticated methods of structural modeling (confirmatory analysis namely) would increase the validity of measurement. This is a space for further research.

In the context of further research, the notice by [24] is inspiring. The authors pointed out the fact that the majority of published work deals with consumers' unethical behavior. However, the customers are sometimes suspicious about the retailers' practices and are afraid of being cheated by them. In their eyes, taking the advantage of return policy is a measure to be protected against dishonest retailers.

REFERENCES

[1] Harris, L. C., 2008, "Fraudulent Return Proclivity: An Empirical Analysis", Journal of Retailing, 84, 4, 461-476.

[2] Rogers, D. S., Tibben-Lembke R., 1998, "Going backwards: Reverse Logistics Trends and Practises", University of Nevada. Reno.

[3] Wirtz, J. and Mccoll-Kennedy, J. R., 2010, "Opportunistic Customer Claiming During Service Recovery", Journal of the Academy of Marketing Science, 2010, 38, 5, 654-675.

[4] Muncy J. A. and Vitell, S.C., 1992, "Consumer ethics: An investigation of the ethical beliefs of the final consumer", Journal of Business Research, 24, 4, 297-311.

[5] King T. and Dennis, C.,2006, "Unethical consumers. Deshopping behaviour using the qualitative analysis of theory of planned behaviour and accompanied (de)shopping", Qualitative Market Research: an international journal, 9, 3, 282-296.

[6] Reynolds, K. L. and Harris, L. C., 2005, "When Service Failure is not Service Failure: An Exploration of the Types and Motives of 'Illegitimate' Customer Complaining". Journal of Services Marketing, 19, 5, 321–335.

[7] Piron, F. and Young, M., 2000, "Retail borrowing: insights and implications on returning used merchandise", International Journal of Retail & Distribution Management, 28, 1, 27.

[8] King T., Dennis, C. and Wright, L.T., 2008, "Myopia, customer returns and the theory of planned behaviour", Journal of Marketing Management, 24, 1, 185.

[9] Harris, L. C., 2010, "Fraudulent consumer returns: exploiting retailers' return policies", European Journal of Marketing, 44, 6, 730-747.

[10] "Return fraud to cost retailers $3.7 billion this holiday season, according to NRF", 2010, Targeted News Service 2010, Avaivble at WWW: <http://www.nrf.com/modules.php?name=News&op=viewlive&sp_id=1024>.

[11] Spencer, B. J., 2002, "The Point of No Return - Stores from Gap to Target Tighten Refund Rules; a 15% `Restocking Fee", Wall Street Journal, 14.5.2002, 1.

[12] Bhatia, N., 2004, "Return Policies for Customer Purchases. California: University of California, Los Angeles" [online],Avaiable at WWW: < http://search.proquest.com/docview/305220714?accountid=16531>.

[13] King T. and Dennis, C., 2003, "Interviews of deshopping behaviour: an analysis of theory of planned behaviour", International Journal of Retail & Distribution Management, 31, 3, 153 – 163.

[14] Mazar, N., Amir, O. and Ariely, D., 2008, "The Dishonesty of Honest People: A Theory of Self-Concept Maintenance", Journal of Marketing Research, 45, 6, 633-644.

[15] Autry, C., Hill, D. and O'Brien, M., 2007, "Attitude toward the Customer: A Study of Product Returns Episodes", Journal of Managerial Issues, 19, 3, 315-339.

[16] King T., Dennis, C. and McHendry, J., 2007, "The management of deshopping and its effects on service: A mass market case study", International Journal of Retail & Distribution Management, 35, 9, 720 – 733.

[17] Hewstone, M. and Stroebe, W., 2006, "Sociální psychologie : moderní učebnice sociální psychologie" [in Czech],Portál, Praha
[18] Ajzen, I., 2011, "Frequently Asked Questions. Icek Ajzen Pages" [online], Avaiable at WWW: <http://www.people.umass.edu/aizen/faq.html >.
[19] Armitage, C. J. and Conner, M., 2001, "Efficacy of the theory of planned behaviour: A meta-analytic review". The British Journal of Social Psychology, 40, 471.
[20] Hair, J., Anderson, R. and Babin, B., 2010, "Multivariate data analysis", Prentice Hall, New Jersey: Upper Saddle River.
[21] Leech, N., Barrett, K. C. and Morgan, G., 2005, "SPSS for Intermediate Statistics: Use and Interpretation", Erlbaum, Mahwah, NJ.
[22] Tabachnick, B. G. and Fidell, L. S., 2006, "Using multivariate statistics", Allyn & Bacon: New York.
[23] Ajzen, I., 2010, "Behavioral Interventions Based on the Theory of Planned Behavior. Icek Ajzen Pages" [online]. Avaiable at WWW: <http://www.people.umass.edu/aizen/pdf/tpb.intervention.pdf >.
[24] Goudge, D., Tran, T. and Genchev, S. 2010, "Post-purchase return intent: the influence of utilitarian and hedonic utilities", Advances in Marketing. Proceedings of the annual meeting of the association of collegiate marketing educators. [online], 134-143. Avaiable at WWW: <http://www.acme.org/Proceedings/ACME_2010_Proceedings.pdf>.
[25] Chang, M.K. 1998, "Predictiong unethical behavior: A comparison of the theory od reasoned action and the theory of planned behavior", Journal of Business Ethics, 17, 1825-1834.

MATHEMATICAL PROGRAMMING APPROACH FOR HAZARDOUS WASTE MANAGEMENT IN AN ORGANIZED INDUSTRIAL ZONE

Yaşlı Fatma [1], Bayraktar Demet [2]

***Abstract** -Many countries are facing with very serious problems in managing hazardous wastes with the rise of high industrialization and technology. In this study, the existing state of hazardous waste management in an organized industrial zone is examined in detail and a comprehensive literature review on hazardous waste management is carried out as well. In the literature, hazardous waste management is generally examined in terms of the collection, transportation, treatment, and disposal of the hazardous wastes. Accordingly, the purpose of this study is to propose a mathematical model to determine the best hazardous waste treatment and disposal centers, with regards to the waste facility in the region and a waste flow allocation pattern such that the total system cost and the transportation risk can be minimized. Since the hazardous industrial wastes are composed of various types, needs of treatment and disposal centers with various technologies are assessed in this study. The constraints set thereby consists of waste compatibility to be treated in the waste facilities, mass balance at the nodes and existing waste treatment and disposal facilities capacity limitation in the region. The proposed mathematical model is applied in an organized industrial zone and the optimum model solutions are composed to help the regional decision makers for long-term planning in hazardous waste management activities for the future*

Keywords – Facility selection, hazardous wastes, mathematical model, optimization

1. Introduction

Increasing population and growing economy have led to be a consumption society. Due to the development of technology and hence increase in production, industrial hazardous wastes have become extremely important. Increasing pressure on resources such as land, energy and finance coupled with strict environmental regulations have made the hazardous waste management problem more complex [9]. The whole world is looking for the optimum system about waste management. All over the world, firstly, the reduction efforts for wastes at generation nodes, then to benefit from them with recycling are in progress. Due to the potential danger for human health of hazardous waste, the regulations have established local and national levels in many countries [13].

The issue of hazardous waste has a multi-directional dimension that is studied chemical, environmental and optimization of the system aspects. In this study, the management of hazardous waste is examined from the point of wiev of hazardous waste producers and the industrial zone as well. The aim of this study is to provide a regional decision support system to determine the best hazardous waste treatment and disposal centers based on real life communication between waste producers and waste facilities' managements. Hazardous waste management is managed under the "Hazardous Waste Control Regulation" in Turkey [6]. According to the regulation, there is "polluter pays principle" like all over the world. All cost arising from control and disposal of hazardous waste must be met by the waste producers. Therefore, producers of hazardous waste are in search a waste facility for recycling and disposal operations for their wastes. The variety of technology and the great number of hazardous waste facilities (252 facilities in Turkey) constitute a challenging selection process for hazardous waste producers.

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2. Literature Review

In the literature, the hazardous waste management is discussed in terms of waste collection, transportation, processing and disposal. There are a number of studies determining the locating the place of hazardous waste facilities with regards to the technology and capacity decisions [1, 2, 3, 4, 5, 8, 11, 14]. In these studies, mathematical models were applied to provide expressing the different alternatives for decision-makers about identification of appropriate management systems [9].

In the literature, the decision for facility location and hazardous wastes transportation to appropriate facility from hazardous wastes' generation nodes was made by means of using multi objective programming [4, 5, 8, 10, 11]. Models which are generated on a single type of waste with different generation nodes examine the cost and risk factors to determine the most appropriate waste facility locations [5, 7, 8, 11]. In the literature, there are also studies in which the diversity of wastes is reflected to the model [2, 10, 14]. From these studies, Nema and Gupta, 1999, 2004 [9, 10] and Alamur and Kara, 2007 [2] applied their models to the problem that is generated on three types of waste. Increase of complexity and the amount of data are inevitable when closer to the reality. Fuzzy approaches were used in case of increased complexity and incomplete data [7, 11, 12].

Differences are observed about compatible recycling and disposal methods of wastes due to each type of wastes differences in the chemical and physical properties. Related to this fact, the studies examining the compatibility among waste types, process technology, and facilities may be accepted as the most comprehensive studies about the hazardous waste management [2, 9, 10, 14]. Alumur, 2007 [2], Nema and Gupta, 1999 [9] and Zhao and Zhao, 2010 [14] dealt with the hazardous waste management system modeling with the cost and risk factors in their objective functions. Under their cost objective, cost of opening new facilities, waste transportation costs and processing costs were taken into consideration. But in these studies, determining the risk varies in contrast to determining the cost. Nema and Gupta, 1999 [9] suggested that the risk calculation is considered for the identification of undesirable events such as accidents. Jianhua, 2008 [7] assumed that if the distances between the new opening facilities and the dwelling district increased, there would be a decrease on the risk as he assumed that the main variable for the risk factor was distance. Alamur and Kara, 2007 [2] assumed that the risk was proportional to the population which was covered by the facilities. So, they assumed that the risk increases as the number of population increases in the region where the waste facility is located. As seen, Jianhua, 2008 [7], Alamur and Kara 2007 [2] reported in their studies, a new waste facility to be opened should be away from dwelling district. In our study, transporting the hazardous wastes to the facilities that have already existed is taken into consideration. So, in our study, it is assumed that when the distances between the waste generation region and the waste facilities decrease, the risk of transportation of the wastes will also decrease. With the adoption of distance as a risk factor, it is thought that the selection of facility that is at the minimum distance makes the transportation risk minimum, as a result of which a unit penalty cost, is added.

In waste management, first of all hazardous wastes need to be processed for recycling. But, if this is not possible, the wastes should be disposed in an appropriate facility [2, 14]. This is accepted as the waste management hierarchy in all over the world.

Many different types of hazardous waste occur in an industrial zone when hazardous waste management system is examined in real life. Accordingly, there are a number of studies related to opening new facility decisions in the literature [2, 3, 4, 5, 7, 8, 11, 14]. Since there are adequate waste facilities in the industrial zone where the application is performed in this study, opening a new facility is regarded.

3. Problem Description

In accordance with the regulations, in all over the world the "polluter pays principle" forces the management of hazardous wastes. The costs that occur due to waste controlling and disposal processes have to be met by the waste producer. Therefore, the waste producers look for an appropriate facility for their hazardous wastes to recycle and dispose processes. The different technologies and the large number of hazardous waste facilities constitute a facility selection decision for hazardous waste generators.

Since the data about hazardous waste generation has kept recently in Turkey, the data for 2010 is used in this study. When analyzing the hazardous waste data in an Organized Industrial Zone for the year of 2010, it is observed that 50 types of hazardous wastes were transported from 81 waste generator firms to the 33 different waste facilities with 210 entries.

In current situation every firm in the zone has to deal with their own wastes. The producers of hazardous waste are making agreements with the multiple waste facility management primarily based on the type, quality, quantity, and also transportation and process costs of the waste. In this study, a facility selection model based on all hazardous wastes in an organized industrial zone to be transferred as batches to the waste facilities is suggested.

In real life it is realized that there is a lack of organization among the waste producers in the region for transporting the wastes to the waste facility. Because of this reason, the wastes in the same type were transported to very different waste facilities. It's seen that these hazardous waste facilities have spread over in a large area through the country. Some of these facilities are located hundreds of miles away from the waste generation region. It is also seen that these facilities may offer very different prices for the same kind of wastes. This situation may arise from the use of varies technologies in the waste facilities. On the other hand, it may arise from marketing procedures towards to the customers. To avoid disadvantages of these and similar conditions of the waste facilities, a compherensive and a scientific decision support system is a requirement for the firms in the same region.

4. Model development and application

The purpose of this study is to propose a decision support system for the regional management of the hazardous waste in an industrial zone. Mathematical programming is used to select waste facilities for transporting the wastes to the compatible ones. A hazardous waste facility selection model that minimizes the cost and the transportation risk of waste for the organized industrial zone is developed in this study.

In Turkey, there are 254 waste facilities which are able to process the wastes. On the other hand, in 2010, the firms in an Organized Industrial Zone transported their hazardous wastes to 33 different waste facilities. It is realized that some of these facilities are located hundreds of miles away from the waste generation region.To eliminate this situation, nine more facilities that are close to waste generation region, compatible for processing region's wastes and also approved by the management for the waste processing have been included to the model. So, 42 waste facilities have been taken into consideration in the model for solving the selection waste facility problem of the organized industrial zone. These facilities have different technologies and there are also the wastes' compatibilities for these technologies.

In the literature, the studies of Nema and Gupta, 1999 [9] and Alamur and Kara, 2007 [2] are based on definitions of the technologies of the waste facilities and waste's compatibility to the technologies. Even though a waste type is compatible for the facility's technology, the facility may not accept the same waste. So, the compatibility of the waste-technology and technology-waste facility cannot be classified exactly in this case. Depending on their technologies, marketing strategies and needs, some waste facilities can determine their compatibility for the wastes.

In our case, by contrast with the literature studies, there are 50 types of hazardous wastes. The reason is that the multiplicity of the waste types makes this study different from the literature studies that are explained in the literature section. The constraint that is called "waste-technology compatibility" in the literature [2, 9] is called as "waste-waste facility compatibility" and it is defined as $y_{w,i}$ as a binary parameter in this study.

When examining the communication between waste facility and waste producers, it is seen that there are different assessments about the waste types. It is possible to say that the hazardous wastes can be classified as "valuable waste", "less valuable waste", and "worthless waste". In this study, depending on these assessments of wastes by the waste facilities, three types of scenarios are generated for understanding the conditions better. In these scenarios, conditions of transportation and processing costing changing with the assessment of the wastes by waste facilities are considered. The scenarios for the waste producers are as follows:

Scenario 1: This scenario is for worthless wastes. The transportation and processing costs are met by the waste producers:

- For this kind of wastes, the unit transportation cost ($tc_{w,i}$) and the unit processing cost ($pc_{w,i}$) will be greater than 0.

Scenario 2: This scenario is for less valuable wastes. Only the transportation cost is met by the waste producers; the processing cost of the wastes is met by the waste facilities:

- For this kind of wastes, the unit transportation cost ($tc_{w,i}$) will be greater than 0 as in the scenario 1. But the processing costs ($pc_{w,i}$) will be equal to 0.

Scenario 3: Both transportation and processing costs are met by the waste facilities or paying a price for the wastes to the producers:

- For this kind of wastes, the unit transportation cost ($tc_{w,i}$) will be equal to 0. As for the processing cost ($pc_{w,i}$) will be less than or equal to 0. There may be a negative processing cost. And it means that the waste processing cost will transform to income for waste producers.

4.1. Assumptions

The assumptions of the proposed model are as follows:

1. The data for hazardous waste types in the industrial region belong to year 2010.
2. Gathering of the hazardous wastes of the firms in the industrial zone is possible.
3. Transportation cost is linearly proportional to the transportation distance.
4. Transportation risk is linearly proportional with the transportating distance of the waste.
5. The capacities of the waste facilities are always sufficient for the organized industrial region hazardous wastes.
6. It is accepted that there is only one waste generation node as an organized industrial region.
7. The hazardous wastes are classified as "valuable waste", "less valuable waste" and "worthless waste" by the waste facility management.
8. If a waste type is accepted as a “worthless waste” by the waste facility, compensation will be demanded from the waste producer for processing.
9. If a waste type is accepted as a “valuable waste” by the waste facility, a value will be offered to the waste producers for the waste.
10. Variety of waste financial assessments by waste facilities arises from the type of waste facility’s technology and due to using areas of hazardous wastes after treatment or recycling processes.
11. Sometimes the different costing may arise from the marketing strategies of waste facility.
12. Some technical analyses of the hazardous wastes are performed to deal with waste facility for the transporting the wastes. In this study, since the amount of the wastes is huge, if can be accepted by the facility without any analysis after reaching a consensus with the experts of the facility.
13. The hazardous wastes can be transported to the selected waste facilities periodically by gathering the wastes as batches depending on the waste types in the region. This is an accepted assumption by the waste facility experts as well.

4.2. Indices, Parameters and Decision Variable

The following indices, parameters and decision variable are used in the model:
Given;

Indices:

$W = \{1,\ldots\ldots,w\}$ hazardous waste types
$I = \{1,\ldots\ldots,i\}$ waste process facilities

Parameters:

$tc_{w,i}$ = unit transportation cost of $w \in W$ hazardous waste for $i \in I$ waste facility according to assessing the waste

$pc_{w,i}$= unit process cost of $w \in W$ hazardous waste for $i \in I$ waste facility according to assessing the waste

q_w= total quantity of $w \in W$ hazardous waste at the waste generation region

d_i= distance between the waste generation node and $i \in I$ waste facility

C_i = annual capacity of $i \in I$ waste facility

$y_{w,i}$= 1 if $w \in W$ hazardous waste is compatible to be processed with the $i \in I$ waste facility; 0 otherwise

p = penalty cost per distance of facility $i \in I$ and quantity of the waste

Decision Variable:

$x_{w,i}$= amount of $w \in W$ hazardous waste transported to $i \in I$ waste facility

4.3. Model Building

Objective Function:

The objective function is established to transport the hazardous wastes to the waste facilities that offer the optimum conditions depending on the focus of this study about valuation of the waste according to the scenarios. In addition, minimizing the transportation risk is seen as an important issue with the goal of the cost advantage in this study. A unit penalty cost (p) for the distance and the amount of waste that provides the minimization of the transportation risk is taken into consideration in this study.

The objective function is therefore established as the cost and the transportation risk minimization as given in (1):

$$\min \left(\sum_{w} \sum_{i} x_{w,i} * (\mathrm{t}c_{w,i} + \mathrm{p}) * \ d_i + \sum_{w} \sum_{i} x_{w,i} * pc_{w,i} \right) \qquad (1)$$

Formulation of the constraints:

- **Mass balance at the nodes:** It must be ensured that all the hazardous waste in the region has to be processed in any waste facilities. Since there are wastes with the huge amounts for each type of waste, there is no limitation to send the wastes to the same waste facility.

$$\sum_{\mathrm{i}} x_{w,i} = q_w, \forall \ w \in W \qquad (2)$$

- **Capasity constraint:** The amount of the hazardous wastes that are transported to the waste facility must not exceed the facility's capacity. The capasities are determined and acceptable for all amounts of hazardous waste types in total that are compatible to the facility.

$$\sum_{\mathrm{w}} x_{w,i} \leq \ C_i \, , \forall \ i \in I \qquad (3)$$

- **Constraint of waste-facility compatibility:** It is provided that the hazardous wastes are transported to appropriate waste facilities. In this study, each waste facility is able to process some types of waste. This compatibility is determined primarily by the facility technologies, but also by the regulations and the facility management strategies. If the parameter of $y_{w,i}$ is 1, capacity of facility $i \in I$will be compatible for the amount of $w \in W$type of waste.

$$x_{w,i} \ \leq C_i * \ y_{w,i}, \qquad \forall \ w \in W \ , \forall \ i \in I \qquad (4)$$

- **Positive status of the decision variable:** The decision variable that represents the quantity of $w \in W$ type of waste transporting to the facility $i \in I$ can not be negative.

$$x_{wi} \geq 0, w \in W, i \in I \quad (5)$$

4.4. Application

The proposed model was applied to the real life problem in an Organized Industrial Zone in Turkey. According to the arragements on the regulation about hazardous waste management, all the firms that produce hazardous waste have recently been controlled strongly by the institutes in the Ministry of Environment and Forestry. The waste producers are becoming increasingly conscious about waste management.

According to the waste hierarchy, there is the "polluter pays principle" all over the world. The firms in an Organized Industrial Zone are trying to provide their wastes being processed at a waste facility. After the hazardous wastes resulting from the production, producers can keep their wastes maximum six months in their facility. At the end of this time, they must transport their wastes to a waste facility. As they do not examine the facilities where can process their wastes in detail, at the end of this time they have to transport the wastes to a random facility which can take their wastes. Otherwise, they are exposed to legal applications of the laws.

The data about the organized industrial zone are obtained from the Provincial Directorate of Environment and Forestry. It is determined that the firms in the organized industrial zone produced 50 types of hazardous waste in 2010. The amounts of generated wastes according to the types in the region are calculated. Fourty two waste facilities are taken into consideration in this study. Fifty types of wastes' assessments of waste facilities are examined by interviewing with all of the facilities. The penalty cost is accepted as ε (0,0001 TL) per kilometers and kilograms. Then, the model is solved with the optimization software GAMS which can solve linear programming and nonlinear programming problems. According to the model solution, 50 type hazardous wastes are transported to the 15 different waste facilities and totally a profit has occurred from the hazardous wastes. The results for the waste types about transporting to the waste facilities are summarized in Table 1. Without taking into account the penalty cost, the total cost is -329335 TL. The objective function value is the total cost of the addition of the distance penalty cost and it is -314688 TL. The negative cost means an acquisition.

TABLE 1
Results of the wastes' assignments according to model

Distance (km)	231	281	238	25	34	358	225	406	94	243	19	404	99	353	282
Facility No	i2	i3	i5	i6	i7	i11	i12	i14	i15	i19	i25	i27	i34	i37	i40
WASTES	w43 w50	w9 w18 w41	w15	w42	w4, w10 w20, w21 w22, w33 w35, w37 w44, w45 w46 w35	w11	w17 w19 w24 w25 w34	w48	w26 w27 w28 w29 w30 w31 w32	w1 w13 w38 w39	w2 w47	w5 w6 w7 w8 w36	w12 w23	w3	w14 w16 w40 w49

The results of the application for waste scenarios are illustrated in Table 2. According the result of the firms in 2010, nine types of waste value have changed from worthless to valuable, two types of waste value from less valuable to valuable, and two types of wastes status have changed from worthless to less valuable with this model. This mean, in totally twelve types of wastes could be assessed more valuable with this facility selection approach.

TABLE 2
Waste scenarios according to application solve

Scenario 1 – Worthless waste			Scenario 2 – Less valuable waste	Scenario 3 – Valuable waste		
w1 - i19	w16 - i40	w41 - i3	w39 - i18	w2 - i27	w24 - i12	w34 - i12
w3 - i37	w18 - i3	w44 - i7		w5 - i27	w25 - i12	w36 - i25
w4 - i7	w20 - i7	w45 - i7		w6 - i27	w26 - i15	w40 - i40
w9 - i3	w21 - i7	w46 - i7		w7 - i27	w27 - i15	w42 - i6
w10 - i7	w22 - i7	w47 - i19		w8 - i27	w28 - i15	w43 - i2
w11 - i7	w33 - i7			w12 - i34	w29 - i15	w48 - i14
w13 - i19	w35 - i7			w17 - i12	w30 - i15	w49 - i40
w14 - i40	w37 - i7			w19 - i12	w31 - i15	w50 - i2
w15 - i5	w38 - i18			w23 - i34	w32 - i15	

5. Conclusion

The hazardous waste management is one of the most important issues in this century. The hazardous wastes are seen as valuable sources increasingly all over the world. In this context, there are a number of studies about hazardous waste management in the literature. The purpose of the hazardous waste management is to collect, transport, process, and dispose the wastes safely, efficiently and cost-effectively as well [9]. Within this context, an organized industrail zone was examined in terms of hazardous waste management. The study of the convenient waste facility selection was proposed for providing the wastes being processed under the objectives of minimum cost and transportation risk with using the mathematical programming.

Waste facilities may value the hazardous wastes differently. In this study, three types of scenarios were generated for understanding the waste value assessments of the waste facilities. In these scenarios, changes in transportation and process cost according to the assessment of the waste by the waste facility were taken into consideration. It will be advantageous for the waste producers to provide the transportation to the hazardous wastes that are produced by the firms in the organized industrial zone as batches.

A mathematical model was proposed to select the waste facilities that offer the minimum cost and transportation risk. The proposed model was applied to the real life problem in an Organized Industrial Zone in Turkey. There are 81 hazardous waste generator firms in the organized industrial zone. These firms produce 50 types hazardous waste and they sent them to 33 waste facilities. The model is solved with the optimization software GAMS. According to the model solution, 50 type hazardous wastes are transported to the just 15 different waste facilities and totally a profit has occurred from the hazardous wastes.

This study shows the hazardous waste valuableness with the scenarios which include the differentiations for the hazardous waste assessments. With the proposed model, the study of optimum facility selection is proposed for the hazardous wastes.

In this study it is assumed that the transportation risk is proportional with the transportation distance and amount of the wastes. For the future studies, it is suggested that the the possibility of accidents can be determined according to the routes, level of the waste danger, and the population on the routes.

Indeed there are many other issues that need to be studied in relation to the development of hazardous waste management. Holding studies on considering the hazardous wastes as renewable energy sources is very crucial for our health and future.

REFERENCES

[1] Alidi A. S., 1996, “A multiobjective optimization model for the waste management of the petrochemical industry”, Appl. Math. Modelling, Vol. 20, December

[2] Alumur S., Kara B. Y., 2007, “A new model for the hazardous waste location-routing problem”, Computers&Operations Research 34 (2997) 1406-1423

[3] Dutton R., Hinman G., Millham C. B., 1974, “Optimal Location of Nuclear Power Facilities in the Pasific Northwest”, Operations Research, Vol. 22, No 3, 478-487

[4] Erkut E., Neuman S., 1992, “A multiobjective model for locating undesirable facilities, Annals of Operation Research”, Vol. 40, No 1, 209-227

[5] Giannikos I., 1998, “A multiobjective programming model for locating treatment sites and routing hazardous wastes, European Journal of Operational Research”, 104 (1998) 333-342.

[6] Hazardous Waste Control Regulations, Turkey, 2005.

[7] Jianhua Y., 2008. “A Fuzzy Optimization Modeling and Algorithm on Hazardous Waste Reverse Logistics”, Wireless Communications, Networking and Mobile Computing, WiCOM '08. 4th International Conference on, 1-4.

[8] List ve Mirchandani, 1991, “An integrated network/planar multiobjective model for routing and siting for hazardous materials and wastes”, Transportation Science 25 (2), 146- 156

[9] Nema A. K., Gupta S.K., 1999, “Optimization of regional hazardous waste management systems: an improved formulation”, Waste Management 19 (1999), 441-451

[10] Nema A. K., Gupta S.K., 2003. “Multiobjective Risk Analysis and Optimiztion of Regional Hazardous Waste Management System”, Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management ASCE / April 2003, 69.

[11] Rakas J, Teodorovic D., Kim T., 2004. “Multi – objective modeling for determining location of undesirable facilities”, Transportation Research Part D: Transport and Environment Vol.9, (2004), 125-138

[12] Wang Z., Yin J., Ma W., 2008. “A Reverse Logistics Optimization Model for Hazardous Waste in the Perspective of Fuzzy Multi-Objective Programming Theory”, 2008 IEEE Congress on Evolutionary Computation (CEC 2008), 1576-1580

[13] Williams P. T., 1998. “Waste Treatment and Disposal”. John Wiley & Sons Ltd. England.

[14] Zhao J., Zhao J., 2010, “Model and Algoritm for Hazardous Waste Location- Routing Problem”, ICLEM 2010: Logistics for Sustained Economic Development, Vol. 4, (387) 398.

INFORMATION SYSTEMS: AS A FACILITATOR FOR GREEN SUPPLY CHAINS

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Abstract - *Today, profit-oriented traditional management paradigm is the dominant management paradigm in our world and environmental management paradigm is not strong enough to suppress it. So, the adoption of green initiatives by supply chain members, which mostly exposed by traditional management paradigm, is possible if these initiatives are not contrary with traditional management paradigm. Moreover, these initiatives should be parallel with this dominant paradigm and should provide profit-oriented benefits. At this point, information systems have a potential of providing profit-oriented and environmental benefits at the same time to the firms and the supply chain members simultaneously, and information systems can be used as a facilitator for adopting green initiatives.*
The adoption of green initiatives by supply chain members is not possible if these initiatives are contrary with traditional management paradigm, although these initiatives may save the planet from possible disasters. And supply chain partners will resist this kind of changes if they result with cost increase. Thus, we need applications which meet the requirements of both traditional management paradigm (provide profit-oriented benefits) and environmental management paradigm (protection of nature). Also these applications should weaken the resistance from the supply chain members. In this study, we will discuss what role that information systems can play in greening of supply chains and we will state information systems as a facilitator for green initiatives. To achieve this, we consider some applications of information systems as case studies.

Keywords - Environmental management paradigm, green, information systems, supply chain, traditional management paradigm

INTRODUCTION

In this study, we state information systems as a facilitator for companies which need to be green, but cannot be green voluntarily because of high costs. We assume that, normally supply chain members will be exposed by traditional management paradigm and they are profit oriented and environment is not their priority because they are exposed to traditional management paradigm. And information systems can be used to satisfy both two paradigms. In this research, we compare two paradigms frequently. Thus, before starting the main part we should clarify the characteristics and what we mean by traditional and environmental management paradigms briefly.

Traditional management paradigm, offers a profit oriented view. Environmental issues are not important, nature is a free source for production, and decreasing costs are vital for a company. This paradigm assumes that humankind is superior to nature.

In environmental management paradigm, profit and cost concerns are still important but environmental issues must be integrated into business processes. Firms' operations must be compliant with environment. Contrary to traditional management paradigm, this one sees humankind as a part of nature.

Also we use term "resistance" to mention the obstinacy of firms to be not green. In the following sections, we will discuss about factors which strengthen or weaken the resistance of supply chain members to go green and the role of information systems in this process.

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Factors that Strengthen the Resistance

The supply chain members which exposed to profit oriented traditional management paradigm tend to resist all of changes which are contrary with this paradigm. To this end, they can use all instruments to support their resistance. The instruments which strengthen supply chain members' resistance against green initiatives can be listed as;

- The power of multinational companies and lobbyists
- Lack of information
- Globalization
- Free market economy

The Power of Multinational Companies and Lobbyists: The majority of the 100 financial giants of the world consist of private companies. Environmental problems increase because of international finance system and firms which are stronger than governments. Those powerful firms can manipulate the legal system and may prevent government initiatives to implement green rules and laws. In some cases governments accept to regulate and reduce the pollution but they are not strong enough to force economic systems through this decision [1]. Governments do not wish to lose support of these lobbies. So, lobbies can easily oppose against sanctions which are contrary to their benefits.

Lack of Information: The literature has mix results for green SCM. Some of it suggest that going green increase cost for companies and reduce their competitiveness, while some others suggest that although there is initial cost increase, in the long run going green will positively affect company in financial forms [2]. As a result, going green has seemed as an uncertain journey.

As the results of Global Supply Chain Survey, in 2008, the most important problem for GSCM is not investment cost but the lack of information about legal regulations and limited knowledge of firms about what they should do to be green [3]. Also, another survey, *"How mature is the green supply chain"* in 2008, supports the idea of lack of information is the most important obstacle of green supply chain management [4].

Globalization: During the globalization process, international operating firms' supply sources have diversified and have spread to many countries. In terms of firms, diversification of supply sources makes it difficult to track the environmental impacts of suppliers. According to Cognizant White Paper (2008), proliferation of supply sources to many countries makes it difficult to monitor carbon footprints of finished products. However, new initiatives increasingly focus on suppliers' carbon footprints. Thus, firms aim to control environmental impacts of their supply chains.

Free Market Economy: Free market economy, which is the precondition of capitalism, has seen as the most important reason of environmental damages and disasters. According the most of researchers, free market economy increase the competitive and cost pressure on firms. It forces companies to ignore their environmental impacts and just focus on their costs and profits. Thus, short term profit expectations gaining more and more importance for companies and they don't care about negative environmental impacts of their business operations.

Modern industrial society is a system based heavily on the notion of profits. The bottom line for industrial companies is financial issues. To be successful they must increase revenues, reduce costs, and thereby achieve a healthy profit margin [5]. Objectives like employment, exports and protecting industries of strategic importance have traditionally enjoyed a higher political priority than safeguarding the environment [6]. So, tolerating expenditures to minimize the environmental impacts of business operations will not fit the notion of profitability.

Roarty [6] mentioned that, free market economics dictates that companies seek to minimize costs in order to maximize profits regardless of any environmental damage that might cause, in order to survive in highly competitive market.

Researchers often tend to state firms as a victim in the face of economic system. For example, according to [8]; given the close relation between minimizing costs and maximizing profits, it is natural to assume that an organization which seeks profits and has significant political power will feel some motivation to use that power to externalize costs, where possible. Also according to [6], to tendency to blame business for environmental problems overlooks the root causes which lie in the nature of the economic system and policy decisions made by government. However, by a more environmentalist perspective, [7] indicated that the expectation of solving environmental problems just by governments or industries, is a widespread incorrect idea. According to him, this manner and thought is a very dangerous delusion. This delusion shadowing the personal responsibility awareness and immobilize people against environmental destruction.

Factors that Weaken the Resistance

In the previous section we cited about factors which strengthen the resistance of firms, which are against environmental initiatives. In this section, we will try to reveal factors which weaken this resistance. The past twenty decades has seen momentous industrial development that has helped our world to realize immeasurable wealth and prosperity [9]. On the contrary, such a rapid development has lead to unintended ecological deterioration, including global warming, ozone depletion, industrial accidents, etc [9]. However, public opinion has interested on environmental issues for last twenty years and has started to forced companies and industries to be green.

Customer pressure is one of the most important factors that weaken the resistance of firms, which are not voluntary to perform green initiatives. In addition to customer pressure, different factors such as economic reasons and legal regulations [10]; market share (negotiations with suppliers and customer loyalty), need of risk management (risk of pollution, risk of bylaw and risk of losing competitive advantage) [11]; legal regulations, brand image, innovation and cost decrease [4]; pressure from supply chain members, rivals, environmental organizations [2] added by different researchers and consulting firms. We have to mention that, increasing energy costs are also an important factor that weaken the resistance of firms and industries.

All of these factors have different weights to weaken the resistance and all of them play a complementary role in this process. It is possible to generate these factors as follows;

- Increasing level of customer awareness
- Competitors gains'
- The need for differentiation from rivals
- Increasing energy costs
- Legal regulations

Increasing Level of Customer Awareness: Since the negative effects of the global environmental problems begin to affect the daily life and even jeopardize the future of mankind, consumers tend to show interest in what they consume and the impact of their consumption to the environment. Most of studies reveal that, today, people are more sensitive to environment [2] . [12] indicates that there has been increasing public attention placed on the overall condition of the natural environment.

Today, most of consumers and managers feel themselves responsible about environmental issues [13]. [14] mentioned that traditionally companies were judged by customers according to quality of their products, quickness of solving customer problems and degree of fairness. But today companies are measured according to (environmental) ethics. This trend affects firms, thereby supply chains and motivate them to be green.

Competitors Gains': Some of today's most successful organizations have made the decision to reshape themselves from the bottom up, improving their environmental profile and their public image, making financial savings and safeguarding against future environmental hazards [15]. By these improvements, a company is able to cost saving and increase their brand value. By this way, green initiatives become attractive for rivals.

3M company proceed a pollution control program called 3P (Pollution Prevention Pays). Between 1975 and 1990, 3M reduced their total pollution by over 530,000 tons (a %50 reduction in total emissions) and, according to company sources, saved over $500million through lower raw material, compliance, disposal and liability costs [16]. Another example is about Toyota, the automobile manufacturer, produced environmental car: Prius. Survey results show that Toyota's brand value increase about 47% [17]. We have to mention that, green initiatives are not profitable always. But it is available for differentiation and having competitive advantage. So, these type of advantages motivate rivals to be green.

The Need For Differentiation From Rivals: Companies operating in the same industry lost their diversity so there is no way for consumers to look civilization level of competing companies when making choices. Today, there is no significant differences between quality and prices so consumers prefer to buy from environment friendly companies [14], [2]. Also [18] cited that the most important reason for companies to be green is, not to lose their competitive positions. And this is why lots of companies are trying to put forward their environmental features and show up how green they are.

Increasing Energy Costs: Increasing of energy costs day by day, pushing companies to find a solution to this problem. Increasing number of green buildings that decrease energy consumption is one of these solutions. Another solution is APUs (Auxiliary Power Unit). The auxiliary power unit (APU) offers long-haul truck drivers amenities like air conditioning during driving breaks while eliminating the need to idle the engine. This technology could help eliminate 11 million tons of carbon dioxide emissions from truck idling in the United States each year [19].

Wal Mart, the retailer company which has the second largest private fleet in USA, purchase and install 7,000 APUs in its long-haul trucks. The company has estimated APUs save $25 million in annual fuel costs, a figure that has likely increased with higher global oil prices in 2007 and 2008 [20].

Legal Regulations: Government, as a regulatory agency, may force companies and ultimate consumers to be compliant with different environmental regulations. Unlike the other factors, government doesn't leave freedom of choice to companies and consumers [2]. Governments warn companies to be more sensitive against environment and force them to comply with environmental regulations. So, governments and legal regulations can be evaluated as one of the most important factor for weaken the resistance of companies, which are not volunteering to be green.

Comparison of Strengthening and Weakening Factors

Recently, the impacts of resistance weakening factors which force supply chain members to be green is rising. It has lots of reasons. Today, global environmental problems affect the daily life of people. Since people face with environmental problems, they are more sensitive to environment. Governments burden more strict environmental regulations to companies, firms burden more strict environmental rules to their suppliers and public opinion pushes consumers to be "green consumers". These improvements are the evidence of how environmental management paradigm get strong. Figure 1 shows the increasing impacts of environmental factors.

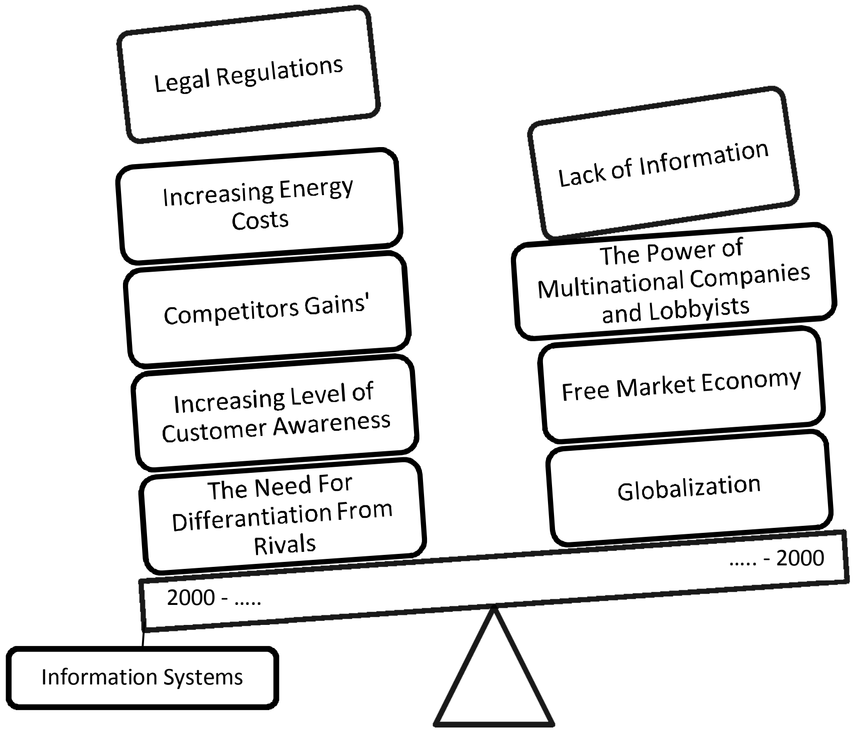

FIGURE. 1
Strengthening and Weakening Factors

Although environmental management paradigm has getting strong, traditional management paradigm is still affecting the supply chains powerfully. The majority of the world has dominated by free market economy and this economic system feeds traditional management paradigm. So, despite on the increasing number of pushing factors, acceleration of green initiatives are still not enough. Acceleration of green initiatives and applications mostly depend on voluntarism of firms. If companies internalize green initiatives voluntarily, then greening of supply chains become easier.

In this point we have to ask this question: How it is possible to increase voluntarism level for green initiatives? The answer is hidden in the foundations of traditional management paradigm. If green initiatives provide some advantages like cost reduction, increasing brand value, operation efficiency…etc, it will be easier to green supply chains.

Then, is it possible to find solutions which save the planet and satisfy companies simultaneously? Now, we will discuss how a role that information systems can play at this point.

THE ROLE OF INFORMATION SYSTEMS IN GREEN INITIATIVES

As we mentioned before, under normal conditions, supply chain members won't go green voluntarily. Some of pressure groups and factors force them to be green, but they are not enough to suppress the impacts of traditional management paradigm. In this section, we suggest that; acceleration of green supply chains can be achieved if supply chain members are voluntarily accept to be green. And information systems can be used for this purpose.

When we have a look at the resistance-breaking factors, like government regulations, customer preference, energy costs etc, they all have a potential to push companies to be green. Firms are performing green applications both for to be compliant with market and avoiding financial sanctions.

But, as we can see in business world, greening process is too slow and these factors are not enough. Actually there are lots of green opportunities for companies but unfortunately just a minority of companies can see and evaluate these opportunities.

The adoption of green initiatives by supply chain members is not possible if these initiatives are contrary with traditional management paradigm, which offers profit orientation and cost reduction. For adaptation of green applications, they should be parallel with traditional management paradigm because firms operating in free market economies are exposed by this dominant management paradigm. It means, green initiatives should provide some advantages to the firms, like profit increase and cost reduction.

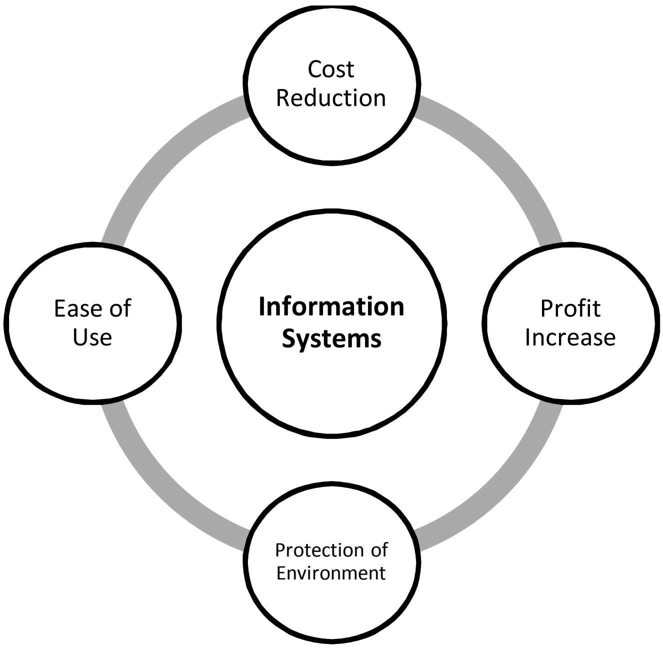

FIGURE. 2
The Role Of Information Systems In Green Initiatives

This study suggests that; information systems are able to provide advantages that facilitate the adoption of green initiatives. If supply chain members are exposed by traditional management paradigm and if they are profit and benefit oriented, then they won't oppose information systems which provide them cost reduction and easy to use. And if these systems are green oriented at the same time, adoption process will be easier.

It is possible to talk about four roles of information systems in terms of green supply chain management;

- Cost reduction
- Profit increase
- Ease of use
- Protection of environment

In the following section, we present a case study which shows all these mentioned benefits of an information system.

Case Study: E-Bill

Today, lots of private and public firms tend to inform their customers about their payments by e-bill. In this study, we state e-bill as a green IS. E-bill is a good example, because it offers all of advantages of green IS; cost reduction, profit increase, ease of use and protection of environment. Now, we will focus on the advantages of e-bill, in terms of business and environment.

Traditional postal system requires lots of actors; like cargo firm, postman etc. And most importantly, it requires a more complicated physical distribution process. On the other side, an e-bill just requires a simple internet system. So, internet allows companies to reduce complexity. Another advantage of e-bill is clearing the errors away. In traditional system, there are lots of processes which made by humans; like material handling, posting, delivery, packaging etc. And these processes are error-prone. In the contrary, just a good working software is enough for an error free process for e-bill system because human hand factor is mostly eliminated. Also, if we compare these two systems with regard to their costs, of course e-bill is cheaper than traditional posting. Beyond these advantages, green image allows companies to increase their brand value. Today, lots of research results reveal that greening efforts have positive impacts on brand value.

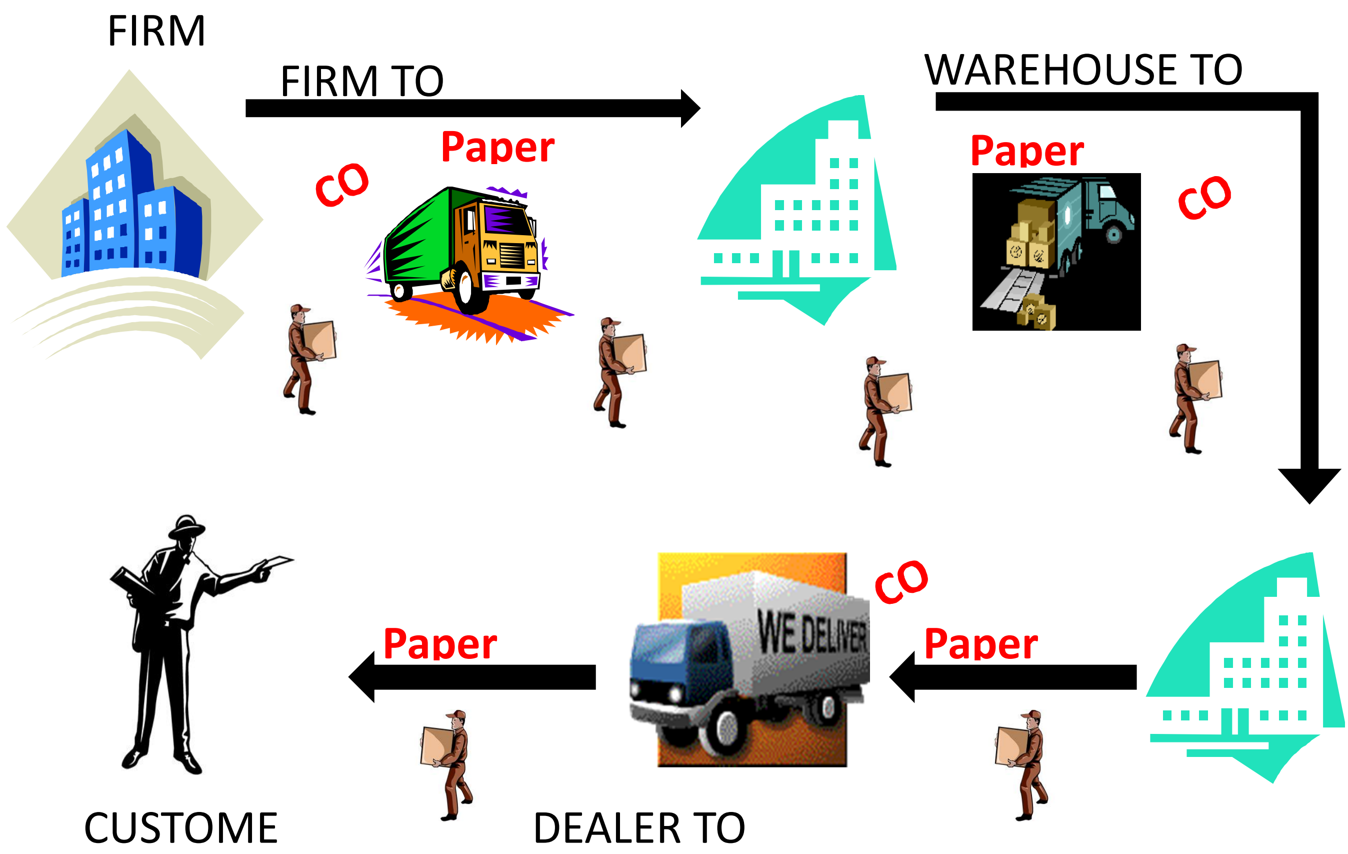

FIGURE. 3
Supply Chain of Traditional Posting System

To benefit from the advantages of e-bill system, companies have to meet two main criteria; (i) technical infrastructure and (ii) convincing consumers. The initial investment cost will be high for technical infrastructure, but the total cost will decrease in the long run. On the other side, convincing consumers to use e-bill rather than traditional bill is more problematic than establishing technical infrastructure.

For convincing customers to use e-bill, putting environmental problems forward is a good strategy and most of companies tend to use this strategy. In different ads, companies indicate global environmental problems and its' consequences to the world and emphasize the importance of e-bill to stop this negative consequence. We caution that , putting environmental problems forward might be a good mask for companies. Are they really environment friendly or just profit oriented? This is uncertain at this point. Additionally, some of companies award their customers who prefer to use e-bill by different promotions. By these efforts, customers become voluntary to use e-bill.

From the perspective of consumers, e-bill allows them to get rid of some problems which they face in traditional postal system. Problems like delaying of bill, losing of bill, the necessity of saving the bill anywhere, the visibility of bill amounts by unwanted persons, can be solved by e-bill system. By this system, bills arrive on time, can be saved into e-mail address, and can be viewed just by the relevant person. Also small promotions make e-bills more attractive. Another advantage of e-bill is to get rid of the cost of traditional postal fee. Companies are generally tend to reflect the postal fee to the customers' invoice and e-bills remove these costs. On the other hand, it allows customers to feel happy to save trees (and planet) and satisfies their consciousness.

From the perspective of nature, e-bill has lots of advantages for planet. First of all, it saves trees by reducing paper usage. So, companies need less paper and less trees need to be cut down. Also, because of decreasing package cycle, in the physical distribution process firms need to consume less gas or petrol. It means they consume less energy, less natural resource, and reveal less carbon emissions to the atmosphere.

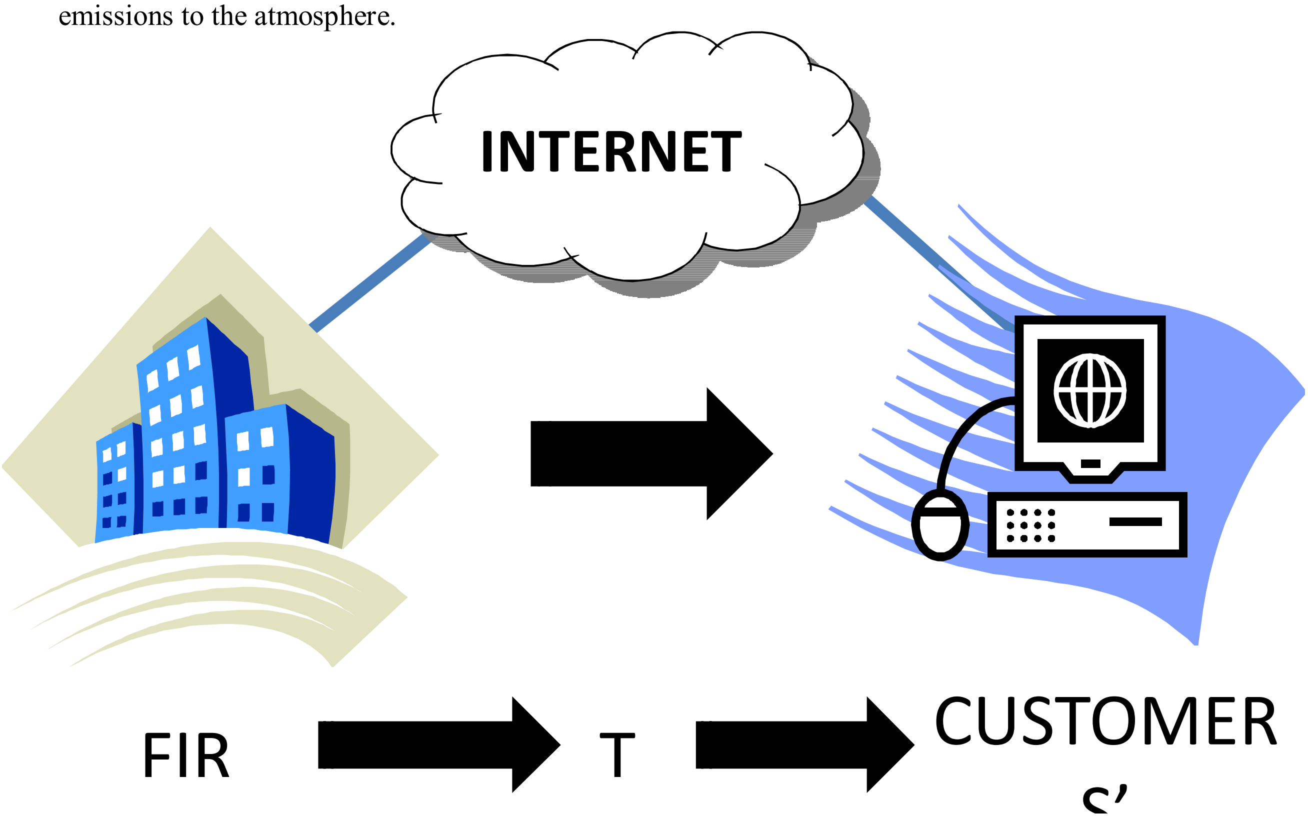

FIGURE. 4
Supply Chain of E-Bill System

E-bill system is a good example for how information systems play a facilitator role in green initiatives. It provides logical and conscientious confidence to the firms and consumers. Of course e-bill system is just a sample of advantage of information systems. There are lots of opportunities that provides advantages to firms, customers and environment, like EDI. EDI (electronic document interchange) allows firms and customers to go paperlesss and speed up the process. Also it reduces the paper usage and saves trees. These examples can be increased easily. Now we will try to determine the common characteristics of these examples;

a) The priority of supply chain members (which are the sides of green information systems applications) is profit and benefit, not environmental concerns. So these information systems were not preferred because of their environmental friendly characteristics.

b) Supply chain members were not forced to implement or participate in these applications. They implement / participate in these applications voluntarily, because of their own benefits.
c) Information systems may offer cost advantages to the supply chain members.
d) Information systems may offer ease of use to the participants and facilitate their daily life of business.
e) Information systems reduce the negative impact of business, saves the natural resources, provides less energy consumption.

TABLE 1

Comparison of Two Systems: TPS vs. E-Bill

	TPS	**E-BILL**
Complexity	High	Low
Possibility of Error	High	Low
JIT Delivery	Low	High
Automation	Low	High
Manpower	High	Low
Delivery Cost	High	Low
Initial Cost of system designing	Low	High
Difficulty of managing system	High	Low
Customer satisfaction	Low	High
Energy consumption	High	Low
Paper usage	High	Low
Carbon Dioxide Emissions	High	Low

Regarding to this consequences, we can suggest that the probability of adoption of green initiatives depends on traditional management paradigm. If new green practices and applications are not based on traditional management paradigm, the adoption of green initiatives by supply chain members will not be possible although these initiatives may save the planet from possible disasters. Information systems are providing some advantages which are based on these values (profit and benefit) and save the planet at the same time and make it possible to adoption of green initiatives. And so, we clarified the importance of information systems in greening of supply chains.

RESULTS

Supply chain members are mostly aware of the global environmental problems and their negative roles in this process. However, because of their profit oriented natures, they are not voluntarily stop their negative impacts if these efforts result with cost increase. Furthermore, they tend to resist all factors which force them to be green. This resistance will be maintained as long as a new paradigmatic breaking occurs in traditional management paradigm, which puts environmental issues in the center of businesses. Although some of instruments began to mature that weakens the resistance of companies (and traditional management paradigm), a full transformation will take a long time.

In that case, the best way to be green is to make companies participate voluntarily. And information systems have this potential of *satisfying firms, customers and environmental issues simultaneously.*

REFERENCES

[1] Ponting, Clive (2007), *Dünyanın Yeşil Tarihi*, çev. Ayşe Başçı, Sabancı Üniversitesi Yayınları, Güncellenmiş Yeni Basım, İstanbul

[2] Güner, S. and E. Coskun (2010), "The Role Of Customer Choices In Green Supply Chain Management-An Ampirical Study In Sakarya Region", VIII. International Logistics & Supply Chain Congress, p.65-75, Istanbul

[3] Cognizant White Paper (2008), *"*Creating a Green Supply Chain, Information Technology as an Enabler for an Green Supply Chain", www.cognizant.com/.../Creating_a_Green%20Supply_Chain_WP.pdf

[4] Bearingpoint Management&Technology Consultants (2008), *"2008 Supply Chain Monitor, How Mature Is The Green Supply Chain"*, www.escp-eap.eu/uploads/.../Supply_Chain_Observatory_2008.pdf, Survey Report

[5] Jackson, Tim ve Roland Clift (1998), "Where's The Profit In Industrial Ecology?", *Journal Of Industrial Ecology,* Vol: 4, No: 1

[6] Roarty, Michael (1997), "Greening Business in a Market Economy", *European Business Review,* Vol: 97, No: 5, p. 244-254

[7] Çepel, Necmettin (1992), *Doğa-Çevre-Ekoloji ve İnsanlığın Ekolojik Sorunları*, Altın Kitaplar Yayınevi, 1. Baskı, İstanbul

[8] Dwyer, Rocky J. (2009), "Keen To Be Green Organizations: A Focused Rules Approach To Accountability", *Management Decisions*, Vol. 47, No:7, p. 1200-1216

[9] Paulraj, A. (2006), "Green Supply Chain Management: Critical Research And Theoretical Framework", *4. Worldwide Research Symposium On Purchasing And Supply Chain Management,* San Diego

[10] Büyüközkan, Gülçin ve Alişan Çapan (2007), "Improving Green Supply Chain Management Practices: A Case Study", *International Logistics and Supply Chain Congress*, 2007, İstanbul

[11] Yang, Tong, Nengmin Wang ve Youlin Zhu (2006), "The Research Actuality And Direction Of Green Supply Chain Management", *International Journal Of Business And Management,* Vol: 1, No: 5

[12] Beamon, B., M., 1999, "Designing The Green Supply Chain", Logistics Information Management, Vol: 12, No: 4, p. 332-342

[13] Zaltman, Gerald ve Lindsay ZALTMAN (2008), *Pazarlama Metaforları*, çev. Ümit Şensoy, Optimist Yayınları, Birinci Basım, İstanbul

[14] Kotler, Philip (2004), *Günümüzde Pazarlamanın Temelleri*, çev. Ümit Şensoy, Optimist Yayınları, 2. Baskı, İstanbul

[15] Zee, Bibi Van Der (2008), *Green Business*, Dorling Kindersley Limited, http://proquestcombo.safaribooksonline.com

[16] Hart, L. Stuart ve Gautam Ahuja (1996), "Does It Pay To Be Green? An Empirical Examination Of The Relationship Between Emission Reduction And Firm Performance"*, Business Strategy And The Environment*, Vol:5, p. 30-37

[17] Yavuz, Hande (2007), *"Yeşil Şirket Olma Yarışı"*, Capital Dergisi, http://www.capital.com.tr/haber.aspx?HBR_KOD=4182, Access Date: 16.03.2010

[18] Erbaşlar, Gazanfer (2007), "Yeşil Pazarlama", *Paradoks, Ekonomi, Sosyoloji ve Politika Dergisi*, Yıl: 3, Sayı: 1

[19] Gereffi, G. and K. Dubay (2009), Auxiliary Power Units, Center on Globalization

[20] Addison, John. (2007), Wal-Mart to Save $300 Million with Hybrids. Retrieved May 22, 2008, from http://www.cleanfleetreport.com/fleets/walmart.htm

INTER-ORGANIZATIONAL ISSUES TOWARD A "GREENER" SUPPLY CHAIN

Dorsaf Zouari [1]

Abstract *—Recent changes in environmental legislation have focused company thinking on business practices, particularly concerning the importance of integrating environmental concerns like outsourcing and procurement in supply chain networks. Supply chain partners are becoming progressively more accountable not only for their internal practices, but also for their suppliers' behavior because implementing a "greener" supply chain is far from an individual strategy.*

The objective of this paper is to study the difficulties that may be encountered by a focal firm with its partners from the perspective of implementing environmental practice issues, or improving these practices if they already exist. In this paper we develop an integrative conceptual framework to show the role of relationship types, contract design and clauses to coordinate the relationship between a focal firm and its supplier in the implementation of a green supply chain.

Keywords — Supply chain, outsourcing relationships, environmental practices, contract design

INTRODUCTION

For the past several years environmental legislation and governmental regulations have evolved in favor of environmental protection, demonstrating that integration of environmental practices is increasingly important [1]. As a result, companies place importance not only on their internal practices, but also on their suppliers' practices [2].Companies have thus started to integrate ecological issues into their global supply chains to preserve their market position, to gain competitive advantage and to improve their brand image.

Environmental performance standards have become commonplace in contract design and guidelines created by multinational companies to define their relations with local and international suppliers [3]-[4]. These constraints are relatively new for suppliers since they exceed traditional customer requirements, which were previously limited to reducing costs and improving product and service quality [5].

There is little researches that consider implications of buyer-supplier relationship type on the absorption of supply chain related inefficiency due to environmental initiatives. The presence of specific conditions influencing the customer relationship, such as power, the governance mechanism or collaboration, could moderate the impact of establishment of environmental practices and their critical requirements. Effective supplier management in substantial projects like Green Supply Chain (GSC) development is an important field, meriting attention and research.

To better understand the context of our research, Figure 1 explains how implementation of green supply chain practices can be perceived, different supplier attitudes and scenarios that a focal company may consider. The buyer- supplier relationship types that we detail later in this article have a strong link with supplier attitudes in this diagram.

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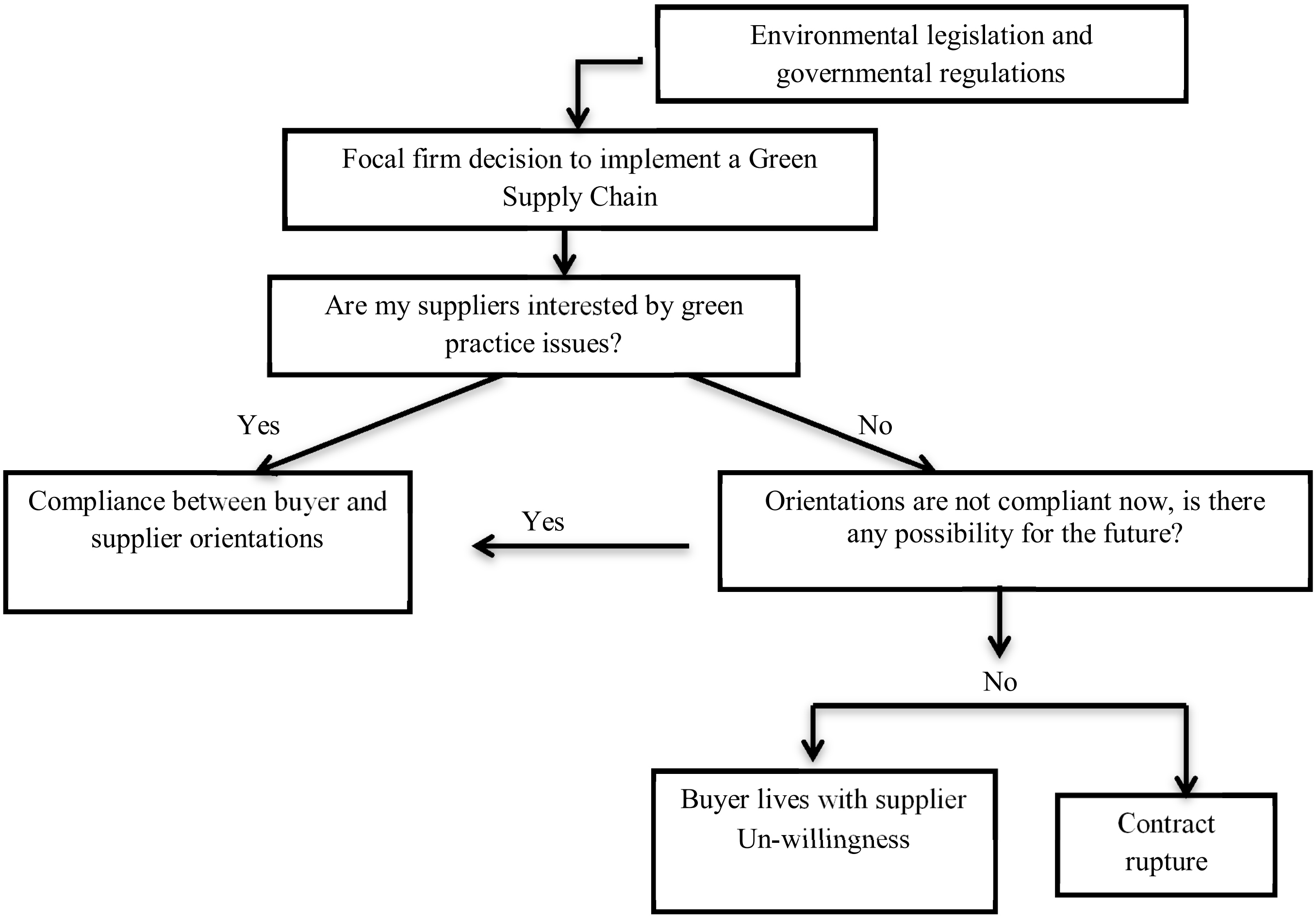

FIGURE. 1
Study Context

Greening the Supply Chain

In recent times, a new challenge for companies has become making their supply chains as "green" as possible. GSC covers vast practice domains including product design, material selection and sourcing, manufacturing processes and delivery. It also implicates end-of-life cycle product management with reverse supply chain and involves management of supply chain participants from suppliers and manufacturers to customers [6]-[7]. Implementation of environmental practices seems to be a lengthy process from start to finish and implies mobilization of many actors and diverse resources.

Generally, big companies are the focal firm in their supply chain networks, and as such are considered major actors in the diffusion of "green" practices within a supply chain. Environmental regulation demands incite these companies to encourage their suppliers to implement green practices, which they then adopt according to national and international standards.

During this transition, these focal companies consider various constraints generated by their suppliers that are generally SME [8]. In this context, SMEs setting up green practices demanding strategy, production process and technical issue changes can face financial problems. To give an example, we cite the case of a product eco-design which requires review of existing strategies and adoption of a holistic approach since the product life cycle must be considered in its entirety. This process is costly.

Certification is another challenging area for suppliers. Indeed, spending on certification is considerable and sometimes difficult with respect to scheduling demands.

Another significant source of difficulty for focal companies is suppliers from developing countries where environmental legislation is not as developed. This point should be considered when studying inter organizational relationships, as it can explain supplier non-compliance with certain standards and informs the influence of cultural differences on perceptions of certain factors in various cultural contexts [9].

Embracing environmental issues can, however, be a key used by SMEs to enhance their relationships with customer companies and to ensure a favored position on the "best" suppliers list.

THE ROLE OF ENVIRONMENTAL LEGISLATION THE DEVELOPMENT OF A GREEN SUPPLY CHAIN

Governmental regulation was the initial key driver for implementation of environmental practices in supply chains [10]. Environmental regulations continually fight against that which may harm the environment and governments encourage companies to be increasingly involved in such initiatives. Environmental certifications indicating compliance with common frames of reference can be viewed as effective communication tools that help buyer companies minimize uncertainty with suppliers. Several authors wonder, however, whether initiatives taken by governments have the same impact on business, broadly speaking, and on SMEs to promote implementation of practices that respect the environment and develop holistic GSC [8].

Evolution of environmental legislation is ongoing and places SMEs in a delicate situation, since direct and indirect nonconformity costs can be considerable (fines in the event of control, investment production process, etc). Companies do, none the less, draw benefit from certifications that effectively ensure their place in the market because of the competitive differentiation that certifications provide.

***Hypothesis* 1**: Environmental legislation has an impact on the establishment of "green" practices in the supply chain.

Buyer –Supplier Relationships in A Green Context

Even though the context of "green management" is relatively new, the buyer-supplier relationship has always been an important topic of research in supply chain management and has been the subject of many articles [11]-[12]-[13].Indeed, management of inter-firm relationships is essential, the type of relationship linking contractors playing a central role in good supply chain coordination and improvement of supplier production and capacity performance [14] [15].

Much research has been done on classification of various inter-organizational relationships – especially the buyer-supplier relationship. In this article, the buyer-supplier relationship is studied in a specific context, i.e. implementation of "green" supply chain practices [16]-[17]. Establishment of environmental strategies and innovation within companies is strongly influenced by the financial resources and technical skills each supply chain partner brings to bear.

Several variables can encourage good behavior in establishing green supply chain practices (in the buyer-supplier relationship context). These variables are not always influenced by trust, but depend on other factors like power sharing and dependence [18].

Reference [19] notes that supply chain relationships are characterized by several dependency levels involving varying degrees of cooperation. We will try to detail this through examination of buyer capacity to impose supplier implementation of "green" practices in differing buyer-supplier relationships.

A Simple Transaction Relationship

In this relationship, the only criterion retained is the lowest price and the relationship is generally a short term one [20]. The low cost approach adopted in this relationship can justify the suppliers' reject to innovation or the establishment of new initiatives such as environmental practices.

The nature of this relation, which is initially market based [21] ,can, however, present blockades (on the supplier's side) to implementing environmental practices due to the weight of investment necessary. This is especially true in countries where environmental legislation is not very developed.

The Buyer is one of the Most Important Customers for his Supplier

In this case, the customer leads the relationship and therefore fixes the game rules. In the context of implementing green practices, the supplier is the dependent party and is thus obliged to cooperate with its major customer to survive and to avoid sanctions. This type of relationship is regarded as cooperation under-constraint [22].

The supplier's situation is very delicate. The customer may suggest knowledge skills and financial help to encourage adoption of green initiatives, or, on the other hand they may not be able to provide any support for the desired changes. Regardless of the position taken by the customer/buyer, they can continue to put pressure on the supplier to keep purchase prices low. Given this variety of interdependence, and resulting from the ensuing pressure, suppliers often have a tendency to cheat on product quality.

Implementing "green" practices represents a new constraint for the supplier, and the customer must therefore be vigilant, using follow-up and monitoring procedures to assure ecological conformity of the supplier's products and practices.

The Supplier Leads the Relationship

In this relationship the supplier leads because of particular technical skills or a specific asset [21] and lack of competition in the field enables them to call the shots.

Generally speaking, the integration of environmental practices in the supply chain depends on the supplier willingness. If they accept to adopt environmental practices they may require to increase the purchase price, the buyer is then obliged to accept.

Interdependences and Mutual Interests Shared by the Buyer and His Supplier

This relationship is completely different from previous ones, and strong interdependence between the buyer and its supplier allows them to carry out joint projects due to the long-term nature of their relationship [23]. According to these authors, this is a cooperative relationship characterized by a high degree of information sharing and based on a high level of trust. The two partners are ready to share knowledge (technical and organizational) [24] and aim at achieving common goals with profit and loss sharing. Consequently, a "green" practices implementation initiative is not likely to create friction between the buyer and their supplier.

Hypothesis 2: Integration of "green" practices in the supply chain depends on the type of buyer-supplier relationship.

Using the above noted classifications of different buyer-supplier relationships, one can observe that these relationships are also influenced by other variables than simply type of dependence. These additional factors include trust and power, which can be described as either coercive or non-coercive.

"Trust" is a critical element in successful relationships in the supply chain and so can facilitate joint action and share knowledge, but it can be exploited for an opportunist behavior and asymmetry of information [25].

If obligation dominates a "GSC" initiative, that gives the customer/buyer partner real coercive power, including the ability to threaten and retaliate in the form of financial penalties or termination of contract with suppliers for non compliance. On the other hand, exercising non-coercive power may have a positive influence on the overall initiative [26]

Hypothesis ***3***: Several control variables can impact (positively /negatively) implementing green practices.

COORDINATION VIA CONTRACT DESIGN

Contracts appear to be important coordination mechanisms to control and manage inter-firm relationships between the buyer company and its partners [27]- [28] -[29]. Indeed, in the context of integration of environmental issues, the buyer has to review the existing game rules with its partners and negotiate new points to be integrated. That's why we propose contract design as a relevant governing tool and guide for good conduct between contractors. Contracts can also attempt to foresee risks likely to appear in the future [30].

In a supply chain, there exist various types of contractual clauses (flexibility, price, quality, incentives) that use contractors as a means to guarantee better performance levels and to protect buyers against risks and uncertainties. In this study we are interested in incentive and control clauses.

In deed, Incentive strategies open up exciting prospects to manage coordination between actors in conflict situations; the success of the GSC implementation is very related to the power factor and incentive control that interferes within relationships between supply chain partners [31].

Our research is concerned with supplier development processes since in our case study, customer companies are not looking for new partners but are trying to work with their existing partners. The decision to focus on contract renegotiation centers on reviewing existing clauses [32] or defining new clauses, which integrate new constraints. This process depends on the level of supplier willingness to participate in a “green” initiative and ultimately on their intention to maintain a relation with their customer.

In our framework incentive clauses define the environmental requirements in which the buyer is interested; if suppliers do not respect theses clauses, penalties can be considered and control clauses make mitigating risks possible.

Hypothesis 4: designing contractual clauses in the context of implementing a “GSC” depends on the type of buyer-supplier relationship.

***Hypothesis 5*:** the contractual clauses depend on the level of supplier willingness to establish new “Green” practices.

Using this conceptual model (based on our analysis and previously performed literature review) we have tried to present various potential interactions between elements involved in implementing “green” practices in a supply chain. This can help supply chain members better understand the diverse elements that must act together to successfully manage a holistic GSC project implementation.

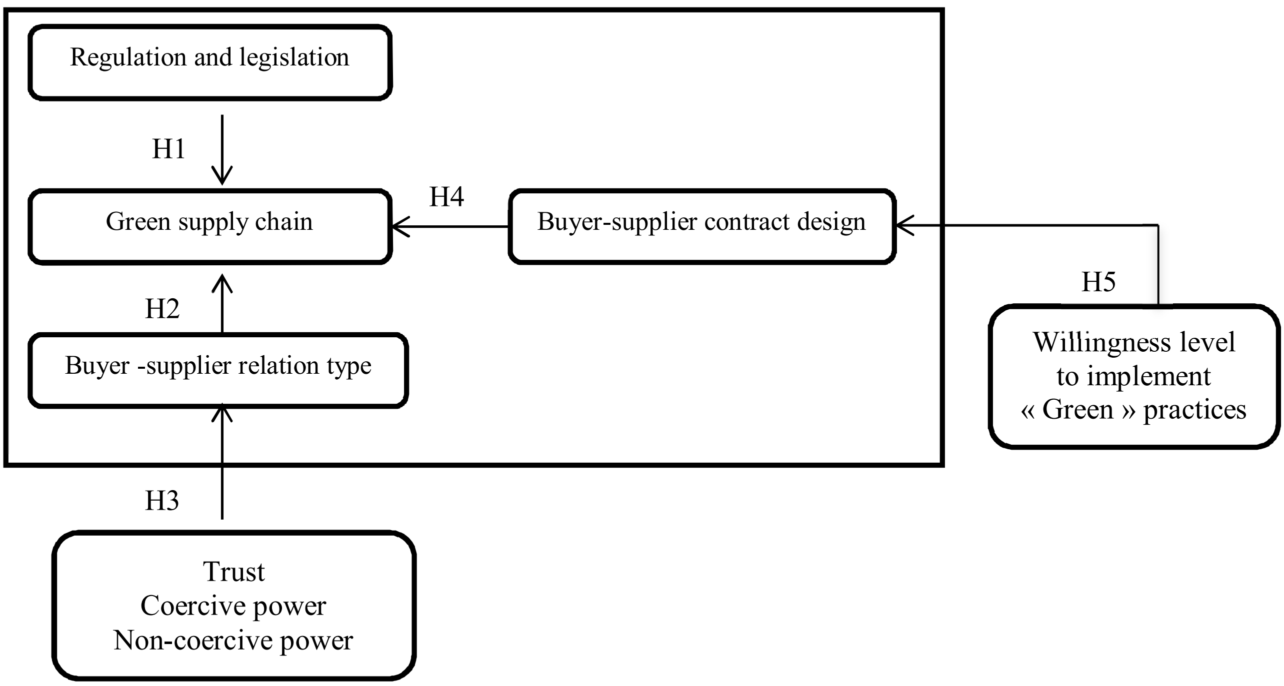

FIGURE. 2
The Implementation of a Green Supply Chain Framework

DISCUSSION AND CONCLUSION

Much attention has been paid to the importance of addressing and implementing responses to green issues within supply chains, including inter organizational initiatives to improve execution of environmental practices and economic efficiency in the context of global supply chain management. The wide-ranging nature of such initiatives makes implementation difficult and complex, and success is influenced by several factors. The conceptual model in this article treats the impact of relational aspects on the establishment of a GSC.

Nevertheless, like all research studies, our framework presents a number of limitations. We can cite two principal ones. The first relates to the fact that this study is undertaken from the buyer company point of view, both in terms of conceptualization of different relationship types and also in terms of contract design as a mechanism to coordinate these relationships in the context of establishing a GSC.

The second limit is related to the absence of empirical validation of the proposed framework; this step is in progress and will be the subject of a later research paper.

Future research should lead to interesting insights, not only concerning the role of contracts as coordination mechanisms in implementation of GSC, but also the importance of contract renegotiation to improve GSC performance.

REFERENCES

[1] Winkler, H., Kaluza, B., Schemitsch, H.B., 2006, "Managing economical and ecological goal conflicts – demonstrated in the context of Sustainable Supply Chain Networks". Discussion Paper of the Economic Sciences at the Alpen-Adria-Universität Klagenfurt.

[2] Maignan, I., Hillebrand, B. and McAlister, D., 2002, "Managing socially-responsible buying: How to integrate non-economic criteria into the purchasing process", European Management Journal, 20, No 6, 641-648.

[3] Browen, F.E., Cousins, P.D., Lamming, R.C. and Faruk, A.C., 2001, "The role of supply management capabilities in green supply", Production and Operations Management, 10, No 2, 174-189

[4] Zhu, Q. and Sarkis, J., 2004, "Relationships between operational practices and performance among earl y adopters of green supply chain management practices in Chinese manufacturing enterprises", Journal of Operations Management, 22, No 3, 265-89.

[5] Lambert, D. and Cooper, M.,2000, "Issues in supply chain management", Industrial Marketing Management,29, No 1, 65-83.

[6] Zhu, Q. and Sarkis, J., 2006, "An inter-sectoral comparison of green supply chain management in China: drivers and practices", Journal of Cleaner Production, 14, No 5, 472-86.

[7] Rao, P. and Holt, D., 2005, "Do green supply chains lead to competitiveness and economic performance? ", International Journal of Operations & Production Management, 25, No 9, 898-916.

[8] Friedman, A.L. and Miles, S., 2002, "SMEs and the environment: evaluating dissemination routes and handling levels", Business Strategy and the Environment, 11, No 5, 324-341

[9] Seppänen,R., Blomqvist K.,. Sundqvist S., 2007, "Measuring Interorganizational Trust – A Critical Review of the Empirical Research in 1990- 2003", Industrial Marketing Management, 36, No 2, 249-265.

[10] Rivera, J., 2004, "Institutional pressures and voluntary environmental behavior in developing countries: evidence from the Costa Rican hotel industry". Society and Natural Resources 17, No 9,779–797

[11] Coviello, N.E., Roderick J.B., Peter J. D. and Wesley J.J., 2002, "How Firms Relate to Their Markets: An Empirical Examination of Contemporary Marketing Practices", Journal of Marketing, 66, No 3, 33-46.

[12] Golicic, S.L, Foggin, H.J. and Mentzer J.T., 2003, "Relationship Magnitude and its Role in Interorganizational Relationship Structure", Journal of Business Logistics, 24, No 1,57-76

[13] Ring, P.S and Van de Ven, A.H., 1994, "Developmental Processes of Cooperative Inter-organizational Relationships", Academy of Management Review, 19, No 1, 90-119.

[14] Handfield, R.B., Krause, D.R., Scannell, T.V. and Monczka, R.M., 2000, "Avoid the pitfalls in supplier development". Sloan Management Review, 41, No 2, 37-49.

[15] Scannell, T.V., Vickery, S.K. and Droge, C.L., 2000, "Upstream supply chain management and competitive performance: the automotive supply industry", Journal of Business Logistics, 21, No1, 23-48.

[16] Simpson, D., and Power, D., 2005 "Use the supply relationship to develop lean and green suppliers", Supply Chain Management: An International Journal, 10, No1, 60-68.

[17] Simpson D., Power, D. and Samson, D., 2007, "Greening the automotive supply chain: a relationship perspective", International Journal of Operations and Production Management, 27, No1, 28-48.

[18] Ferrer, M., Santa, R., Hyland, P. and Bretherton, P., 2010, "Relational factors that explain supply chain relationships", Asia Pacific Journal of Marketing and Logistics, 22, No 3, 419-440.

[19] Turner, G. B.; LeMay, S. A.; Hartley, M. and Wood, C. M., 2000, "Interdependence and cooperation in industrial buyer-supplier relationships", Journal of Marketing Theory and Practice, 8, No 1, 16-24.

[20] Agrawal, N., Smith, S.A. and Tsay, A.A., 2002, "Multi-vendor sourcing in a retail supply chain". Production and Operations Management, 11, No 2,157-182.

[21] Williamson, O., 1975, “Markets and Hierarchies: Analysis and Antitrust Implications”. Free Press, New York.
[22] Boersma, M., Buckley, P. and Ghauri, P., “2003). Trust in international joint venture relationships”. Journal of Business Research, 56, 1031-1042.
[23] McEvily,B., Perrone, V. and Zaheer, A., 2003, “Trust as an Organizing Principle” , Organization Science, Informs , 14, No 1, 91-103.
[24] Richardson G.B., 1972, “The organization of industry”, Economic Journal, 82, 883-896.
[25] Cheng, J.H, Yeh, C.H and Tu, C.W., 2008, “Trust and knowledge sharing in green supply chains”, Supply Chain Management: An International Journal, 13, No 4, 283-295.
[26] Hausman, A. and Johnston, W.J., 2010, “The impact of coercive and non-coercive forms of influence on trust, commitment, and compliance in supply chains”, ndustrial Marketing Management, 39, 519–526
[27] Houston, M.B. and Shane A.J., 2000, “Buyer-Supplier Contracts Versus Joint Ventures: Determinants and Consequences of Transaction Structure”, Journal of Marketing Research, 37, No l, 1-15.
[28] Anderson, S.W. and Dekker, H.C., 2005, “Management control for market transactions: The relation between transaction characteristics, incomplete contract design, and subsequent performance”, Management Science, 51, No 12, 1734-1752.
[29] Taylor, T.A. and Plambeck, E.L.,2007,”Supply chain relationships and contracts: the impact of repeated interaction on capacity investment and procurement”, Management Science, 53, No. 10,1577–1593.
[30] Pppo, L., Zenger T., 2002, “Do formal contracts and relational Governance Function as substitutes or complements? ”, Strategic Management Journal, 23, No 8,707-725.
[31] Kogg, B., 2003, “Power and incentives in environmental supply chain management”, Seuring, S., Müller, M., Goldbach, M., Schneidewind, U., Strategy and Organization in Supply Chains, Physica, Heidelberg, p. 65-81.
[32] Tirole, J., 1986, “Hierarchies and Bureaucracies”, Journal of Law, Economics and Organization, 2, No 2,181-214.

A METAHEURISTIC APPROACH FOR LOGISTICS MANAGEMENT OF DRUG COLLECTION, DISPOSAL AND RECYCLING

Ayşe BAYRAK[1] , Bahar ÖZYÖRÜK[2]

Abstract − *The importance and necessity of the health sector on throughout the world shows a progressive increase. Accordingly, the drug needs and drug consumption is also increasing. If not appropriate disposal, losses of medicines can reach serious proportions. That is also a known fact. In this study, after the patient's drug needs, the collection of drugs without harming the environment are addressed via a reverse logistics operation. Survey was conducted to determine the general trend in this context. Patients being dealt with drugs in the system collection, separation and sorting centers, according to the methods of destruction to be sent to extermination centers targeted. In order to determine the most appropriate that places of Collection centers, sorting centers and disposal centers, a model is proposed and solved by using meta-heuristic methods.*

Keywords− Meta-heuristic methods, pharmaceutical, reverse logistics, waste management.

INTRODUCTION

The hazardous waste management systems and reverse logistics systems which threat the environment was considered and it is indicated that it will provide significant contribution to the economy of country by considering both the hazardous waste management systems and the recycling process of medicine boxes in the medicine industry.

In this study, problem is defined as uncapacitated facility location problem. There are two stages of facility location which are transportation from collection centers to decomposition centers and transportation from decomposition centers to recycling or to disposal centers. The simulated annealing heuristic is suggested for solving problem.

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Problem Description of Medicine for the Recycling System

Collection, Separation and Recycling / Disposal System for Drug Wastes

It is propounded that junking unused medicines or disposal in appropriate places threat human health dramatically in the numerous studies.

In this study, lots of processes which include collecting medicines from end users, separating them their species, separating their boxes and sending them recycling centers are taken into consideration. Relevant general process is showed at figure 1.

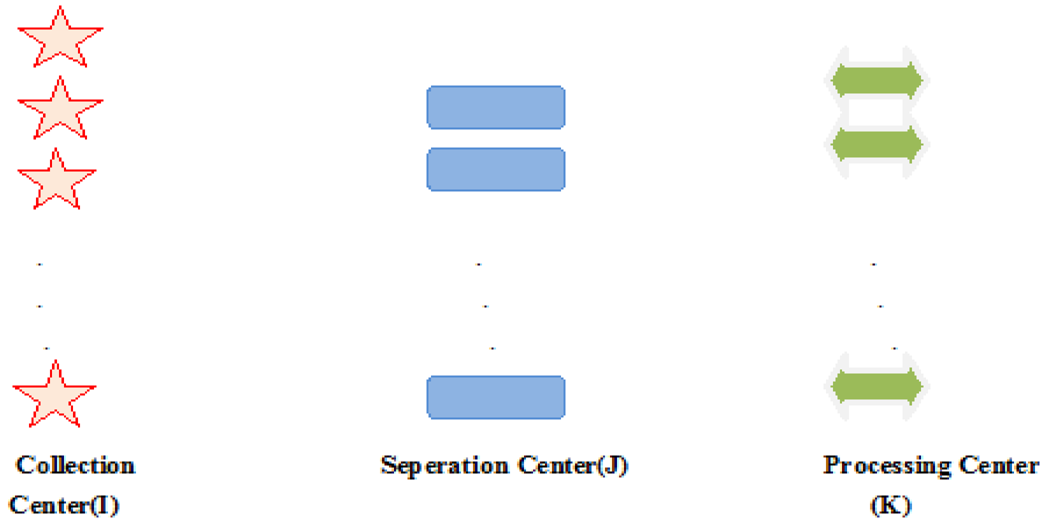

FIGURE. 1

Medicines Recycle System From Consumers

This figure states the general process which can be implemented in the overpopulated regions which have more collection and decomposition centers.

In this study, model consist of 7 collection center, 5 separation center and 3 processing center (recycling or disposal center). This numbers was made taking into account and the representation of the structure are given in figure 2.

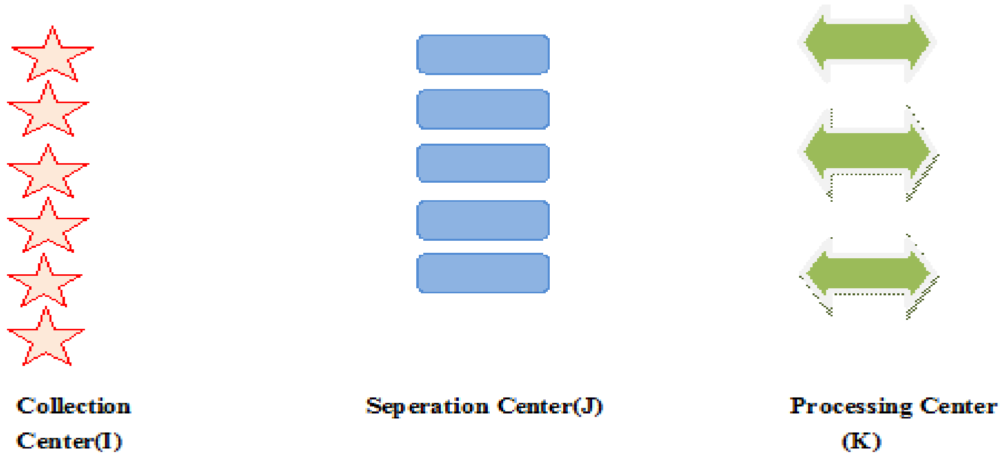

FIGURE. 2

Reverse Logistics Network For The Drug with The Actual System Under Consideration

The certain amont of packages that are brought to pharmacies by consumers should be conveyed to collecting points. The elapsed time that is used for transportation is not considered, and the duration as from collecting points is considered. The medicines which are brought collection centres are separeted according to their species in the separation centers. Afterwards, they will be sent to processing centres for recycling or disposal.

PROPOSED SIMULATED ANNEALING I (SA I)

Proposed Simulated Annealing Algorithm For The Problem

Specific decisions for problem

Neighbourhood structure

When making a search around of available solution (when determining neighbourhood), the revulsion of the worst ordered from solution method is used.

Initial solution: y0

In the beginning, a solution is identifid as random. Objection function value is accounted. The revulsion of the worst ordered from solution method and by adding a new ordered which is identified as random, the neighbourhood of avilable solution is reached.

Cost function: f

The minumum cost solution of the cost function problem was searched by considering, from collecting points to seperation points, and then recycling or disposal centres distances and transaction costs.

General decisions

Initial temperature: T_0

McKendall and his friends' studies indicated that simulated annealing algorithm gives good solutions [1]. Based on the study which is mentioned, the initial temperature is determined in the manner of accepting the objection function values of initial solutions which are 10% over the solutions by probabilty of 0.25.
$T_0 = -0.10\ f(y_0) / \ln(0.25)$.

The numbers of solution which will be defined in all iteration(temperature)

K_1 which is defined as a certain ratio is identified as 0,1 in literature. In this study, it is taken as 7*5*3=105*0,1=10. And the number of solution which is determined in all iterations become 10.

Temparature decrease ratio: α

"Geometric cooling" schedule has been used as cooling schedule, α is determined as 0.90, α = 0.90.

Stop condition

When of the temperature decreases up to 90% of the initial temperature, and reaches 10% of the initial temperature, the algorithm terminates.
Given with the decisions, the algorithm plays 20, 30 and 50 iteration and results show in table 1.

TABLE 1
SA-I Results

Iteratıon Number	Min Cost	Max. Cost	Avg. Cost	Min Dev. %	Max Dev. %	Avg. Dev.%	CPU
20	984,000	1,180,000	1,182,000	3,57	39,28	20,13	2,22
30	780,000	1,170,000	1,168,000	3,35	39,22	18,71	2,43
50	465,000	1,165,000	910,000	2,7	37,3	16,01	2,51

Proposed Simulated Annealing II

In this approach, the parameters were determined as a result of preliminary studies. In other decisions are the same as SA-I. The best combination of α and T values are determined by running the algorithm 50 times. This schedule results in table 2 are also included.

TABLE 2
The Parameter Values Obtained From Experimental Work

α	T	Min Cost	Max. Cost	Avg. Cost	Min Dev. %	Max Dev. %	Avg. Dev. %	CPU
0,85	**1000**	**434,000**	517,000	477,420	1,54	19,12	8,01	2,24
0,85	3000	440,000	527,000	480,700	0,91	19,77	9,25	2,54
0,85	5000	453,000	530,000	485,880	0,88	16,99	7,25	2,85
0,90	1000	446,000	530,000	481,640	0,9	18,83	7,99	3,67
0,90	3000	445,000	522,000	480,459	0,23	17,3	7,97	2,99
0,90	5000	448,000	530,000	482,459	1,12	18,3	7,69	2,88
0,95	1000	445,000	527,000	480,720	0,45	18,43	8,02	2,85
0,95	3000	448,000	530,000	482,500	1,12	18,3	7,70	3,23
0,95	5000	446,000	522,000	481,560	0,45	17,04	7,98	3,05

The preliminary study that provides the best combination of convergence α, 0.85, and the initial temperature, T, 1000 is found to be the case. With these decisions, SA-II Algorithm results are given in table 3, with 20, 30 and 50 iteration.

TABLE 3
SA-II Algorithm Results

Iteration Number	Min Cost	Max. Cost	Avg. Cost	Min Dev. %	Max Dev. %	Avg. Dev. %	CPU
20	446000	521000	483000	3,59	16,82	8,33	1,09
30	446000	521000	481000	2,92	16,79	7,92	1,54
50	**434,000**	**517,000**	**477,420**	**2,54**	**19,12**	**10,01**	**2,24**

Random Search Algorithm Approach (Rsa)

There is no test problem for 2-stage uncapacitated facility location problems. So, in order to test the performance of the propoced algorithms (SA I and SA II), 20,000 pcs. solution are been obtained with RSA. In 20,000 pcs of the solution, the best solution is 472.000.

COMPARISON OF RESULTS

Propoced Simulated Annealing I and II (SA-I and SA-2) algorithms and Random Search Algorithm (RAA), C ++ coding using language, C ++ compiler, with a solved on the computer, the Intel Core 2 Duo, 2.4 Ghz processor and 4 GB of RAM. SA-I and SA-II algorithms results are been obtained by running 50 times reported. The results results are given in table 4.

TABLE 4
SA-I, SA-II and RSA Solutions

	Min. Cost	**CPU**
TB-1	465,000	2,51
TB-2	434,000	2,24
RAA	472,000	4,95

Examined in Table 6.1, SA-I algorithm solution is better than RSA algorithm solution. SA-II, parameters are obtained (α and T) as a result of experimental studies, is best solution.

CONCLUSION

These results show that simulated annealing algorithm have a good performance with good solutions for uncapacitated facility location problem of 2-stage. The study will give better results in the implementation of large-scale problems. In the next study, the capacity of the facilities are taken into account, recycling and disposal centers to evaluate the applications separately, plans to undertake.

REFERENCES

[1]McKendall Jr Alan R., Shanga J., Kuppusamy S., 2006, "Simulated annealing heuristics for the dynamic facility layout problem", ***Computers & Operations Research,*** 33: 2431–2444.

WHAT TURKEY EXPECTS FROM LOGISTICS OUTSOURCING?

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Abstract - *The economies of the world have become increasingly interdependent, and organizations have come under tremendous pressure to maximize productivity and profitability. Creating value through outsourcing has emerged as a popular competitive strategy for firms of all sizes in all types of industries. The aim of this research is to investigate the use of third party logistics in Turkish companies from the users' perspective to identify the types of logistics services outsourced, problems encountered in outsourcing these services, logistics costs, decision makers in outsourcing logistics activities, and information sources used in the decision-making process. A structured survey was selected as the tool for data collection. The field study involved face-to-face interviews with 204 companies out of top 500 companies ranked in terms of turnover that are registered with industrial associations and chambers of commerce in Turkey. Moreover, a decision support system based on Bayesian Causal Map is proposed for 3PLs in order to assist them in their service proposals for different sectors. This study is a first attempt to reveal and compare the outsourcing perception of the companies in different sectors, to expose the firms' underlying motives as well as the respective importance of these motives for outsourcing logistics activities in Turkey. The use of Bayesian Causal Map based on the survey results provides an important guide to the 3PL providers to pick a suitable strategy and to prioritize their operational activities in different sectors in such a way to achieve a competitive advantage.*

Keywords: Outsourcing, Logistics, Structured-disguised survey, Decision Support for 3PLs, Turkey

INTRODUCTION

An essential aspect of SCM is consistent, high-quality logistics services. As SCM becomes more sophisticated and the gap between what companies want to accomplish and what they can do in-house continues to grow, the rationale for outsourcing to third party logistics providers (3PLs) is further justified. Therefore, there is currently a trend among industrial firms of outsourcing those products and activities that are outside the company's core business.

Previous research has shown that the decision to employ 3PLs is often restricted to the warehousing and transportation functions, which somewhat reduces the extent of the 3PLs' impact on overall supply chain performance [1-3]. This raises key questions about the impact on supply chain effectiveness when the client organization motivated to outsource is different from the 3PL motivated to integrate logistics across the chain. To compete successfully, 3PLs may have to develop skills, competencies, and more value-added activities, which inevitably results in additional cost. Therefore, the main challenge for a 3PL provider is to pick a competitive strategy and prioritize their operational activities in such a way to achieve acceptable business performance. While substantive research has been done in the area of 3PL strategy and operational drivers, very little research has been conducted to address 3PL strategies and their operational priorities in relation to business performance [4]. In fact, if the customer segments vary in their logistics desires, it should be possible for 3PLs to customize logistics programs for different customer segments, which would improve both effectiveness and efficiency by not offering a one-service-fits-all type of offers. If, in contrast, customers view logistics services similarly across segments, and if that view consistently affects outcomes such as customer satisfaction in the same way across segments, 3PLs should be able to create logistics services that appear identical across customer segments, enabling them to leverage economies of scale. Therefore, 3PLs need to know the components that constitute logistics

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service quality from the perspective of the customer. They should know what logistics service quality means to customers if they want to examine whether groups of customers place varying degrees of emphasis on specific aspects of this perspective.

This study analyzes the clients of 3PLs in Turkey using the results of a survey conducted in 2007. The reason of focusing on Turkey is that Turkey is accepted as an emergent market in the new millennium expected to attract the interest of global companies in their attempt to obtain competitive advantage. In recent years, in important international projects, such as TEN (Trans European Transport Network), TRACECA (Transport Corridor Europe-Caucasus-Asia) projects, Pan European Transport corridors (Corridors no 4, 8 and 10) Turkey has been placed over the international transport corridors, and takes part in the Trans European Transport System. From this perspective, Turkey, at the epicenter of transport corridors connecting Europe to the Caucasus and Asia as well as the Middle East, North Sea, and Balkan countries has a potential of becoming an important international logistics zone. This necessitates the realization of strategic plans to overcome logistics inefficiencies.

According to the findings of this study, 16% of the users had been using 3PL services, for one-to-five years, 17 % for five-to-ten years, and 67% reported using such services for more than ten years. Taking into account the fact that in India, 28.6 % of outsourcing companies have been using the services of third party logistics service providers for over three years and 18.8 % have been working with third party logistics service providers for 1-3 years, it can be said that Turkey has a relatively high amount of experience with third party logistics service providers [5].

The objectives of the research were:

1. To expose the firms' underlying motives as well as the respective importance of these motives for outsourcing logistics activities.
2. To show the most frequently outsourced logistics services, the share of logistics costs in total and problems encountered in outsourcing partnerships.
3. To develop a model which can aid the 3PLs to build up strategies for offering their services

LITERATURE REVIEW

The logistics issue has witnessed an evolution from a passive cost-absorbing function to a strategic one which provides competitive advantage. 3PLs, which originally emerged out of companies that had previously been involved in warehousing and transportation, have extended their capabilities to involve a broad range of functions [6].

Despite recent rush in outsourcing service processes, its advantages and disadvantages brought to firms are increasingly debatable across industries [7]. Some studies show that outsourcing allows a firm to not only cut costs, but also focus on its core competences and help speed up its innovation processes [8]. In contrast, other research suggests that a firm that engages in outsourcing may lose control and flexibility, and potentially risk disclosure of proprietary knowledge to suppliers, who may become its competitors in the future [9]. While these contradictory viewpoints are equally appealing, yet no consensus is drawn in the literature as to the effect of outsourcing on firm performance. But the analysis of the literature shows that in order to get added-value from outsourcing, 3PLs should have a good understanding of what is required by what type of enterprise and develop strategies to enhance their service to aggregate value. More research should build on current work to explore any other factors that may influence a firm's outsourcing decision [10].

Table 1 provides a comparative summary of the above-mentioned papers. As it can be seen from TABLE 1, most heavily investigated topics are outsourced logistics services, logistics expenditures, strategic implications and reasons for outsourcing. The research is generally empirical and based on surveys. The actors involved in outsourcing decision making process are not commonly analyzed. The literature review also shows that 3PL services are often limited to warehousing and transportation functions, which somewhat reduces the extent of impact of 3PLs on the overall supply chain performance. This raises key questions about whether the motivation of the client organization for outsourcing is different from the 3PL firm's motivation. In order to compete successfully, 3PL providers may have to develop skills, competencies, and more value-added activities, which inevitably results in additional cost. Therefore, the main challenge for a 3PL provider is to pick a competitive strategy and prioritize their operational activities in such a way to achieve acceptable business performance. While substantive research has been done in the area of 3PL strategy and operational drivers, very little research has been conducted to address 3PL strategies and their operational priorities in relation to business performance. In fact, if the customer segments vary in their logistics desires, it should be possible for 3PLs to customize logistics programs to different customer segments, hence improving both effectiveness and efficiency. If, in contrast, customers view logistics services similarly across segments, and if that view consistently affects outcomes such as customer satisfaction in the same way across segments, 3PLs should be able to create logistics services that appear identical across customer segments, enabling them to leverage economies of scale. Closer interactions between 3PLs and its customers shall provide advantages to both firms. With more information about the characteristics of the client, the service provider would be able to design an offering adapted to the context of the buyer [6]. Therefore, 3PLs need to know the components that constitute logistics service quality from the perspective of the customer. They should know what logistics service quality means to customers if they intend to examine whether groups of customers place varying degrees of emphasis on specific aspects of quality.

TABLE 1
Findings of The Literature Survey

	Outsourced logistics services	Logistics expenditures	Strategic implications	Reasons for outsourcing	Information sources	3PL Selection criteria	Departments included in the decision process	Contracts	Satisfaction with the outsourcing	Country
Arroyo et al., 2006	✓			✓	✓	✓				Mexico
Yeung et al., 2006			✓	✓					✓	Hong Kong
Sahay and Mohan 2006	✓	✓	✓	✓						India
Aktas and Ulengin, 2005	✓	✓		✓	✓	✓	✓		✓	Turkey
Jaafar and Rafiq, 2005	✓	✓		✓				✓	✓	UK
Lieb and Bentz 2005	✓	✓	✓					✓		USA
Sohail and Al-Abdali, 2005	✓	✓	✓		✓					Saudi Arabia
Hong et al., 2004	✓		✓	✓		✓		✓	✓	China
Sohail et al., 2004	✓	✓	✓		✓	✓				Ghana
Wilding and Juriado, 2004	✓	✓	✓	✓					✓	Europe
Sohail and Sohal, 2003	✓	✓	✓		✓					Malaysia
Bolumole, 2001			✓	✓						UK
Sum et al., 2001	✓			✓		✓	✓			Singapore
Boyson et al., 1999	✓			✓	✓	✓	✓	✓	✓	USA
Fernie 1999				✓				✓		UK
Dapiran et al., 1996	✓	✓	✓	✓	✓		✓	✓	✓	Australia
Lieb 1992	✓	✓	✓	✓	✓	✓	✓			USA

METHODOLOGY

This section explains how the survey was designed and administered. The purpose of conducting this survey is to describe the state of 3PL in Turkey and to analyze the responses of current users.

Survey Design

To determine the current usage of 3PL services, a field study involving face-to-face interviews with the clients of logistics service providers was conducted. This study is based on a descriptive research conducted in 2007; the population consists of all companies registered with industrial associations and chambers of commerce in Istanbul. Five hundred firms were selected to be included in the survey so that they represent the market appropriately in terms of turnover, number of employees, industry, etc. and the rate of return was 41%. Consequently, the survey was realized with 204 firms which are currently using 3PLs services.

In the field study, face-to-face interviews were preferred, rather than sending questionnaires by mail. The main reasons for this are the low rates of return for studies performed via mail, the lack of possibility to correct misunderstandings and the loss of the opportunity to obtain information that can only be achieved during an interview.

In the field study, the people to be interviewed were informed orally and in writing about the objective, method and content of the research before the interview.

Questionnaire Design

The questionnaire contains 7 sections. The first section includes 15 questions about company profile. The second section is about the operations of the company: the type, number, size, and capacity utilization rate of their warehouses; the number of owned and rented vehicles in their fleet, the total capacity of their fleet and the percentage of transport mode used. The third section is about the outsourced logistics services. The users of outsourcing companies are asked questions about the most frequently preferred 3PLs and the services that are outsourced, the average ratio of the total logistics cost, percentage of logistics expenditures, share of outsourced logistics activities in total logistics activities and their respective cost, the type of logistics services that will be required in the future and the most frequently faced problems encountered with 3PLs, the names of three 3PL companies that they can recall immediately, the factors that are important in the 3PL selection process and the information sources used to find them, and the authorities responsible for the selection process. In the fourth section human resources activities of the company are analyzed: the number of employees, the ratio of white and blue collar workers, the number of employees taking part in logistics activities as well as their educational background. The fifth section is about the quality activities of the firm, the certificates they possess and plan to possess in the future. The sixth section is about the technology structure of the company, the type of the technologies they might develop, the reason for requiring new technologies, whether the R&D activities are done in-house or outsourced. The last section includes questions about the type of projects they are conducting, the ones they plan to actualize by using external sources from the projects, and whether they conduct a market research or not.

RESEARCH FINDINGS

Company Profile

Breakdown of the participants according to the sectors they belong, is presented in either as primary sector or secondary area of business, depending on their responses. In terms of proportional distribution, automotive, FMCG, construction, and textile sectors seem to be prominent ones. The relatively high number of participants from these sectors can be attributed to more test subjects being chosen from these sectors due to their size in the country's economy and to the fact that more test subjects from these categories have accepted to participate in the research (Figure 1).

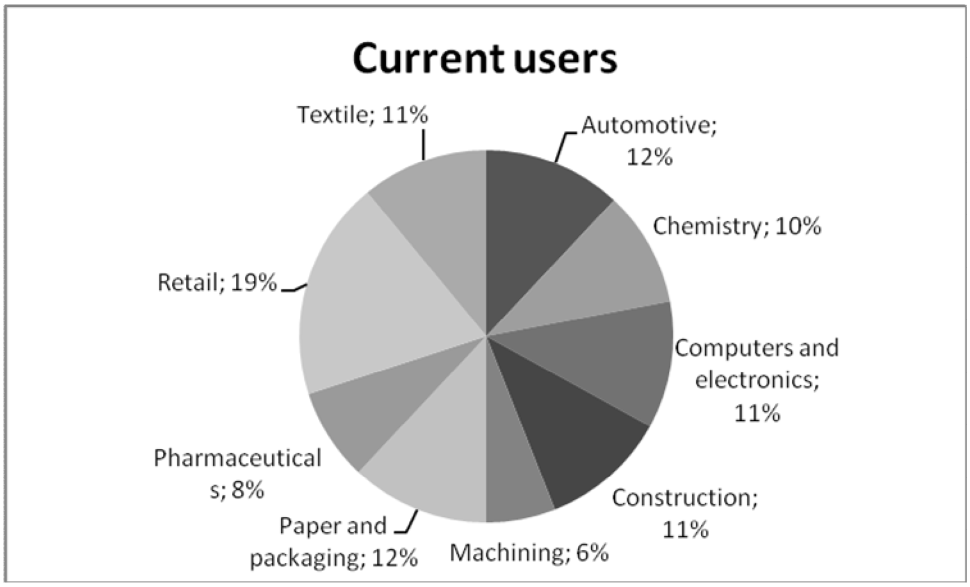


FIGURE. 1
The Distribution of Sectors

The average duration of operation of the companies by sector is provided in TABLE 2. 58% of the participants outsourcing their logistics activities had been operating for more than 20 years.

TABLE 2
Sectors of The Sample

	Average duration of operation (years)
Industry	**Current users**
Automotive	22.8
Chemicals	21.0
Computers and electronics	17.5
Construction	17.9
Machinery	32.5
Paper and packaging	19.4
Pharmaceuticals	18.5
FMCG	23.3
Textile	22.0

Details on the partnership status of the participating companies are given in Figure 2. Regarding the partnership status of the participants, it is seen that 66% of the companies are in multi-partnership structure, 24% are in single-partnership structure and 8-10% are public companies.

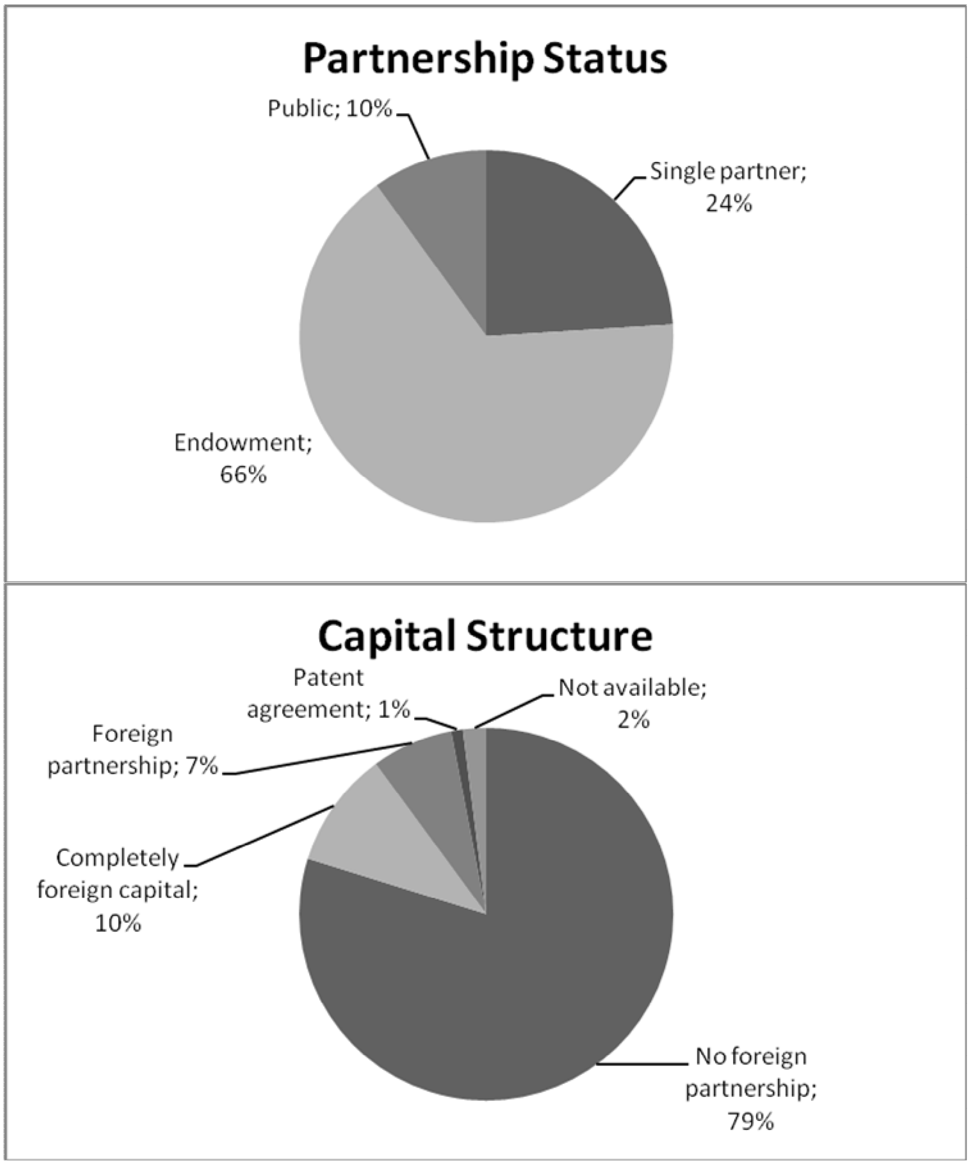


FIGURE. 2
Partnership Status and Capital Structure of Participating Firms

There is no foreign partnership in 79% of logistic service users, 10% operate with totally foreign capital, 7% have foreign partnership, 1% have patent agreements.

Logistics Services

Another question logistics service customers were asked was in which logistics areas and to what extent they were using external sources for their logistics activities. As can be seen from FIGURE. 3, the most frequently outsourced logistics functions are domestic and international road transportation. This service is followed by customs clearance and distribution to customer warehouse.

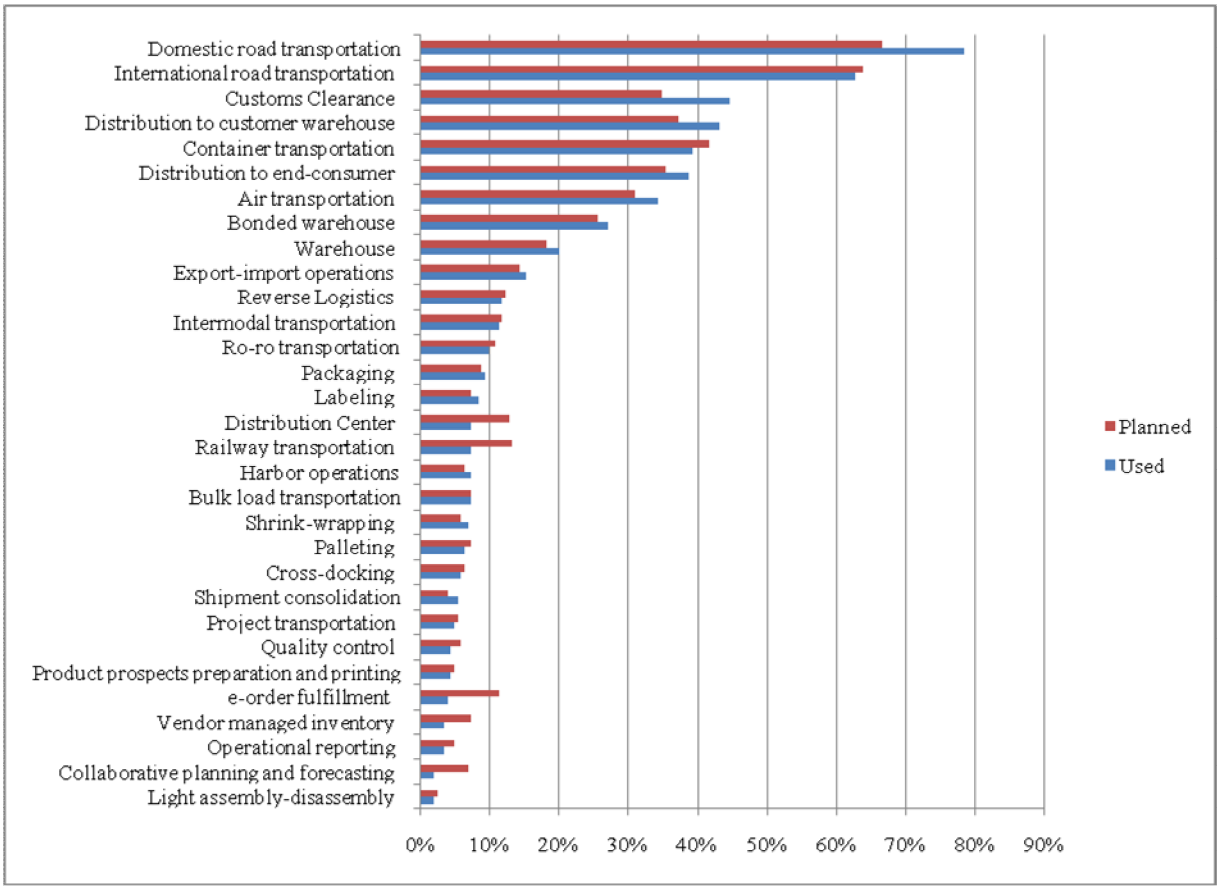


FIGURE. 3
The Logistics Services That Are Currently Being Purchased and Planned To Be Purchased

This result is similar to the results of previous studies carried out by PE Consulting [25], Ferrari [26], and Jaafar and Rafiq [12] in that transportation and warehousing remain the main services used by the customers.

The participants were asked in which areas they wished to outsource in the coming years. It was found out that the breakdown of the services intended to be procured was not any different than the present situation. Domestic highway transportation was again prominent, whereas distribution to end customer and customs clearance were recognized as areas where less outsourcing was planned. An interesting outcome to mention is that 7% of the firms do not plan to outsource in the following 1-2 years.

It could be seen from FIGURE. 3 that the customers of some services (distribution to customer warehouse, domestic road transportation, and customs clearance) do not plan to continue outsourcing. On the other hand, the customers may shift from domestic road transportation to other modes. It is promising that several rarely used services such as e-order fulfillment raised from 4% to 11%, collaborative planning and forecasting (2% to 7%), or vendor managed inventory (3% to 7%) are being planned to be used by the customers in the very near future. The increase in the demand for railroad transportation (7% to 11%) may be due to soaring energy prices.

The companies outsourced 8.83 different logistics services on average. Considering the variety of services rendered by 3PLs, it is noteworthy that customers are interested in certain areas only. For example, actual and planned outsourcing in the field of order fulfillment is less than 5%. The main reasons behind this might be the insufficient information of customers regarding the 3PLs; customers' unwillingness to outsource activities they deem to be critical, such as warehousing and customer services; and their belief that the logistics firms in the market are incapable of providing such services at acceptable levels.

Within the framework of the research, the effects of operations on the competitive advantage of the companies were investigated for every sector and the participants were asked to state in which areas their logistics operations created a competitive advantage. Despite showing sector based differences, in almost all sectors the logistics service clients stated the areas in which logistics operations would create a competitive advantage as, in order of priority, low supply chain costs, an increase in the level of customer service, perfection in meeting orders, accessibility to a larger field, and effective inventory management. Of the respondents, 87% state that logistics cost reduction is the most important reason for outsourcing which facilitates competitive advantage (see TABLE 3). Although this result is not in line with the majority of findings in earlier studies in which customer service improvement is ranked as top benefit [2, 19, 22, 25], the research finding from developing countries such as by Sahay and Mohan [5] and Sohail et al. [27] reveals the similar results. Moreover, it is totally in agreement with the latest studies that underline that the economic slowdown will see a move back towards cost-driven outsourcing [28, 29].

It is noteworthy that on average, 57% of the respondents do not consider outsourcing logistics activities has an impact on effective inventory management. Inventory management requires information sharing. However, the biggest barrier in inter-company coordination is in information sharing and the issue of trust. Many researches carried out about information sharing show that companies which collaborate and share information reaped tremendous amounts of benefits.

Moreover, approximately 40% of respondents do not consider outsourcing as an opportunity to focus on in their core businesses.

TABLE 3
The Impacts of Outsourcing Logistics Activities

Positive impact of outsourcing logistics services	**Current users**
Lowering costs	87%
Improving Service quality	85%
Meeting demands just in time	84%
Ability to reach wider markets	69%
Focus on core business activities	61%
Efficient inventory management	43%

Logistics Expenditures

Current users were asked about their logistics expenditures in terms of transportation, storage, distribution center and order management (

TABLE 4). The area with the highest rate within total logistics expenditure was transportation expenditure. The share of transportation costs in total logistics costs was found to be 78%. The share of storage costs was found to be 24.7%, the cost of distribution center was found to be 20% and finally, order management costs were 21% on average for 3PLs customers.

TABLE 4
The Share of Different Logistics Functions in Total Logistics Expenses for Outsourcing Firms

Industry	Transportation management	Warehouse management	Distribution center operations	Order management
Automotive	77	25	20	27
Chemicals	71	20	18	10
Computers and electronics	84	30	6	10
Construction	81	18	4	27
Machinery	84	27	15	10
Paper and packaging	84	20	10	32
Pharmaceuticals	65	27	31	11
FMCG	81	25	11	10
Textile	78	33	46	55

The respondents of this study declared that expenditure on outsourced logistics services constitutes 40% of the total logistics expenditure whereas this ratio is on average 47% in north America and 66% in Europe [30].

Generally speaking, the fact that transportation was found to be the area with the highest proportion of expenditure is in line with the findings of other similar studies done in Europe and in the rest of the world [12, 31].

Customer Satisfaction in Outsourcing

The clients of 3PLs were asked an open-ended question about the problems they encountered in their outsourcing partnerships. Eight different categories of problems were detected: delays, shipping errors, poor exchange of information, quality of personnel, level of cost, loss and damage performance, low service quality, and technical insufficiency. 30% of customers declared to have encountered no problems. In other words, the level of satisfaction is 30%. From another point of view, the fact that 70% of the participant firms outsourcing logistics services had complaints is a serious warning.

The 29% of the complaints expressed by the participant firms were related to delays and incompliance with timing arrangements. Apart from the 30% of the participants that had no complaints, 29% of the remaining 70 percent - i.e. almost half of them - had complaints about timing (TABLE 5). This shows to the service providers that they must concentrate on this issue. As mentioned above, the clients of 3PLs declared that they gave less importance to service quality. Hence, selecting service providers on the basis of lowest cost quotes might be the source of quality and technical insufficiency related issues.

TABLE 5
Problems Encountered in Outsourcing Partnerships

Industry	Delays	Service quality	Price	Communication	Vehicle
Automotive	58%	33%	13%	21%	13%
Chemicals	70%	20%	20%	**25%**	10%
Computers and electronics	59%	36%	18%	9%	0%
Construction	48%	4%	30%	0%	0%
Machinery	50%	17%	17%	**25%**	17%
Paper and packaging	40%	24%	4%	4%	16%
Pharmaceuticals	35%	35%	18%	6%	0%
FMCG	66%	18%	18%	16%	21%
Textile	65%	17%	30%	**22%**	9%
Grand Total	56%	23%	19%	14%	10%

As mentioned previously, although information systems departments are one of the main components of logistics processes, they do not participate in the decision-making process at all. The problems encountered in terms of technical insufficiency can be explained by the lack of integration of information systems between the service providers and the customers.

A ROAD MAP FOR 3PLS

As an additional analysis, a decision support system based on Bayesian Belief Networks is built to analyze the change in the behavior of firms according to the industry they operate in, their capital structure or partnership status. Moreover, to help 3PLs in their future decisions regarding specific sectors and services is another motive underlying this model. For this study, all of the 204 firms that outsource their logistics activities are used as to provide the data to the network.

Bayesian Belief Network (BBN) is a type of graphical model, which uses probability theory to manage uncertainty and complexity by explicitly representing the conditional dependencies between the nodes (concepts) [32]. The visual representation of BBN can be very useful in clarifying previously opaque assumptions or reasoning hidden in an expert's mind. From a mathematical point of view, the basic property of BBN is the chain rule: a BBN is a compact representation of the joint probability table over its universe.

The chain rule for BBNs then yields

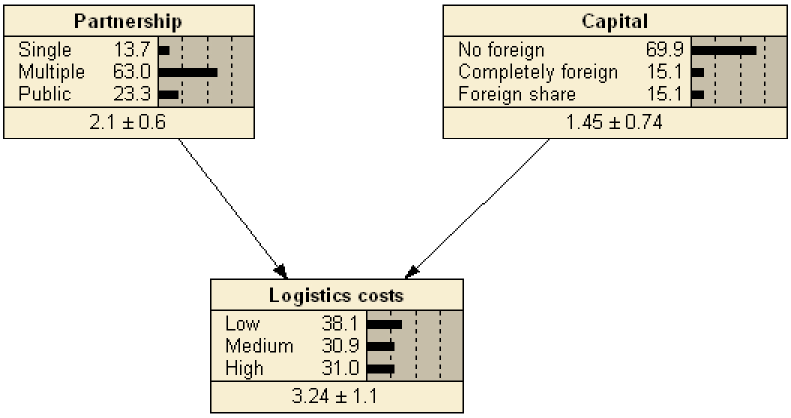
$$P(A, B, C) = P(A) \cdot P(B \backslash A) \cdot P(C \backslash B)$$

In theory, the posterior marginal probability of a variable can be computed from the joint probability by summing all other variables one by one:

$$P(A_i \mid B) = \frac{P(A_i)P(B \mid A_i)}{\sum_{i=1}^{n} P(A_i)P(B \mid A_i)}$$

Single	Multiple	Public
13.699	63.014	23.288

No foreign	Completely foreign	Foreign share
69.863	15.068	15.068



Partnership	Capital	Low	Medium	High
Single	No foreign	50.000	25.000	25.000
Single	Completely foreign	25.000	25.000	50.000
Single	Foreign share	33.333	33.333	33.333
Multiple	No foreign	37.500	37.500	25.000
Multiple	Completely foreign	40.000	20.000	40.000
Multiple	Foreign share	60.000	20.000	20.000
Public	No foreign	25.000	25.000	50.000
Public	Completely foreign	33.333	33.333	33.333
Public	Foreign share	25.000	50.000	25.000

FIGURE. 4
Simple Example of Bayes' Rule

The example in FIGURE. 4 shows that if the company is single partnered and its capital is completely foreign, then logistics cost will be low with 25% probability, medium with 25% probability, and high with 50% probability. In practice, such an approach is computationally intractable when there is an extensive number of variables since the joint distribution will have an exponential number of states and values. Although BBNs create an efficient language for building models of domains with inherent uncertainty, it may be time consuming to calculate conditional probabilities, even for a very simple BBN. Fortunately, there are several commercial software tools such as Hugin and Netica that can perform this operation.

In the current research, Netica version 1.12 was used. It is a complete software package designed to work with BBNs, decision networks, and influence diagrams. In particular, it can be used to identify patterns in data, create diagrams encoding knowledge or representing decision problems, and then utilize those patterns to answer queries, find optimal decisions, and create probabilistic expert systems. It is suitable for application in the areas of diagnosis, prediction, decision analysis, sensor fusion, expert system building, reliability analysis, probabilistic modeling, risk management, and selected types of statistical analysis and data mining.

Bayesian Belief Network of the system analyzed in this paper is given in FIGURE. 5. Although BBNs create a very efficient language for building models of domains with inherent uncertainty, it is a tedious job to perform evidence transmission even for a very simple network [32]. In this paper, Netica [33] software is used to carry out this operation.

Level 1 in this map shows the sectors of the companies involved in the analysis along with their partnership status and capital structure. It is assumed that the sector that the firm is in as well as its partnership and capital status directly affects the reasons for outsourcing logistics activities to 3PLs. So level 2 shows the reasons of these firms for outsourcing logistics activities to 3PLs. For sector, partnership and capital structure nodes, discrete variables, meaning that a well defined finite set of possible values are used where as for the nodes denoting the outsourcing reasons, continuous variables are used since the related data was on a 1-5 scale.

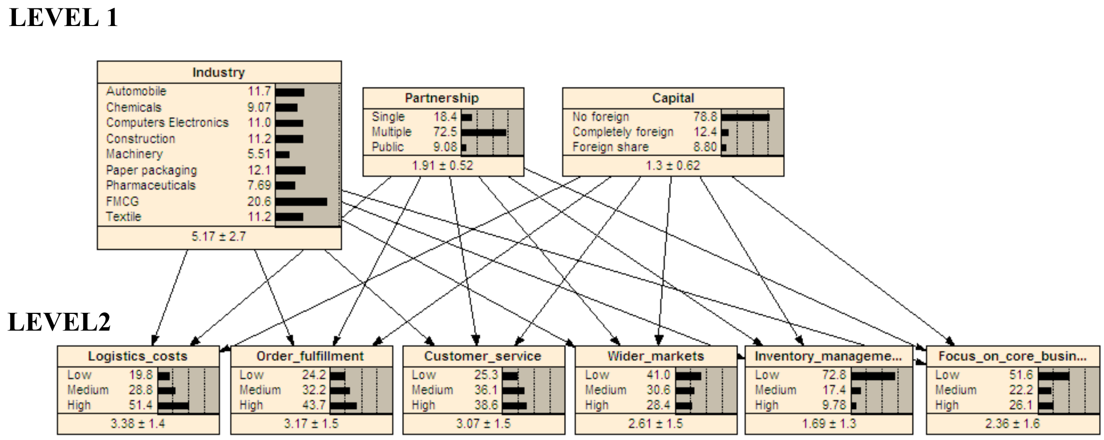


FIGURE. 5
An Analysis For Reasons To Outsource

When the firms' answers are analyzed, logistics cost (3.38) is seen as highly important while order fulfillment (3.17) and improved customer services (3.07) keep their medium level importance. Inventory management has the least importance among all (1.69).

A Guide Map For 3pls

The effects of sector, partnership status and capital structure of the firms in decision making process for outsourcing are analyzed in details in the following sections. The purpose of this analysis is to provide insights on the impact of a prospective client's sector, partnership status, and capital structure. Scenario analysis can easily be conducted by specifying values for each variable, i.e. sector = FMCG, partnership status = single, and capital structure = no foreign. The reasons for outsourcing of such firms can easily be revealed by BBN.

Scenario Analysis

The merit of this model is aiding 3PLs in managing their customer relationships according to the sectors they intend to provide services in. By generating several different scenarios, the proposed model can offer useful guidelines to the 3PLs in their attempt to specify their strategies for different customer segments. For example, a 3PL aiming at providing service to those firms having public partnership with foreign capital in chemicals sector (see FIGURE. 6) should propose an outsourcing service package especially in a way to help the firm to access wider markets (2.89). Besides, focusing on core business is an area which should be stressed by the 3PL. With such available information, the 3PL would avoid focusing on some other factors such as improving customer service, which seemingly has less importance for logistics customers acting in chemicals sector.

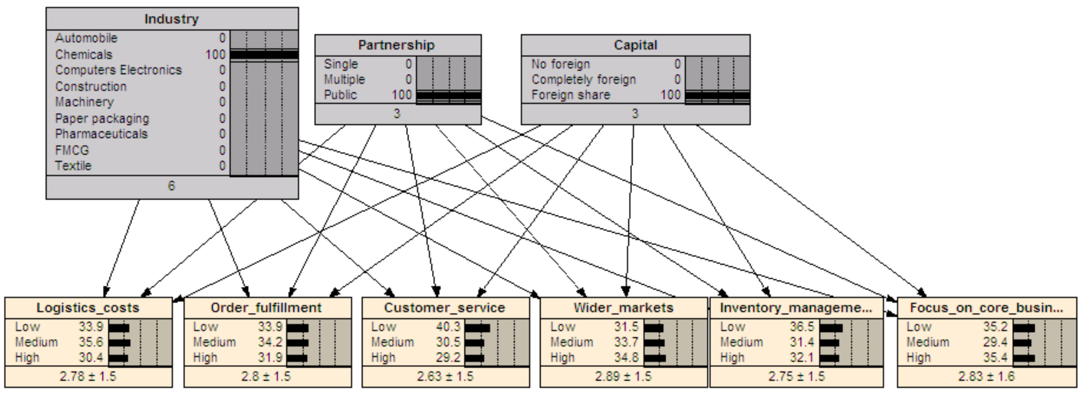


FIGURE. 6
Scenario 1: Chemicals Sector /Public Partnership/With Foreign Share

On the other hand, as can be seen from FIGURE. 7, a 3PL planning to provide services to those firms in the pharmaceuticals sector, with multiple partnership and completely foreign capital, should be aware of the fact that the main reasons of outsourcing for those firms is order fulfilment (4.46) and thus, the 3PL could provide an outsourcing package proposal using this information.

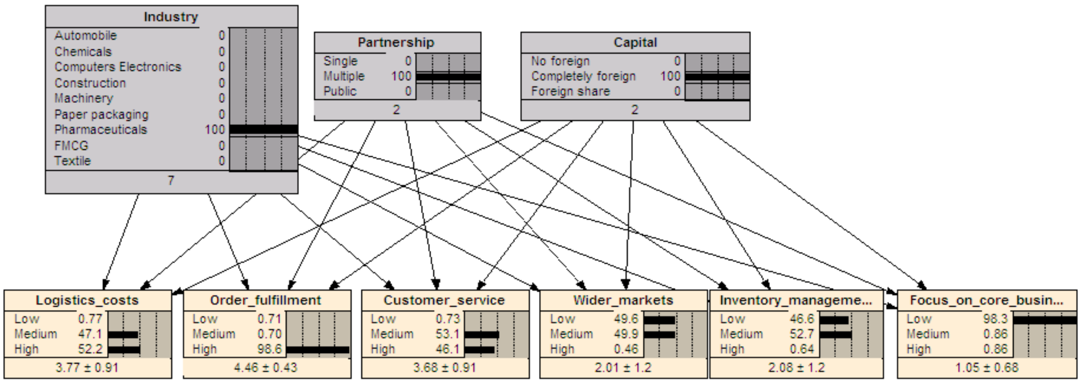


FIGURE. 7
Scenario 2: Pharmaceuticals Sector/Multiple Partnership/Completely Foreign Capital

A 3PL can conduct similar type of analysis for different firms having different characteristics and prepare appropriate proposal packages for each of them based on the information that will be received from the model.

SUMMARY AND FURTHER SUGGESTIONS

This study has portrayed several key findings on logistics outsourcing practices of the logistics service customers' perceptions of 3PLs in Turkey based on a structured survey, carried out in 2007. It is aimed at performing a scientific study that will draw the profile of the logistics sector and create a source of reference that will meet the needs of 3PLs operating in the sector and the companies that demand their services.

When the BBN model is analyzed according to industry, partnership and capital structure parameters, no significant difference is found between the outsourcing reasons. In most of the cases, the most mentioned reasons are logistics costs, order fulfillment and improved customer service. The only exception is for firms with foreign share capital structure; focusing on core business has a priority among other reasons.

Though this analysis has not reached a clear conclusion, the actual purpose of building a BBN model is to provide a decision support system that might assist 3PLs as to which characteristics of firms to consider and what areas to focus on while preparing offers to such firms. Two samples with regard to this have been presented in Section 5.1.1. Although the model has not found discontiguous results upon individual analysis of parameters, it has produced striking and discriminating results when all 3 parameters showing firm characteristics were modified. By using this model, a 3PL preparing a quote in order to provide outsourcing to a firm can do so knowing full well what to consider while preparing its offer.

Cost-related factors seemed to gain top priority among customers, over service-related factors, in 2007. This is in parallel with the global trends where the economic slowdown will see a move back towards cost-driven outsourcing- despite the fact that, over the long term, service-driven or value-driven deals tend to deliver more stable, successful relationships [28].

As a result, it can be said that the drivers for outsourcing deals are cyclical. In slower economic times, cost has played a more significant factor, while in better times, the other benefits of outsourcing may receive a greater focus. In fact, the 2007 results may be accepted as the signal of 2008 global crisis.

In light of the predicted economic slowdown in 2008, the cost will become more prominent. But, as in previous economic slow-downs, this tightened focus on cost over value needs to be approached with caution. Companies should look back to previous economic cycles and appreciate that projects driven by value or service issues tend to be more successful.

Another reason seems to be that, considering the high volume of complaints, (satisfied customer level is only 17%) outsourcing firms may think that they do not get value for money for the service that they receive from the 3 PL providers and hence attempt to drive down costs.

Although warehouse services rank among the most frequently purchased services, contributors assigned the least significance to effective inventory management in their ratings of outsourcing impacts on competitive advantage. There may be two reasons for this: 1. the insufficient information the service customers have on the logistics service providers' offers and/or their belief that the logistics firms in the market are incapable of providing such services at accepted levels 2. their unwillingness to outsource the activities they deem as critical, and require information sharing. In addition, the mere percentage usages of VMI and collaborative forecasting services (2 and 4% respectively) reinforce the reluctant behavior of outsourcing firms in information sharing with third party logistics firms. From 3PL provider's standpoint, having early demand information and being part of the collaborative forecasting effort, will definitely help in planning the transportation capacity, inventory levels, and scheduling. This will on one hand decrease total supply chain cost and on the other hand increase responsiveness of the outsourcing firms as well as the 3PLs.

When the companies working with 3PLs were asked about their satisfaction with the services they had been purchasing, 17% of them stated that they had no problem at all. This is a very small percentage of satisfied customers and this may be due to their cost oriented preferences. 40% of the participants declare that the company's name and prestige in the market were not considered as an importance factor in selecting 3PLs partner. The reason for such high volumes of complaints might be that service providers are selected from among those offering the lowest prices rather than the ones with the ability to satisfy said companies requirements. The main complaint of participating companies is related to delays and non-compliance with timing. As it was previously mentioned, with collaboration in certain areas, the timing problems can be resolved. The 3 PLs must emphasize the cost benefits and improvements to service quality in order to persuade their customers with regard to information sharing and both parties have to work together to build mutual trust. The competitiveness of 3PLs depends, to a large extent, in their ability to add value to their clients. 3PLs can do that effectively through cooperating with their clients, learning their business practices and introducing innovation with a view towards improving the performance of the supply chain [34].

It is a long-term process to reveal the profile of the logistics sector clearly. This and similar research should be repeated in the coming years; guided by the results from this research, the survey questions and the areas to be focused on should be continuously reviewed and the related data should be collected and analyzed continuously.

As a further suggestion, a cross validate information with 3PLs will be used to confirm if they are using a differentiation strategy and/or segmenting customers in terms of clients profile.

It is also possible to link Bayesian network with Structural Equation Modeling (SEM) in order to benefit from both. SEM is suitable to model linear relationships. However, if the relationships are non-linear, the potential effect of independent variables would not be accurately known, resulting in poor prediction and diagnosis.

REFERENCES

[1] Ulengin F., Ulengin B., 2003. Impact of Internet on supply chain activities: the case of Turkey, The International Logistics Congress 2003 30 June, 1 July 2003.

[2] Arroyo, P., Gaytan, J., de Boer, L., 2006. A survey of third party logistics in Mexico and a comparison with reports on Europe and USA. International Journal of Operations & Production Management 26 (6), 639–667.

[3] Marasco, A. (2008), Third-party logistics: A literature review, Int. J. Production Economics 113, 127−147.

[4] Yeung, J.H.Y., Selen, W., Sum, C.C., and Huo, B., 2006, Linking financial performance to strategic orientation and operational priorities. International Journal of Physical Distribution & Logistics Management, 36(3), 210-230.

[5] Sahay, B.S., Mohan, R., 2006. 3PL practices: An Indian perspective. International Journal of Physical Distribution & Logistics Management 36 (9), 666–689.

[6] Gadde, L-E, Hulthen, K. (2009), Improving Logistics Outsourcing through increasing buyer-provider interaction, Industrial Marketing Management, 38, 633-640.

[7] Kotabe, M., Mol, M. J., & Murray, J. Y., 2008. Outsourcing, performance, and the role of e-commerce: A dynamic perspective. Industrial Marketing Management, 37, 37−45.

[8] Graf, M., & Mudambi, S. M. (2005), The outsourcing of IT-enabled business processes:A conceptual model of the location decision. Journal of International Management, 11(2), 253−268.

[9] Harris, A., Giunipero, L. C., Hult, T. M. (1998). Impact of organizational and contract flexibility on outsourcing contracts. Industrial Marketing Management, 27, 373−384.

[10] Lee, R.P., Kim, D. (2010). Implications of service processes outsourcing on firm value. Industrial Marketing Management (in press, available on-line)

[11] Aktas, E., Ulengin, F., 2005. Outsourcing logistics activities in Turkey. The Journal of Enterprise Information Management 18 (3), 316–329.

[12] Jaafar, H.S., Rafiq, M., 2005. Logistics outsourcing practices in the UK: A survey. International Journal of Logistics: Research and Applications 8 (4), 299–312.

[13] Lieb, R.C., Bentz, B.A., 2005. The use of third-party logistics services by large American manufacturers: The 2004 survey. Transportation Journal 2, 5–15.

[14] Sohail, M.S., Al-Abdali, O.S., 2005. The usage of third party logistics in Saudi Arabia. Current position and future prospects. International Journal of Physical Distribution & Logistics Management 35 (9), 637–653.

[15] Hong, J., Chin, A., Liu, B., 2004. Logistics outsourcing by manufacturers in China: A survey of the industry. Transportation Journal 43 (1), 17–25.

[16] Sohail, M.S., Austin, N.K., Rushdi, M., 2004. The use of third party logistics services: Evidence from a sub-Sahara African nation. International Journal of Logistics: Research and Applications 7 (1), 45–57.
[17] Wilding, R., Juriado, R., 2004. Customer perceptions on logistics outsourcing in the European consumer goods industry. International Journal of Physical Distribution & Logistics Management 34 (8), 628–644.
[18] Sohail, M.S., Sohal, A.S., 2003. The use of third party logistics services: A Malaysian perspective. Technovation 23, 401–408.
[19] Bolumole, Y.A., 2001. The supply chain role of third-party logistics providers. The International Journal of Logistics Management 12 (2), 87–102.
[20] Sum, C.C., Teo, C. B., and Ng, K.-K., 2001, Strategic logistics management in Singapore. International Journal of Operations and Production Management, 21(9), 1239–1260.
[21] Boyson, S., Corsi, T.M., Dresner, M.E., Rabinovich, E., 1999. Managing effective third-party logistics partnerships: What does it take? Journal of Business Logistics 20 (1), 73–100.
[22] Fernie, J., 1999. Outsourcing distribution in UK FMCGing. Journal of Business Logistics 20 (2), 83–95.
[23] Dapiran, P., Lieb, R.C., Millen, R., Sohal, A.S., 1996. Third party logistics services usage by large Australian firms. International Journal of Physical Distribution & Logistics Management 26 (10), 36–45.
[24] Lieb, R.C., 1992. The use of third-party logistics services by large American manufacturers. Journal of Business Logistics 13 (2), 29–42.
[25] P.E. Consulting (1996) The Changing role of third-party logistics –Can the customer ever be satisfied? Survey; Egham, P.E. Consultancy
[26] Ferrari, R. (2000), White Paper Frontline Supply Chain Managers Struggle with E-Business. A Richmond Events and AMR Research White Paper, September 2000, New York, USA.
[27] Sohail, M.S., Bhatnagar, R., Sohal, A.S., 2006. A comparative study on the use of third party logistics services by Singaporean and Malaysian firms. International Journal of Physical Distribution & Logistics Management 36 (9), 690–701.
[28] Edgell, J., Meister, G., Stamp, N., 2008. Industry Insight: Global Sourcing Trends in 2008. Strategic Outsourcing: An International Journal, 1(2), 173-180.
[29] Hansen, M. Schsumburg-Müller, H., 2008. Towards a Developing Country Firm Perspective on Outsourcing, Strategic Outsourcing: An International Journal, 1(3), 210-229.
[30] The State of Logistics Outsourcing 2009. Third-party logistics, Executive Summary, Capgemini Consulting, Georgia Institute of Technology, Oracle
[31] Ballou, R.H., 2004, Business Logistics: Supply Chain Management, Prentice Hall.
[32] Jensen, F., 2002. Bayesian Networks and Decision Graphs, Springer, New York.
[33] Netica Software: www.norsys.com
[34] Panayides, P.M., So, M. (2005) Logistics Service Provider-Client Relationships. Transportation Research Part E 41, 179-200

USING OUTSOURCING IN THE TEXTILE SECTOR: A NOTIONAL ANALYSIS

Özlem Kaya[1], Serdar Kılıçkaplan[2]

Abstract *- Textile is a sector in which competency always remains on the agenda. It has also high potentials in exporting and great interests in Turkish economy. Outsourcing that is one of the strategies for the sector to keep its competitiveness and this enables firms to focus on their own exact activities and increase their performances. Outsourcing, one of the administrating strategies to protect the competitive advantages, has become a sine qua non for today's firms. In terms of the theories and previous studies in this literature, this study analyses advantages and disadvantages of outsourcing and accordingly extent of its success in textile firms. In accordance with newly appeared trends in preserving dynamic and competitive senses of the textile sector, the study also attempts to shed light on the current situation of the textile firms as well as to contribute this literature.*

Keywords - Textile sector, outsourcing in the textile sector

INTRODUCTION

The companies which are under the influence of the globalization and rapid technological developments to survive in this highly competitive environment should satisfy three basic features: rapidity, flexibility and the advantage of cost. Today, customers have been conscious and have demanded for being supplied privatized products in appropriate quantity and rapidity according to their own expectations. Moreover, the sudden fluctuations at the country and global economy constitute significiant risks to the companies. The companies depending to these factors have begun to make radical changes at the structures of their management and production. The method of 'outsourcing' with the aims of adapting to change and variability, being affected less by the fluctuations, making use of recent technologies and knowledge rapidly is widely applied [4].

Outsourcing is that a company doesn't produce the service which it intends to offer but it hands over for producing service to another company which is specialized in this area[5] This application is a significiant step for companies to save up in terms of times and costs on a large scale. So, the company has the quality that it wants thanks to a specialized company and it increases its productivity [7].

The company reduces its costs, uses its resources more effectively, gains rapidity and increases business performance through the outsourcing. The outsourcing is a management strategy and it has become widespread in Turkey as well as all over the world and the companies have started to use it recently. The textile sector which has a significiant share and high export figures at Turkish economy needs to implement innovative strategies for preserving its competitiveness and market shares which it has and satisfying the customers' expectations with rapid, low-cost and quality methods. The outsourcing which is one of the strategies used for this purpose by the sector will help to increase the competitiveness [2],[16].

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OUTSOURCING

Outsourcing is the transferring of the activity which was made and managed in the company before together with human resources with the long term contract to the foreign business [20].

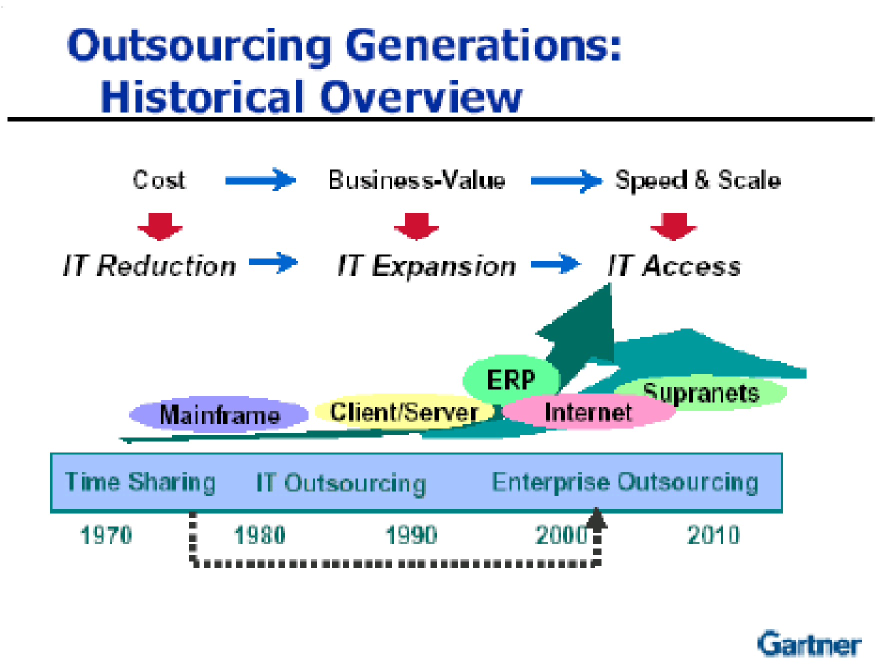

FIGURE. 1
Historical Development of the Outsourcing Model [3]

Increased international competition and difficult economic conditions have led both private and private sectors about providing services and goods to explore more cost-effective ways. Therefore, it's usual for many state organizations and private companies to benefit from the outsourcing with the purpose of increasing the competition while the opinion of the focus on the activities for the organizations have become widespread.

It comes into prominence more that making the product design, product assembly, packing and the works of parts production done by the outside sources at the outsourcing agreements [20].

For the reasons that increased competition and the companies' wishes of having the flexible structure in parallel to the rate of growth in all sectors turned into this activity as an effective management strategy. Indeed, over time, all the companies regardless of the type have focused on the business which they do best to be more competitive in the market, while they have headed for using other businesses' sources which they believe they can do the business better in the market. So, outsourcing has gotten away with a simple purchase decision and process in the operational and tactical level and has begun to define as a strategic management model. Thus, it brings advantage about using the competence and resources of companies much more efficiently than other strategies [19].

In its first years, outsourcing began as a small scale in the areas (maintenance, repair, cleaning, distribution,etc.) outside the main fields of activity of companies. Seriously, the first applications to benefit from outside sources have emerged in the production of spare parts in the American automotive industry. Later, outsourcing has become widespread with supplying of the various activities which are carried out in organization traditionally from the foreign companies because of the effects on reducing costs, savings of personel and producing of free personnels to perform other tasks [22].

There are some reasons for outsourcing. They can be classified under six headings such as reasons depending on companies, development, financial, conditions, employees and costs [15].

The Advantages of Outsourcing

A competitive advantage can be gained providing products or services by outside suppliers more effectively and productively. The advantages of outsourcing may be operational and strategic or both operational and strategic. Strategic advantages provide long-term contributions to maximize the opportunities while operational advantages usually provide short-term solutions to problems [9]. We can classify the advantages of outsourcing such as: reducing costs, reducing risks by sharing, increasing capacity and flexibility, developing the main activities, [12] the acquisition of machinery for specific sections, getting rid of the costs of repair and maintenance, getting rid of the problems arising from too many personnels, working with trained personnel and technology, reduction, positive effect on the specialist suppliers, gaining rapidity, transferring the resource, redelivering of resources, access to desired information as soon as possible, having knowledge about the costs, reducing the costs of investment, accelerating the benefits of restructuring [6], following the technological innovations, gaining specialists, supplying the competitive advantage[10], increasing the productivity, improving the quality, entering between the successful companies.

The Disadvantages of Outsourcing

Although the outsourcing has many advantages, it has also many disadvantages. If the strategy is not applied correctly, advantages turn into disadvantages. These can lead to costly for companies[13].

The risks arising from the outsourcing and the emergence of potential problems although it's different for each collaboration, it can be defined in general with the following headings.

These are: increasing dependency on outside resources, cultural attenuation [12], increasing of the costs, losing of flexibility, reducing the quality, losing of the control, disclosuring of trade secrets, selecting an unqualified subcontractor company, the company's losing of its competences, loss of control over personnels, focusing on short-term economic goals, missing of the opportunities in the future [18].

OUTSOURCING PROCESS

The decision of outsourcing should be thought carefully. Unless it is determined carefully by the business to outsource about which matters, from which provider, on which conditions, the expected benefits will not be provided. Trying to provide the goings on, which are in the scope of business' ability from outsources, the preference of wrong provider, and mistakes about the agreement may cause to lose the existing advantages of business [1].

By focusing on their main actions, businesses think of outsourcing in order to cope with increasing competition. Although, it is mostly used in information technology among sectors, today the fields of outsourcing have been diversified. The process of outsourcing in businesses starts with a preparation process which involves the born of a need, evaluation, taking the decision of outsourcing and determination of outsourcing strategy. The process continues with the preparation of articles and conditions, determination of the provider, making the contract and putting it into service. The last step, on the other hand, involves bringing the cooperation to a better level by bringing the both businesses into consonance with the other, making arrangements to control and manage the newly established constitution [4].

Outsourcing has been concentrated on especially such fields as information technology, supervisory activities, real estate property, distribution, logistic, production, customer care, human resources and finance.

Before outsourcing, businesses should make clear definitions of vision and mission and they should focus on information, ingenuity and ability in accordance with these definitions. So, we will have clear ideas about in which fields we should outsource and what should be done by the business [1].

Accordingly the strategic decision about outsourcing should come up. One of the points that will be determined is which business process how and under which conditions will be provided by outsourcing. At the second step, articles and conditions are prepared in accordance with the developed strategy, and they are transmitted to the providers that can apply for these businesses. Proposals that are prepared by providers are analysed and business is given to the best candidate. At the third step an outsourcing contract is prepared with the provider that takes the business. As stated earlier, this contract should be long term, and its scope, service level, critical success factors, punishment and award criteria should be certain. After the contract, the provider business gets the job and starts to service. An activation process is applied through this transition period in order to affect the existing operation minimally, and prevent the sudden fluctuation on the service quality. Throughout this process both the provider team and the business team creates an intimate working environment. After the job content is quoted to the provider successfully, control of service level begins [17].

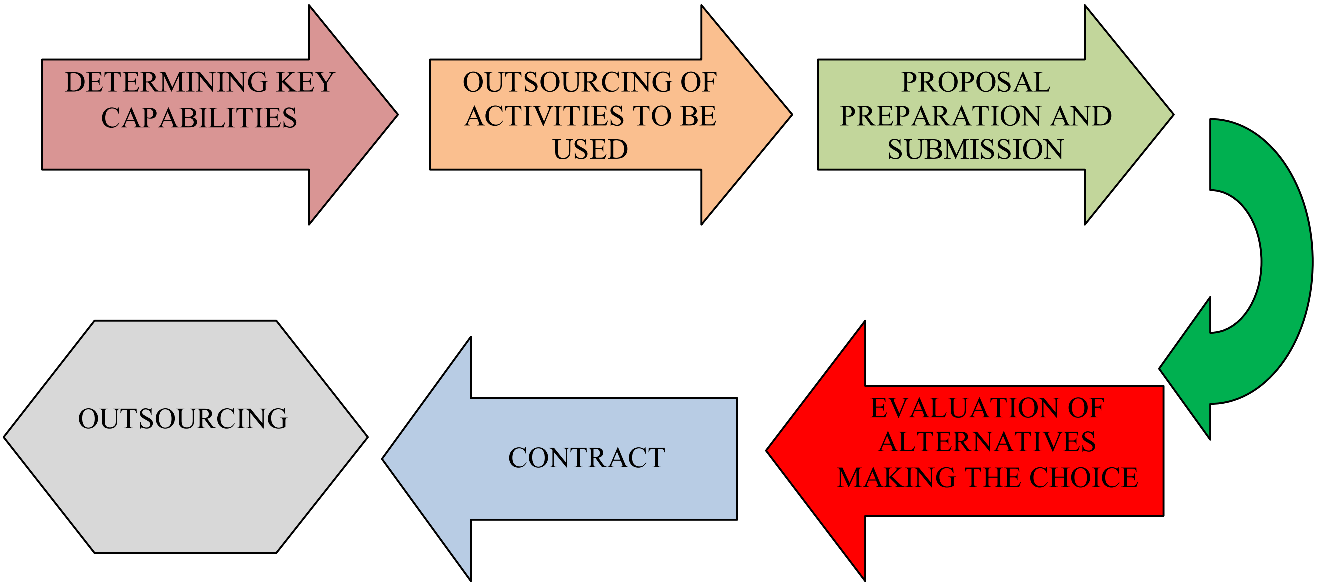

FIGURE. 2
Stages of Outsourcing [14]

A successful supplier – customer relation at outsourcing starts with drawing up an agreement. The agreement must be drawn and conducted carefully in advance in order to reduce the expenditures, direct the equities to actual province and make the attention of company that will benefit from outsourcing, focus on actual field of business [21].

OUTSOURCING AT TEXTILE SECTOR

The strategic importance of outsourcing is rising in our country as it does in the rest of world. No company that competes at international markets can have its own sources which are adequate for doing all activities by itself. Every company is in effort of directing its current sources and work force to its actual field of business, existing at the market with its these properties and providing an advantage for competing. Companies that do not settle in that way cannot survive [8].

Outsourcing which enables company to focus on its actual business, reduce the expenditures, increase profitability, evaluate its sources efficiently, use downsizing strategy successfully enables company to provide products/services/processes from other companies which are expert at that business field.

Below are the companies' reasons for preferring outsourcing[11];

- Controlling and reducing the operating costs,
- Developing the core functions of company,
- Gaining the ability and opportunity to opening up to the world,
- Ease of directing equities to other fields,
- Opportunity to access other sources,
- Realizing of restructuring,

- Having difficulty at conducting functions,
- Sharing the risk,
- Reducing vulnerability against external factors,
- Demand for cash

Today outsourcing is used in many areas and processes by businesses with success. Businesses successfully benefit from the outsourcing also in activities except from daily and repetitive activities which have no critical importance for business success. Apart from food, service, cleanliness, security, distribution, maintenance and repair, IT services, processes such as human resources, marketing, production, research and development, even management that affect business success directly can be provided outside the business. Focusing on the areas in which they are best, businesses grow smaller but their turnover and profitability grow bigger. The reflection of outsourcing in the world on turkey is a little bit different. Compared with their rivals in the world, Turkish businesses have discovered outsourcing much later. The rate of success through outsourcing is lower than their rivals in the world because they have not considered that the real advantages of outsourcing can only manifest itself in the long term and they tried to save the day and they have not been able to fully grasp or apply the essence of outsourcing and the risk-sharing strategy. Depending on all these, outsourcing investments and market are also smaller compared with the world profile.

One of the sectors in which outsourcing is used; textile is a dynamic, innovative, and successful sector that has an important part in our country's economy, ranks high in export figures and has a high potential for employment. When we look at the area of outsourcing, 1.4 million of 2.1 million people working in the textile and apparel industry work in enterprises operating as a supplier [15].

Textile sector has to survive in markets where ruthless competition and aggressive trade politics dominate, and protect the market share. Businesses has to make fast, high quality, innovative and low cost productions in order to survive in textile sector where there are new formations and the production and market dominance has shifted to Far East. Above all, they have to satisfy their customers and meet the demands and expectations of the customers. For this reason, they can benefit from outsourcing which is a management strategy [6].

Business that gets service with method of outsourcing will benefit from the prominent features of this method such as speed, low cost, and flexibility. Supplier that will undertake the job will do the current operation without problem in a short time as it has the stock of knowledge, ready infrastructure, with qualified personnel and appropriate legal permissions, which are all the advantage of providing similar services to similar customers. It will be able to respond to the changes demanded by the customer (level of service, quality, content and the type of services) in the content of the job it has undertaken. Supplier can present the current work with lower cost and on top of it all, with high quality and service using the common infrastructure, shared use of staff and effective business processes.

Turkish businesses in Europe and America for many years and even today, businesses operating in the textile sector, in other words, outsourcing companies have been outsourcing partners, and have fulfilled their tasks successfully. Be implemented, conditions for successful use of outsourcing as a business risk-sharing relationship with the contractor-manager, selecting the right outsourcing business, outsourcing businessfactors such as good management of relations with the Europeans and Americans who choose to take advantage of the use ofoutsourcing has been successfully applied by businesses. Textile firms, although they are aware of the existence of outsourcing and apply, they face difficulties in the implementation phase, non-application of the core of the outsourcing relationship between the risk-sharing contract-management business and Turkey, which is common in outsourcing contract with the business mix the use of outsourcing business.

Common understanding of the outsourcing business in Turkey is defined as employment in the textile industry sent to subcontracting. Materials are usually required during the production phase,business plans and work orders are prepared and given to a business outside the enterprise, called "to give work to subcontracting". Usually applied in the case of job which is unable to overtake the orders sent to subcontracting and in case the business of producing erroneous,it ends with a person's checking from the main company That job is completely in control, and each stage of the businessentity managed or controlled by the enterprise. However, in the usage of business outsourcing while outsourcing business is giving the job it gives the detailed descriptions of expectations and demands, determine the time needed to overtake and quality standards and leave the job completely outsourcing operation. After this stage business is not concerned with how the work is done, how the material is supplied, how a technology being used. Because subconstractor is the expert in the usage of business and the goal is to benefit from his expertise. The successful implementation of outsourcing mistakes can be made throughout the process (such as the wrong choice of subcontractors, in the usage of business), need to be realized early if needed businesses should benefit from the non-business experts in order to take timely measures.In Turkey, there are businesses which gives consulting services on outsourcing usage and they can support businesses at every stage of business process outsourcing. But the research shows that, the vast majority of businesses in the process of outsourcing are not benefiting from the non-business experts. Outsourcing usage is applied both other sectors in Turkey and the textile industry for more than a routine critical to the success of enterprises did not constitute activities such as meal, service, maintenance repair and distribution. In addition, in the textile sector,some stages such as printing, embroidery, as a partial package of production, are supplied by the usage of the outsourcing. Yet businesses play an important role in the success of marketing, R & D, management, main parts like production of all is not truly supplied by the usage of outsourcing. Businesses operating in the textile industry in order to save their competitive power and to be successful they should analysis their activities to do correctly with the support of the experts when it is necessary, identify the main activities and they should go throught to supply the outside activities which is determined according to the business objective, strategies and suitable plannig with the usage of outsourcing. Only in this case can use their sources effectively, reduce costs, increase profitability benefit from all the advantages of outsourcing in the long run [6].

CONCLUSION

Textile businesses that try to accommodate with changing conditions, are in new searches by changing their management policies in order to solve their problems, enter into new markets and sustain the continuity of their profits and business. Since outsourcing, which is one of the management strategies that can be used in order to be able to maintain their competitive advantages, to compare and contrast their power, to determine their powerful and weak sides, to see the chances and risks at the market, to measure their efficiency and to accommodate to the changes, has many advantages and provide them to the business, it has been widely used in the recent years.

Textile businesses should focus on their major point that's to say to the point which creates them and they should concentrate on this way. All businesses should state their powerful and profitable points and should direct all of their sources to these points. The matters that are not related with the main field of the business should be described as unnecessary burden for the business and its accounts should be kept separately. The costs of this kind of subservices should be calculated accurately instead of hiding and losing in the overhead cost. So it will be more appropriate and more economical to take out these services which are out of the main field of activity of business and to buy these services from the qualified people and businesses about these matters.

Researches that have been carried out, show that application of outsourcing increases the performance of business and its competitiveness. In order to maximize this benefit the preference for the provider enterprise is important and it is also important to be sure that there is an agreement about common benefits and goals with the provider business. Also it is a truth that benefits from application of outsourcing increases the applications. But textile businesses have come to an agreement about the impossibility of assigning their major works to outsources and there are powerful ideas that secondary activities of businesses such as food, cleaning as well as such matters which are out of the major works of businesses but may provide competitive advantages to the business such as building up the technologic facilities, finance carriage, storage may be given to outsources.

Textile businesses should think long term and they should prepare the most appropriate road map for their business by predicting and analysing the developments in the world in order to exist in future instead of seizing the day. Outsourcing is one of the important management strategies that can be used now and it will be important in the future.

REFERENCES

[1] Ataman, G., 2004. "İnsan Kaynakları Fonksiyonunda Dış Kaynaklardan Yararlanma/Yararlanmama Kararı: Akaryakıt Dağıtım Sektöründe Bir Örnek Olay", Öneri: Marmara Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 21, 13-24.

[2] Bilge, H., 2005. "İşletmelerin Global Rekabet Ortamında Rekabet Güçlerini Arttırıcı Bir Yaklaşım: "Outsourcing", Akademik Bakış, Uluslararası Hakemli Sosyal Bilimler E-Dergisi, Issn:1694 – 528X S:5 January.

[3] Business Solutions Development, 2008. "Bilgi Sistemlerinde Outsourcing Modeli", www.bsd.com.tr. Adana. Erişim Tarihi:07.06.2011

[4] Doğan. M., 2010. "Dış Kaynak Kullanımı Uygulama Süreci", http://outsourcingturkiye.blogspot.com [14.02.2006].aktaran, Kucur, M.Z., İşletmelerde Dış Kaynak Kullanımı Ve Uygulamaya Yönelik Bir Araştırma, Yıldız Teknik Üniversitesi Sosyal Bilimler Enstitüsü İşletme Anabilim Dalı İşletme Yönetimi Yüksek Lisans Tezi, İstanbul.

[5] Empleton P., Philip, R. and Wright, C., 1998. "A Practical Guide To Successful Outsourcing", Empowerment In Organizations, Vol.6, No:3, MCB University Press.

[6] Kanat, S., 2007. "Hazır Giyim Sektöründe Outsourcing (Dış Kaynak Kullanımı) Uygulamaları Ve İşletme Performansına Etkisi", Yüksek Lisans Tezi, Ege Üniversitesi Fen Bilimleri Enstitüsü, İzmir.

[7] Kovancı, A., Ecerkale, K, 2005. "İnsan Kaynaklarında Dış Kaynak Kullanımı", Havacılık Ve Uzay Teknolojileri Dergisi, Temmuz, Cilt 2, Sayı 2, 69-75

[8] Kucur, M.Z., 2010. "İşletmelerde Dış Kaynak Kullanımı Ve Uygulamaya Yönelik Bir Araştırma", Yıldız Teknik Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Anabilim Dalı, Yüksek Lisans Tezi, İstanbul.

[9] Lankford, W.M. and Parsa, F., 1999. "Outsourcing: a primer", Management Decision, 37(4): 310-316.

[10] Loh, L. and Venkatraman, N., 1997. "Determinants of Information Technology Outsourcing: ACrosssectional Analysis", Journal Of Management Information Systems, 9(1), 7-24.

[11] Margılıç, T., 2006. "İşletmelerde Dış Kaynak Kullanımı Ve Verimliliğe Etkisi", Maltepe Üniversitesi, İİBF., Sosyal Bilimler Enstitüsü, Yüksek Lisans Tezi, İstanbul.

[12] Özgün, M., 2006. "Kalite Arttırıcı Bir Strateji Olarak Dış Kaynaklardan Yararlanma ve Lojistik Hizmet Sağlayıcı Firmalar Üzerine Bir Araştırma" Yüksek Lisans Tezi, Marmara Üniversitesi, Sosyal Bilimler Enstitüsü

[13] Öztürk A. ve Sezgili. K., 2002. "Dış Kaynaklardan Yararlanmanın Yeni Bir Rekabet Stratejisi Olarak Kullanılması ve Uygulama Süreci", Uludağ Üniversitesi, İ.İ.B.F. Dergisi, Cilt XXI Sayı 2, 127-142.

[14] Özdemir, A.H., 2010. "Atık Yönetiminde Dış Kaynak Kullanımı", http://www.iwes.com.tr/2010sunumlar, Erişim Tarihi: 07.06.2011

[15] Paksoy, T., 2010. "Dış Kaynak Kullanımı(Outsourcing)", http://www.turanpaksoy.com/dersnotlari/tedarik5.pdf, Erişim Tarihi:07.06.2011

[16] Pelit, E., 2007. "İşletmelerde Dış Kaynak Kullanımı Ve Etkinliği: Otel İşletmeleri Açısından Kavramsal Bir İnceleme", Verimlilik Dergisi, 2007/3, 25-40, www.mpm.org.tr.

[17] Stone, L., 2003. "Evaluating External Service Providers: Turning Chaos Into Order", Lisa Stone - Gartner Group, Outsourcing and IT Services Summit

[18] Tutar, A.E. İnaç, H. ve Güner, Ü., 2006. "Dış Kaynak Kullanımının (Outsourcıng) Makroekonomik Etkileri", Afyon Kocatepe Üniversitesi, İ.İ.B.F. Dergisi, C.VIII, 2.

[19] Quınn, J.B. and F. Hilmer. 1994. "Strategic Outsourcing", MIT Sloant Management Review, Cilt:35, 43-55.

[20] Quelın, B. and Duhamel, F., 2003. "Bringing Together Strategic Outsourcing and Corporate Strategy: Outsourcing Motives and Risks", European Management Journal, Vol. 21, No.5, 647-461.

[21] Webb, L. And Laborde, J., 2005. "Crafting a successful outsourcing vendor/client relationship", Business Process Management Journal, 11(5), 437-443.

[22] Yazıcı, T., 2003. "İşletmelerde Dış Kaynak Kullanımı (Outsourcing) ve Örnek Uygulamalar", Tezsiz Yüksek Lisans Bitirme Projesi, Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü İşletme Anabilim Dalı Uluslararası İşletmecilik Programı, 72.

AN AGENT-BASED ORDER DISPATCHING MODEL FOR THIRD PARTY LOGISTICS SERVICE PROVIDERS

Vahit Kaplanoğlu[1], Adil Baykasoğlu[2]

Abstract *— Third party logistics service providers have to solve a well-known order dispatching problem in their routine operations. This problem is especially complex when the orders to be transported are less than a truck-load and subject to sudden changes. This is because orders which have different pickup and delivery points and different service time windows might be grouped within the same container for the sake of transportation cost reduction. Due to the complex and distributed nature of this problem domain some novel system approaches seem to be suitable to solve this dynamic problem. Agent-based approaches especially multi-agent paradigms which can be considered as relatively new members of system science and software engineering are providing effective mechanisms for modeling this kind of dynamic systems. In this paper an agent-based order dispatching model is proposed. The order dispatching decisions are made by self-adaptive software agents.*

Keywords — Order dispatching, multi-agent systems, third party logistics, logistics costs

INTRODUCTION

Transportation of goods between different parts of the world is an important domain of human activity. It supports and makes possible most other social and economic activities and exchanges [1]. Worldwide interdependence of trade and flow of goods is constantly growing, therefore logistics and the planning of freight transports are of crucial relevance both for economical and ecological reasons [2]. In this age of international competition, improving information systems has forced logistics companies to use new business management techniques [3]. The complexity of the logistics systems has also increased due to the product variety. Products produced and transported globally have a tremendous variation. As a consequence, some less-than-truckload (LTL) order groups are to be forwarded within same containers. However, making the decision of this operation is not trivial. In addition to business complexity and product variety, the dynamism of the transportation domain results in some unexpected events. The real-world situations are complicated as a result of ambiguity in the requirements of the services, the uncertainty of solutions from service providers, and the interdependencies among the services to be composed [4].

Handling unexpected events in transportation is a challenge for both operations research and information technology practices. Figure 1 summarizes how the new order changes the operations data and schedule of the trucks. When a new order arrives to the system, the previous operations might be (if feasible) cancelled or delayed by inserting the new order to the schedule of any truck. The operations of truck 1 and truck 2 are straightforward up to the time of new order request arrival to the third party logistics provider because the operations of the trucks are scheduled. However, when a new order request arrives to the system, the dispatch officers must consider the attributes of the newly arriving order (such as volume, weight, pick up time, delivery time, pickup point, delivery point and etc.), schedules of truck 1 and 2, and container capacities of the truck 1 and 2. Therefore in each change in the system or when any event occurs, the dispatch officers must reconsider the system so as to make a good decision. When the scale of the system increases, handling this kind of dynamic events becomes harder. While handling the unexpected events, third party logistics service providers have to solve the well-known order dispatching problem in their routine operations. This problem is especially complex when the orders to be transported are less than a truck-load and subject to sudden changes. This is because orders which have different pickup and delivery points and different service time windows might be grouped within the same container for the sake of transportation cost reduction.

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On the other hand, the information technology which is available today provides some new opportunities to handle the problems aroused from this domain [6]. Satellite monitoring systems, geographic information systems, mobile communication systems, navigation systems and etc. are some examples of the novel technologies which can be used in transportation domain. However, usage of these sophisticated technologies requires a good analysis and design of the transportation domain. As a newly emerging area of system science; ***agent based*** systems can be considered for adaptive solutions generation and for combining these technologies so as to make good decisions in dispatching operations.

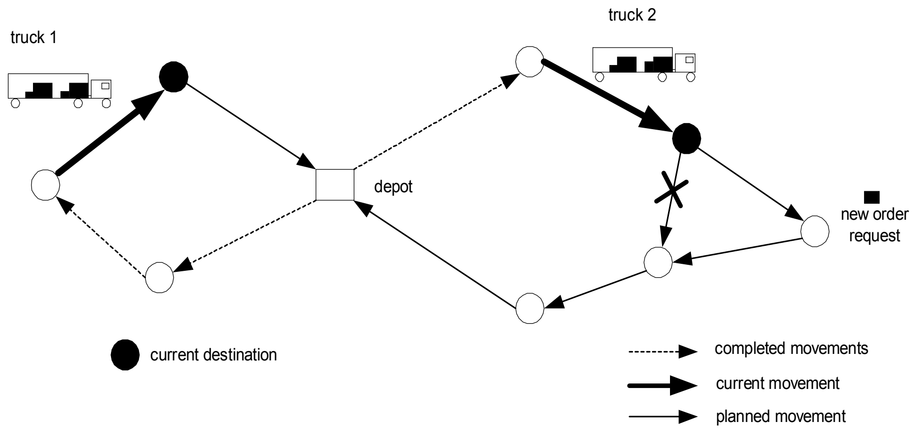

FIGURE. 1
On-Line Routing Of Trucks Adapted From [5].

In this paper an agent-based order dispatching model is proposed. The order dispatching decisions are made by self-adaptive software agents. The proposed model is illustrated with a case study which is implemented in a third party logistics service provider. The logistics service provider which is the subject of the present agent based order dispatching model is delivering logistical services within international markets [7, 8]. There are 15 different points on the transportation network of the provider. The provider has more than two hundred trucks. Real data of the third party logistics service provider such as transportation network attributes, trailer attributes, container attributes, operation costs and etc. are being used in the case study.

AGENT BASED ORDER DISPATCHING MODEL

As it is expected from a fairly young area of research, there is not yet an universal consensus on the definition of an agent [9]. However, the most widely accepted definition of the agent is of Wooldridge and Jennings (1995). According to their definition, an agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives [10]. In this study, the agent based order dispatching model is built on the multi-agent paradigm. As the multi-agent paradigm is a methodology at its infancy, there are some novel approaches to model such systems. There is not a high-level development methodology for the agent systems. In principle, agent architectures can be divided into four main groups: logic based, reactive, belief-desire-intention (BDI) and layered architectures [11]. The proposed system works with the BDI architecture. Figure 2 gives the general framework and agent types within the proposed model [12].

There are three different agent types within the proposed model; order, truck and regional dispatcher agent types. Order dispatching decisions are made by these agent types collaboratively. The negotiation protocols between agent types are defined via using Foundation for Intelligent Physical Agents (FIPA, http://www.fipt.org) contract net protocol. The FIPA is a multi-disciplinary group pursuing software standards for heterogeneous and interacting agents and agent-based systems. This organization has made available a series of specifications to direct the development of multi-agent systems [13]. Sample negotiation protocol between order and truck agent types are given in figure 3.

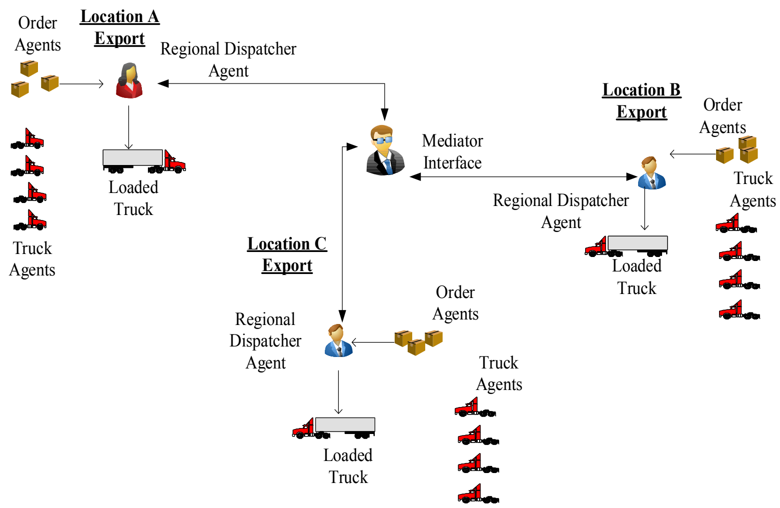

FIGURE. 2
Multi Agent-Based Order Dispatching Model [12]

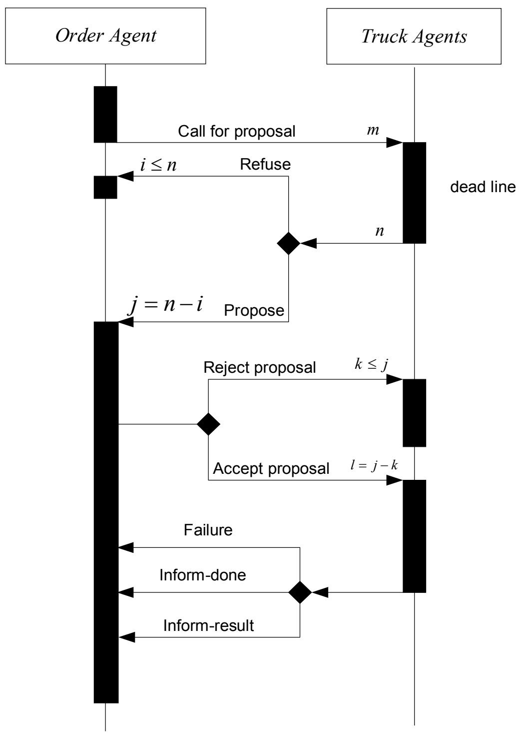

FIGURE. 3
Sample Negotiation Protocol Between Order and Truck Agent Types [12]

When an order agent o enters to the system and the available truck agents are determined by the regional dispatcher agent, it has to bid to truck agents for a call for proposal. As presented in the figure 3, the order agent calls for proposal to the truck agents which are provided by the regional dispatcher agent. If there is m number of truck agents within the truck agent set provided by the regional dispatcher agent, the order agents call for proposal to these m trucks within the system. n is the number of truck agents responding to the call for proposal. i is the number of rejection, j is the number of acceptance of truck agents. k is the rejection number, and l is the acceptance number of order agent. The truck agents check the feasibility of acceptance of the order agents and their respective cost of transportation by checking their schedules, container capacities and other business rules then they send the message of acceptance or rejection.

Order dispatch decision is made if the order transportation is economical for the overall system. Therefore the order dispatch decision is made with a self-emerging mechanism. The order agents can suit to the truck agent containers or their schedules at the end of their respective negotiations. Or they can be rejected due to the feasibility, profitability reasons or shipper order cancellation.

Case Study

The proposed model is implemented by using an agent integrated development environment (IDE) which is named as JACK ™. The negotiation protocols given in figure 3 are built under the JACK™ framework. A sample run is done to see the outputs of the system. Sample run is conducted by releasing some order agents according to some distributions. Table 1 represents the output of the order agent types. The operations data of the third party logistics provider is considered in this case study. The order attributes are given in table 1 with the columns such as origin and destination of the orders. **RT** in table 1 stands for the response time attribute of any order agent and TrStatus stands for the result of the order transportation, 0 means order agent is excluded from the system and 1 means order is transported. The rejection reason column stands for the reason of order agent exclusion from the system. For example, order 1 is rejected from the system due to the shipper cancellation. However order 9 is transported from node 7 to 14. We can distinguish that distance between node 7 and 14 is 4967 kilometers. Volume and weight of order 9 are 16 and 7 respectively.

TABLE 1
Order Agents Output Report

Order	From	To	Distance	Volume	Weight	RT	TrStatus	Rejection Reason
1	15	14	2528	25	1	3	0	Cancellation
9	7	14	4967	16	7	3	1	Null
4	14	0	3842	12	4	3	1	Null
3	14	2	4047	4	2	3	1	Null
0	14	0	3842	5	11	3	1	Null
7	14	1	4317	13	13	3	1	Null
8	5	9	1358	23	4	3	1	Null
2	11	14	3500	23	7	3	1	Null
6	14	5	2600	4	13	3	1	Null
5	14	2	4047	29	7	3	1	Null

In addition to order output report we can get the truck agent data after the sample run. Table 2 shows the operations of the truck agent which were defined to the system. We can see from table 2, truck 0 have completed 6 operations. It has done 3 consecutive pick-up operation and 3 delivery operations.

If we focus on the operations of truck 1 agent we can see the consecutive operations of truck 1. Truck 1 completes 6 operations. It first picks up order agent (OA) 2 and then OA 5, then it delivers OA 2, then it picks up OA 6 and delivers OA 6 and finally it delivers OA 5. Figure 4 and figure 5 summarize the operations of truck1.

As figure 4 and 5 illustrate, the operations decisions of the truck agents are reasonable. The truck agents consider their schedules, their container capacities and business rules of transportation operations. As any order arrives to the proposed model, it is being directly scheduled by the agent types with a self-emerging manner. In other words, the proposed model can handle the dynamism of the transportation operations (to some extent). Truck agents can update/change their schedules while they are doing transportation operations.

The proposed model can handle some unexpected events and new order request arrival to the system in a self emerging and adaptive multi-agent environment.

TABLE 2
Truck Agents Output Report

Truck	Order No	From	To	Final Volume	Final Weight	Distance	Type
Truck 0	0	0	14	5	11	3842	pick-up
Truck 0	3	14	14	9	13	0	pick-up
Truck 0	4	14	14	21	17	0	pick-up
Truck 0	4	14	0	9	13	3842	delivery
Truck 0	3	0	2	5	11	655	delivery
Truck 0	0	2	0	0	0	655	delivery
Truck 1	**2**	**0**	**11**	**23**	**7**	**2300**	**pick-up**
Truck 1	**5**	**11**	**14**	**52**	**14**	**3500**	**pick-up**
Truck 1	**2**	**14**	**14**	**29**	**7**	**0**	**delivery**
Truck 1	**6**	**14**	**14**	**33**	**20**	**0**	**pick-up**
Truck 1	**6**	**14**	**5**	**29**	**7**	**2600**	**delivery**
Truck 1	**5**	**5**	**2**	**0**	**0**	**852**	**delivery**
Truck 2	9	0	7	16	7	1164	pick-up
Truck 2	9	7	14	0	0	4967	delivery
Truck 2	7	14	14	13	13	0	pick-up
Truck 2	8	14	5	36	17	2600	pick-up
Truck 2	7	5	1	23	4	615	delivery
Truck 2	8	1	9	0	0	1955	delivery

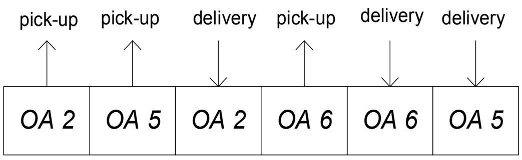

FIGURE. 4
Truck 1 Operations

CONCLUSIONS

In this paper, a multi-agent based order dispatching model is proposed. The inspiration behind this study is to support the decisions made during the third party logistics company operations. Logistics organizations mainly the ones providing land transportation services are facing with difficulties while making effective operational decisions. This is especially the case in making load/capacity/route planning and load consolidation decisions where customer orders are generally unpredictable and subject to sudden changes.

In summary, the proposed model pursues the order dispatching objective while conducting the following operations which are distributed to agent elements by utilizing negotiation and BDI reasoning capabilities of the agent types.

- Load acceptance/rejection
- Load assignment
- Re-assignment
- Routing

- Scheduling

The proposed system inherently include these operation decisions because making a good order dispatching decision in a dynamic business environment requires the decision of load acceptance/rejection, load assignment, load re-assignment, vehicle routing and vehicle scheduling.

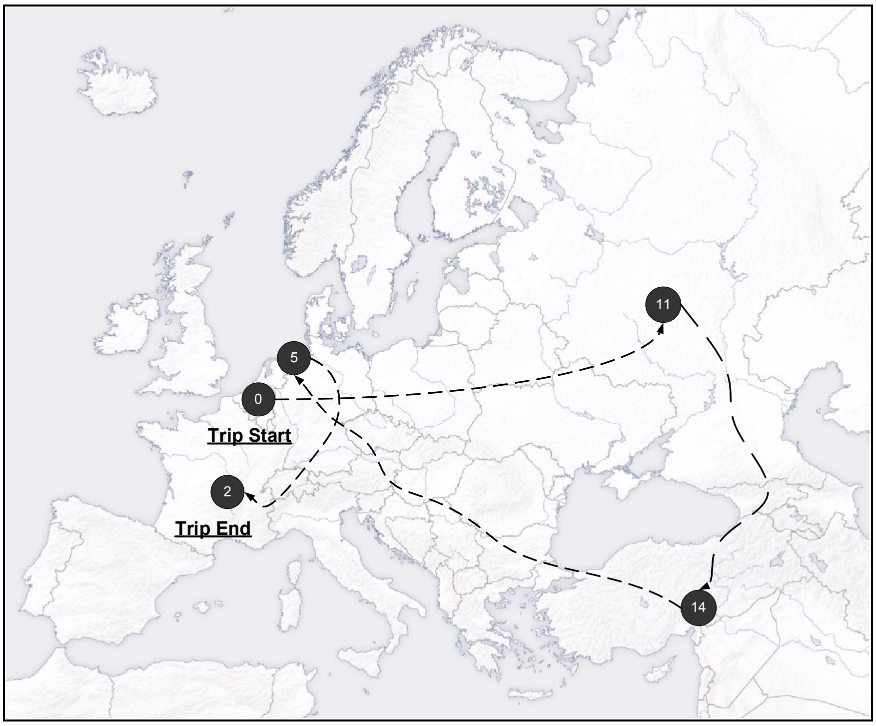

FIGURE. 5
Operations of Truck 1 Agent

REFERENCES

[1] Crainic, T. G. 2003. "Long-Haul Freight Transportation", Massachusetts: Kluwer Academic Publishers
[2] Fischer, K., Müller, J. P. and Pischel, M. 1996, "Cooperative Transportation Scheduling: an Application Domain for DAI", Applied Artificial Intelligence. 10:1-34.
[3] Baykasoglu, A. and Kaplanoglu, V. 2006, "Developing a service costing system and an application for logistics companies", International Journal of Agile Manufacturing. 9:13-8.
[4] Wang, M., Wang, H., Vogel, D., Kumar, K. and Chiu, D. K. W. 2009, "Agent-based negotiation and decision making for dynamic supply chain formation", Engineering Applications of Artificial Intelligence. 22:1046-55.
[5] Gendreau, M., Guertin, F., Potvin, J. Y. and Taillard, E. 1999, "Parallel tabu search for real-time vehicle routing and dispatching", Transportation Science. 33:381-90.
[6] Lau, P. K. H. and Lau, H. C. W. 2008, "Development of an optimised transport logistics system for supporting distribution operations", International Journal of Computer Applications in Technology. 31:187-96.
[7] Baykasoglu, A. and Bartik, E. 2005, "Modelling work processes of a logistic company for performance improvement and training", 3rd International Logistics & Supply Chain Congress.133-8.

[8] Baykasoglu, A., Kaplanoglu, V. and Unutmaz, Z. D. 2007, "Lojistik firmalarında yük konsolidasyonu için bir model önerisi", YA/EM 2007: Yöneylem Araştırması ve Endüstri Mühendisliği 27 Ulusal Kongresi.in CD.
[9] Padgham, L. and Winikoff, M. 2004. "Developing intelligent agent systems a practical guide", Melbourne, Australia: John Wiley & Sons, Ltd
[10] Wooldridge, M. and Jennings, N. R. 1995, "Intelligent Agents: Theory and Practise", The Knowledge Engineering Review. 10:115-52.
[11] Bellifemine, F., Caire, G. and Greenwood, D. 2007. "Developing Multi-Agent Systems with JADE": John Wiley & Sons Ltd.
[12] Baykasoglu, A., and Kaplanoglu, V. 2011, "A multi-agent approach to load consolidation in transportation", Advances in Engineering Software. doi:10.1016/j.advengsoft.2011.03.017 (*In press*)
[13] Lin, F. R. and Lin, Y. Y. 2006, "Integrating multi-agent negotiation to resolve constraints in fulfilling supply chain orders", Electronic Commerce Research and Applications. 5:313-22.

A DECISION MODEL FOR THIRD PARTY LOGISTICS PROVIDER SELECTION USING THE ANALYTIC HIERARCHY PROCESS

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A DECISION MODEL FOR THIRD PARTY LOGISTICS PROVIDER SELECTION USING THE ANALYTIC HIERARCHY PROCESS

Nikitas Nikitakos[1] *& Vassilios Pirkatis*[2]

Abstact -- *Outsourcing in the recent past has emerged as business strategy to gain competitive advantage .Various industries raging from manufacturing banking, finance, logistics marketing and IT to a plethora of other successfully using this strategy.Different managers and academics have stated that an organisation's competitive advantage stems from its ability to identify, Concentrate on and develop its core competencies and activities, and outsource anything which is non core. Outsourcing of logistics systems can contribute to profits by enabling users to maximise financial benefits, focus on core competencies, reduce risk and liability, provide wider coverage and flexible capacity, provide dedicated resources, etc.Supplier selection is a multi-criteria decision making problem which includes evaluation factors. In order to select the best suppliers it is crucial to consider the both qualitative and quantitative factors simultaneously. In the selection process suppliers, manager also has to consider multi-criteria factors related with decision. This paper tries to identify the selection third-party logistics provider (3PL) criteria. The criteria which affects the selection third-party logistics providers (3PL) decision where recorded from literature review and pilot study (interviews from logistics experts and academics). In this paper, a decision-making model for selection third-party logistics providers (3PL) was developed using the Analytic Hierarchy Process (AHP). With this technique, several options are considered in the decision analysis that make it possible to adequately evaluate and choice the best 3PL provider for the company. The case example given in this paper proves that AHP can be used effectively to analyse the 3PL providers selection decision. The criteria and subcriteria for selection 3PL providers and their weight ranking were provided from the logistics managers and experts. The results of this study will provide a practical reference for logistics managers who want to engage the best 3PL provider*

Keywords -- Analytic Hierarchy Process, Decision model,Third-party logistics, 3PL Selection provider.

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INTRODUCTION

Outsourcing of logistics services is not a new concept by any means While it how gained renewed emphasis in recent years , the practice can be track back almost as far as one would care to research it .In Europe, a number of logistics service providers can trace their origin back to Middle Ages. Through 1950's and 1960's the outsourcing of transportation and warehousing was common . The relationships were primarily transactional and typically short term in nature .During the 1970,s manufacturers put heavy emphasis on cost reductions and improved productivity .Long -term relationships become more common , particularly in warehousing area .In early 1980's the services offered by the most of the outside firms expanded rapidly .So called value added services included packaging ,blending ,systems support , inventory management, customized handling and other offerings which had not been available previously .In the same decade consolidation of facilities became a necessity , and what better time to re-analyze the distribution systems and put the centers where they really ought to be? Many of these new consolidated facilities were outsourced; and by 1990 there was an increasing interest in outsourcing any function that was not directly related to a company's core business [1].

Third party logistics (3PL) companies are a becoming an important part of today's supply chain. These companies offer services that can allow businesses to outsource part of all of their supply chain management function. Many 3PL companies offer a wide range of services including; inbound freight, freight consolidation, warehousing, distribution, order fulfillment and outbound freight. The growth of 3PL companies has been driven by the need for businesses to become leaner, reducing assets and allowing focus on core business processes [2]

The advantages and disadvantages of logistics outsourcing in according to [3] Harry L. Sink And C. John Langley, Jr. (1997) are presented in the following table 1.

TABLE 1

Benefits and problems reported with Logistics Outsourcing

Benefits:	***Problems:***
Costs for outsourced functions have been reduced 57.7%	Control over outsourced function(s) has diminished 35.2%
Increased flexibility 56.3	Time and effort spent on logistics have not decreased 33.8
Service levels for the outsourced functions have been improved 52.1	Cost reductions have not been realized 25.4
Employee base has been reduced 50.7	Quality of third-party employees has not been realized 2.5
Firm is better able to focus on core competencies 38.0	Service-level commitments have not met our expectations 21.1
Capital expenditures for logistics have been reduced 31.0	Unsatisfactory transition occurred during implementation stage 18.3
Availability of greater/more specialized logistics expertise 26.8	Customer complaints have increased 12.7
Improved use of information technology 19.7	Other 8.5

Other 12.7	

Source:Harry L. Sink And C. John Langley, Jr. (1997)

The third party logistics has several advantages and disadvantages instead of working by their own companies or sub-companies,Heung-Suk Hwang, Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan (2005) [4] summarize as following;(see table 2)

TABLE 2

Advantages and Disadvantages of Third Party Logistics

Advantages:
- Economical advantages by outsourcing to a specialized company
-The risk can be reduced

Disadvantages:
-Uncertainty of services
-The beliefs will be worse by the customers
- Internal company information security problem
–Labor problem by reducing the workers for outsourcing part of work
–Difficulties of fast reply to customer claims
–Difficulties of knowledge accumulation for outsourcing area.

Source: Heung-Suk Hwang, Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan (2005)

This paper tries to identify the selection criteria of third party logistics provider by enterprises. In particular it employs the Analytical Hierarchy Process (A.H.P) as an analysis method for decision of 3PL provider selection by managers of enterprises . Finally, a new decision model for 3PL provider selection ping is developed. Section 2 presents a literature review of 3PL provider characteristics Section 3 presents a review of literature on selection criteria of 3PL . Section 4 presents the use of the Analytic Hierarchy Process in Third –party Logistics Provider Selection and a conceptual model for Third –Party Logistics Provider Selection ..Section 5 presents the Analytic Hierarchy Process, that is a multicriteria method for decision making. Section 6 presents implementation of this method to decision making of 3PL provider selection and we propose a new hierarchical decision model for 3PL provider selection, also we give an example of the implementation of this 3PL provider selection decision model in a enterprise. Finally conclusions are given.

LITERATURE REVIEW FOR 3PL PROVIDERS

Much has been written in recent years about outsourcing logistics activities. To describe the outsourcing phenomenon, a 3PL is used and defined as activities carried out by a logistics service provider on behalf of a shipper and consisting of at least management and execution of transportation and warehousing. In addition, other activities can be included, for example inventory management, information related activities, such as tracking and tracing, value added activities, such as secondary assembly and installation of products, or even supply chain management [5] The terms of ‘third party logistics’, ‘logistics outsourcing’, and ‘contract logistics’ have generally been used interchangeably both in literature and practice. 3PL refers to the utilization of external organizations to perform all or part of the logistics activities that have traditionally[6] (Soon Hu Soh 2010) . Table 3 summarizes the specific logistics services outsourced by 3PL users. As indicated in Table 3, the most frequently outsourced services in 2008 were domestic and international transportation, followed by warehousing, customs clearance and brokerage, and forwarding.

TABLE 3

Outsourced logistics services

Domestic transportation
International transportation
Warehousing
Customs clearance and brokerage
Forwarding Shipment consolidation
Reverse logistics (defective, repair, return)
Cross-docking
Transportation management
Product labeling, packaging, assembly, kitting
Freight bill auditing and payment
Supply chain consultancy by 3PL provider
Order entry, processing and fulfilment
Fleet management
LLP/4PL services
Customer service

Source: SoonHu Soh (2010)

Types of Logistics Providers

It is assumed that the outsourcing of logistics services (3PL's Logistics Outsourcing) is defined as an activity which passes a part or all of the logistics functions, basically from the non-production character, to external logistics organizations – third-party logistics providers. *Logistics providers (LP)* can be further called *Logistics Service Providers* or *3PL providers* (LSPs, 3PLs, TPLs).. They are trade organizations, which provide services in the fields of logistics, execution of separate operations or complex logistics functions (warehoused stock, transportation, order management, physical distribution, etc.) and accomplishment of integrated management of logistics chains of the client-organization. Companies may leave under the control of an external partner all logistics operations, including consulting, execution of the necessary surveys, and implementation of information systems. These companies frequently possess rich experience in logistics management, have at their disposal qualified personnel and developed infrastructure (terminal or terminal network, car pool, often even international transport agents).3PL providers are predominantly daughter companies, which separate from their headquarters (a freight forwarder, a company providing warehouse services, etc.) in order to satisfy the growing consumer needs and to offer them a wider range of services.

There are five types of *3PL providers*: *LP* – carrier-companies, *LP* – warehouse operators, *LP* – freight forwarding & broker companies, *LP* – optimizing transportation services, and *LP* – software processing programs [7]

3PL SELECTION CRITERIA

As mentioned previously, the supplier selection is a multi-criteria problem and hence a complex process because it involves various criteria such as price, quality, delivery, etc.Some criteria are developed with specific client needs while others are common for all circumstances. The main studies done so far on 3PL selection criteria are empirical in nature.

S. Jharkharia, R. Shankar (2007) [8] are summarized of literature on the criteria of the selection of a logistic service provider : 1. Compatibility with the users (CPT) , 2. Cost of service (CST) , 3. Quality of service (QLT), 4. Reputation of the company (RPT) ,5. Long-term relationships (LTR) ,6. Performance measurement (PM) ,7. Willingness to use logistics manpower (WIL).,8. Flexibility in billing and payment (FBP) ,9. Quality of management (QM) ,10. Information sharing and mutual trust (INF) ,11. Operational performance (OP) ,12. Information technology (IT) capability ,13. Size and quality of fixed assets (FA) 14. Experience in similar products (ESP) 15. Delivery performance (DP) ,16. Employee satisfaction level (ESL) ,17. Financial performance (FP) ,18. Market share (MS) ,19. Geographical spread (GS) and range of services provided (RS) ,20. Risk management (RM) ,21. Surge capacity of provider (SC) ,22. Clause for arbitration and escape (CAR) ,23. Flexibility in operations and delivery (FOD).

Jao-Hong Cheng, Shiuann-Shuoh Chen, Yu-Wei Chuang (2008) [9] were offered an evaluation framework of 4PLs built by the key criteria in the uncertainty and complex business environment. In the result, they find that there are eleven subcriteria in the dimension of supply chain integration capabilities, and five subcriteria in the dimension of information technology capabilities. From these views of experts, supply chain integration capabilities are more important than information technology capabilities .Besides, the results indicate that there are different weights among individual dimensions or criteria and subcriteria rather than equivalent weights., Obtained from comprehensive analysis, five evaluation criteria with most importance “Specialization”, “Extent of Partner Relationships”, “Intra Organizational Integration”, “Members’ Participation”, and “Customer Satisfaction” of industrial viewpoint. Whereas, the five most important criteria of academic viewpoint are “Extent of Partner Relationships”, “Specialization”, “Intra Organizational Integration”, “Members’ Participation”, and “Communication with Customers.” Regardless of the aspect in practices or in theories, the most important five criteria are all focus on the dimension of supply chain integration capabilities.

The International Warehouse Logistics Association (IWLA), the leading trade association dedicated to logistics outsourcing, commissioned a study in early 2003.The study, conducted by Dr Dale S Rogers, was an update of similar studies conducted in 1994 and 1999. The subjects were the IWLA’s membership of more than 550 logistics companies [10].The study included follow-up interviews with several customers of 3PL providers. This study answered in the question “what are the primary factors that influence its choice of third party logistics (3PL) provider?” (See table 4)

TABLE 4

3PL Selection Factors

Factor	**2003**	**1999**	**1994**
Price	1	4	1
Reliability	2	2	2

Service quality	3	1	1
On-time performance	4	3	3
Cost reduction	5	6	14
Flexibility	6	5	7
Good communication	7	10	4
Management quality	8	7	8
Location	9	12	13
Customise service	10	13	9
Speed of service	11	8	6
Order cycle time	12	9	10
Easy to work with	13	16	12
Customer support	14	11	5
Vendor reputation	15	15	15
Technical competence	16	18	19
Special expertise	17	14	16
Systems capabilities	18	17	17
Variety of available services	19	20	20
Decreased labour problems	20	23	22
Personal relationships	21	19	18
Decreased asset commitment	22	22	23
Early notification of disruptions	23	21	21
Increased competition	24	24	24
Global capabilities	25	25	25

TABLE 5: Dickson 23 Supplier Evaluation criteria

1 Quality
2 Delivery
3 Performance history
4 Warranties and claim policies
5 Production facilities and capacity
6 Price
7 Technical capability
8 Financial position
9 Procedural compliance
10 Communication system
11 Reputation and position in industry
12 Desire for business
13 Management and organization
14 Operating controls
15 Repair service
16 Attitude
17 Impression
18 Packaging ability
19 Labor relations record
20 Geographical location
21 Amount of past business
22 Training aids
23 Reciprocal arrangements .

Source:Weber, C.A., J.R. Current, A. Desai, 2000.[11]

Dickson, (1966) suggested 23 supplier evaluation criteria with absolute rank of importance.(see table 5) . Also Heung-Suk Hwang ,Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan , (2005) [4] suggested supplier selection indicators .(see table 6)

TABLE 6

Supplier selection indicators

Major indicators Sub-indicators
1. Serviceability Meet the lead time
Inventor rotation rate
Lead time
Customer satisfaction
Market share
2. Supply capability Production flexibility
Multi-item production capability
New item development/production capability
3. Quality assurance
Return penalty
After service level

Source: Heung-Suk Hwang etc.(2005)

Soon-hoo So JaeJon Kim KiJu Cheong Geon Cho (2006) [12] proposed SERVQUAL, perceived service quality is measured along five generic dimensions such as tangibles, reliability,responsiveness, assurance, and empathy. However, despite the wide spread of SERVQUAL, empirical research that uses this scale in the 3PL services context is very scarce. Therefore, we have attempted to use the five dimensional structure of SERVQUAL to measure the quality of service provided by 3PL service providers .

The exploratory study conducted by Menon *et al.* (1998) [13] in the USA depicts that both the firm's competitiveness strategy and external environmental affect the selection criteria. They also show that there are eight important criteria which are: on time shipment and deliveries, superior error rates, financial stability, creative management, ability to deliver as promised, availability of top management, responsiveness to unforeseen occurrences and meet performance and quality requirements before price discussions occur.

In the context of reverse logistics, Meade and Sarkis (2002) [14] present special factors for 3PL selection and which are: time, quality, cost, and flexibility.

Moberg and Speh (2004) [15] study the process of selecting 3PL in order to outsource warehousing. Their empirical survey in the US shows that the most important indicators for choosing a particular 3PL are related to responding to service requests, quality of management, and track record of ethical performance. The three least important criteria are investment in state-of-the art technologies, size of firm, and national market coverage.

Boyson et al. (1999) [16] found that financial stability, customer service capability, and service price were rated as the most important characteristic for selecting 3PL providers.In addition to cost and service, a variety of other selection criteria have been cited in prior literature. According to a survey of 154 firms offering warehousing services in the United States by Spencer et al. (1994), the most important evaluative criteria for selecting external or third-party service providers are, in descending order of importance, the following: on-time performance, service quality, communication, reliability, service speed, and flexibility.

In according to Lynch (2000) [1] the criteria for evaluation Logistics service providers are the following : Financial stability, business experience, management depth and strength ,reputation with other clients ,strategic direction , physical facilities and equipment ,operations, information technology ,quality initiatives, growth potential, chemistry and compatibility ,cost.

The abovementioned studies clearly show that the 3PL selection is an MCDM problem, including both quantitative and qualitative factors that are often in conflict with one another. Accordingly, this study proposes a balanced and integrated multi-criteria hierarchical framework for selecting 3PL providers through a careful examination of relevant criteria

DEVELOPING A MODEL FOR THIRD PARTY LOGISTICS PROVIDER SELECTION

The Use of the Analytic Hierarchy Process in Third –party Logistics Provider Selection

Sanjay Jharkharia, Ravi Shankar (2007) [8] were proposed methodology consists of two parts: (i) preliminary screening of the available providers, and (ii) analytic network process (ANP)-based final selection. The criteria, which are relevant in the selection of a provider, have been identified and used to construct an ANP model. Thereafter, the application of ANP for the final selection of a provider has been demonstrated through an illustrative example. The results of this example indicate that compatibility between the user and the provider companies is the most important determinant, which influences the final selection process.

In according to Fu Yao and Liu Hongli (2007) [17], one of the most critical steps in outsourcing is vendor selection, which is a strategic decision. They model the vendor selection problem as a multi-objective optimization problem .Also they suggest five factors, including cost, quality, project, certification and delivery performance, should be considered for outsourcing vendor selection, and proposes the use of analytic hierarchy process (AHP) method in making IS outsourcing vendor selection. The AHP is used to analyze the structure of the outsourcing problem and determine weights of the criteria and make the selection.

Soon Hu Soh (2010) [6] considers that the 3PL provider selection process is an MCDM problem which involves subjective value judgements. The AHP is the most common method for an MCDM problem, AHP seems insufficient and imprecise in terms of accurately capturing a decision maker's subjective judgments regarding the interpretation of qualitative evaluation criteria. To compensate for this deficiency in the crisp pairwise comparison of the conventional AHP, a hybrid approach integrating the AHP methodology with fuzzy logic has been proposed and applied to a practical case study for selecting the best-suited 3PL provider. The proposed fuzzy AHP approach has both the advantage of AHP, which decomposes complex decision problems into a systematic hierarchical structure, and the advantage of Fuzzy logic, which reflects the subjectiveness and imprecision inherent in the human decision making process.

Heung-Suk Hwang, Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan ,(2005) [4] proposed a supplier selection using a multi-criteria decision making method which includes analysis method and also its programs.They used AHP and fuzzy-AHP methods for the purpose of multiattribute characteristics of supplier selection problems.. In this study, they used a three-step approach of decision analysis .Those steps are: 1) brainstorming to define the alternatives and performance evaluation factors, 2) individual evaluation the alternatives using fuzzy-AHP, heuristic and fuzzy set reasoning methods,and 3) integration the individual evaluations using majority rule method. They applied this method in supplier selection problem for a third party logistics considering the 11 evaluation factors and 4 supplier candidates.

Soon-hoo So ,JaeJon Kim ,KiJu Cheong ,Geon Cho (2006) [12] apply the analytic hierarchy process (AHP) to evaluate the service quality of third-party logistics (3PL) service providers. They first conceptualize five dimensions of 3PLservice quality (i.e. tangibles, reliability, responsiveness, assurance and empathy). They then apply the AHP method to determine the relative weights of the five service quality dimensions and eventually select the best 3PL service provider. To implement this idea in practice, they conduct an empirical case study on four companies providing 3PL services in Korea. The results indicate that Responsiveness out of the five service quality dimensions is the most important factor in the perception of 3PL customers.

Kumar, Pravin (2008) [18] consider that the performance measurement of third party logistics (3PL) is very important to improve the customer service level and hence efficiency of supply chain. This is a multi-criteria decision making problem which incorporates various supply chain parameters. He has been developed a framework for performance measurement of 3PL providers , which uses AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). This framework may help to supply chain manager to select a best 3PL and to improve the performance of existing 3PL.

Hasan Karagul ,M. Murat Albayrakoglu (2007) [19] suggested two important factors, which affect the long-term relationships with 3PLs, for the selection and evaluation process of 3PLs ,The functions to be outsourced and their need must be properly investigated with capability of 3PL. They proposed an integrated model of AHP and TOPSIS which has been used to evaluate the performance of various 3PLs. AHP is used to assign the weight to criteria for 3PL rating. It has been further used in TOPSIS to determine the order of preference of 3PLs. TOPSIS is a good tool to determine the order preference, since in this method a normalized matrix is used and there is no chance to produce a biased result due to large variations in value of criteria quantitatively.

Conceptual Model for Third –Party Logistics Provider Selection

In our paper a new conceptual model for Third –party logistics provider selection (figure 1) is proposed which is based on the models for 3PL selection of SoonHu Soh (2010) , Fu Yao and Liu Hongli (2007), Heung-Suk Hwang, Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan (2005) , Soon-hoo So ,JaeJon Kim ,KiJu Cheong ,Geon Cho (2006), Hasan Karagul ,M. Murat Albayrakoglu (2007) , Kumar, Pravin (2008) First, a decision hierarchy for selecting a 3PL provider was designed with three levels as appeared in Figure 3. The top level of the hierarchy stands for the ultimate goal: to evaluate and select a 3PL provider that best meets the shipper's requirements.

According to the model , 3PL selection decision is affected from five criteria: finance service level, relationship, management and infrastructure .The above criteria and their sub-criteria are determined by bibliographic review and from 20 interviews with logistics experts . To construct the criteria framework, a preliminary list of 23 criteria was prepared from literature review and subsequently presented to twenty logistics experts for their review to determine the final set of candidate criteria.

After an intense discussion and a round of voting, a final list of 13 criteria was determined. During this phase, the 13 criteria were categorized into five groups: finance, service level, relationship, management, and infrastructure.

These five factors are affected from other (subcriteria) .Finally, taking in to account the above criteria and sub-criteria we will decide who 3PL provider we will choose. The decision process should include clear, coherent analytic steps and can generate numerical results to convince those who will be the recipients of the results.

Saaty (1980)[20] developed a method namely Analytic Hierarchy Process (AHP) to solve decision problems with uncertainty and with multiple criteria characteristics .AHP is a method that collects the expertise of decision makers and uses a hierarchy structure to present complex decision problems by decomposing them into several sub-problems [21] . The first level of hierarchy is the goal we want to reach and the elements of lower levels are criteria ,sub-criteria and on the lowest level are the alternatives, so there are hierarchical levels (see figure 3). The criteria ,sub-criteria and sub-sub- criteria are used to evaluate the alternatives .The AHP method encompasses three steps : First constructing the hierarchy ;second ,computing the weight of criteria and sub-criteria ; and third, computing the weight of alternatives ,evaluation of the alternatives and decision making [22].

THE ANALYTIC HIERARCHY PROCESS

Method Description

AHP is a multicriteria method for decision making and priorities ranking developed by Saaty (1980;1990;1994)[20,23,24] This method collects expertise of decision makers and uses a hierarchic structure to present a complex decision problem by decomposing it into sub problems . AHP is a method which combines subjective and objective estimations or perceptions in an integrated framework which is based on scale ratios from pair comparisons [20].The AHP algorithm is based on matrix algebra .The judgments from the pair comparisons are made by experts or decision makers and in combination with the use of the AHP algorithm they are the tools which produce the final combination. This is the ranking priorities of each element or alternative regarding the ultimate goal according to their specific gravity, which is expressed in percentile form. Before proceeding further to the discussion of the method it is worth defining the term "experts who are the responders of the AHP questionnaires .There are three types of AHP applications[24].These are : (a) the AHP which is based on the distributive relative measurement approach , (b) the one which uses the ideal relative measurement approach and (c)the one which uses the absolute measurement mode.

The AHP method encompasses three steps, first constructing the hierarchy ;second computing the weight of the elements on each level ;and third computing the weight of alternatives [22]

a) The construction of a hierarchy .A complex problem can be dealt with by decomposing it into sub problems within hierarchy . The elements in a level of hierarchy would not exceed seven because it is difficult for human beings to deal with more than seven things simultaneously. The highest level with only one element is the goal we want to reach and the elements in the lowest level are the alternatives . Elements in the middle levels are the criteria or attributes for evaluating alternatives.
b) Compute the weight of the elements in each level. Three steps can describe this phase: Paired comparisons, computing vector priorities and measuring consistency. 1.The paired comparisons can be based on preference, probability or importance and are usually based on expert's estimations ,usually on a 9 point scale. The number of comparison is n(n-1)/2 where n= number of criteria.
c) The synthesis of the priorities and the measurement of the alternatives (if they exist) which will give the outcome of the whole process. There are four ways for the calculations of priorities .1.The consensus 2.the vote compromise 3. The geometric mean of personal judgments and 4.the weighted arithmetic mean.

AHP has four axioms which are of vital importance for its application and the extraction of reliable results .These are [21]:

-The reciprocal axiom. If Pc(Ea, Eb)is a pair comparison of the subcriteria a, b regarding the criterion c ,thenPc(Eb ,Ea)= 1/Pc (Ea, Eb)

-The homogeneity axiom .The importance of criteria or sucriteria is equal [23]

-The independence axiom .The elements in the hierarchy are not dependent on the elements in the lower level of the hierarchy.

-The proper use of AHP. In order to have reliable results from the application of AHP ,except from improper use of judgments in pair comparisons must be consistent. In order to trace the inconsistency ,there is an inconsistency ratio (IR). This ratio must be IR< 0,1 in order to have reliable judgments and out comes [20].

RESEARCH FRAMEWORK FOR APPLYING AHP IN THIRD PARTY LOGISTICS PROVIDER SELECTION .

The construction of hierarchy model

The research framework aims at the selection and evaluation 3PL providers that can be used by enterprises using the AHP. This decision is based on 5 criteria and 5or 4 sub-criteria for each criterion, also each sub-criterion is affected by 1 to 3 sub-sub-criteria.

The study applies the AHP as a decision making tool. Following the three processes approach , the first step in research is the construction of hierarchy .The selection and evaluation 3PL providers designated as the ultimate goal(upper level).In the middle levels of hierarchy there are 5 criteria : Finance ,service level, relationship with provider, management , infrastructure. For each criterion there are 2 to 5 sub-criteria .The sub-criteria for each criterion are the following : for criterion Finance, the sub-criteria are costs and financial stability, for criterion Service level ,the sub-criteria are Reliability ,on time performance ,quality of service ,flexibility ,and responsiveness of service requirements, for criterion Relationship with provider, the sub-criteria are Compatibility and trustworthiness ,for criterion Management, the sub-criteria are Performance management, safety and security and Reputation and experience for criterion Infrastructure, the sub-criteria are IT capability and logistics staff attitudes .In the lowest level there are the alternatives : 3PL provider 1 , 3PL provider 2 , 3PL provider 3 (See figure 1)

Interviews development and sample selection

The criteria , sub criteria that can be taken into account for 3PL provider selection, defined by semi structured interviews and questionnaire with logistics experts. The next step in the research framework has been the development of questionnaire based on AHP model. Based on AHP theory we were received interviews by experts and decision makers.

A total sample of 20 experts , was developed. The second stage contains the computation of the weight of the elements in each level, paired comparisons, computing vector priorities and measuring consistency. The third stage of research contains the synthesis of the priorities and the measurement of the alternatives .

Example: Suppose General manager and Logistics manager of a enterprise will decide for selection 3PL provider .The candidate alternatives are 3PL provider 1, 3PL provider 2 and 3PL provider 3 .The leader of task force is General manager. He decide to employ AHP method in decision process .

Since many factors attributes would affect the decision of selection 3PL provider , the General manager employs the decision model for Selection and evaluation 3PL providers and refers to figure 2 choosing the attributes that would influence the decision **.**(See Appendix 1 ,Graph 1-3)

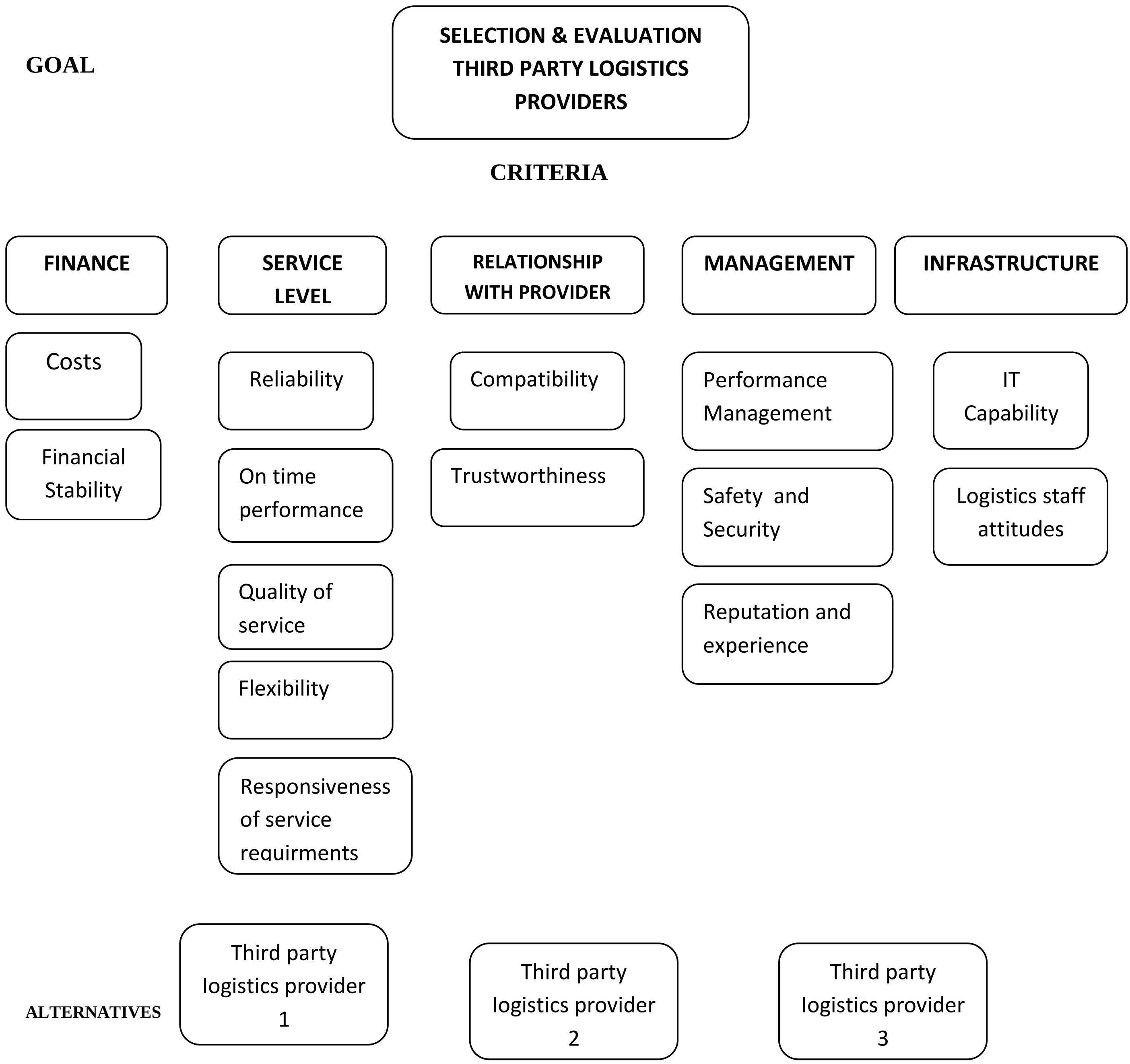

FIGURE 1

The construction of the hierarchy model for Selection and evaluation 3PL providers decision

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Model Name: SELECTION 3PL PROVIDER

Treeview

- **Goal: SELECTION 3PL PROVIDER**
  - **1st FINANCE(L:1,000 G:1,000) (L:0,213 G:0,213)**
    - **1st Costs (L:1,000 G:0,000) (L:0,565 G:0,120)**
    - **2nd Financial stability (L:0,435 G:0,093)**
  - **2nd SERVICE LEVEL (L:0,348 G:0,348)**
    - **1st Reliability(L:1,000 G:0,000) (L:0,166 G:0,058)**
    - **2nd On time performance (L:0,234 G:0,082)**
    - **3rd Quality of service (L:0,238 G:0,083)**
    - **4th Flexibility (L:0,161 G:0,056)**
    - **5th Responsiveness of service reqirments (L:0,201 G:0,070)**
  - **3rd RELATIONSHIP WITH PROVIDERS (L:0,112 G:0,112)**
    - **1st Compatibility(L:1,000 G:0,000) (L:0,476 G:0,053)**
    - **2nd Trustworthiness (L:0,524 G:0,059)**
  - **4th MANAGEMENT (L:0,142 G:0,142)**
    - **1st Performance management(L:1,000 G:0,000) (L:0,263 G:0,037)**
    - **2nd Safety and Security (L:0,337 G:0,048)**
    - **3rd Reputation and experience (L:0,400 G:0,057)**
  - **5th INFRASTRUCTURE (L:0,185 G:0,185)**
    - **1st IT Capability(L:1,000 G:0,000) (L:0,565 G:0,105)**
    - **2nd Logistics staff attitudes (L:0,435 G:0,080)**

Alternatives

3PL PROV. 1	**0,396**
3PL PROV. 2	**0,310**
3PL PROV. 3	**0,294**

* *Distributive mode*

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FIGURE 2

The final model for Selection and evaluation 3PL providers decision

CONCLUSIONS

In this study a new conceptual model for Selection and evaluation 3PL providers decision

is proposed, which is based on the decision models for 3PL provider selection of SoonHu Soh (2010) , Fu Yao and Liu Hongli (2007), Heung-Suk Hwang, Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan (2005) , Soon-hoo So ,JaeJon Kim ,KiJu Cheong ,Geon Cho (2006), Hasan Karagul ,M. Murat

Albayrakoglu (2007) , Kumar, Pravin (2008) . According to this model ,third party provider selection decision is affected by the five criteria : finance service level, relationship, management and infrastructure . These five criteria are affected from other subcriteria .Finally, taking in to account the above criteria and sub-criteria we will decide who 3PL provider we will choose. The decision process should include clear, coherent analytic steps and can generate numerical results to convince those who will be the recipients of the results.

This study tries to identify the factors which take into account the managers when they make decision for selection and evaluation 3PL provider. In particular it employs the Analytical Hierarchy Process (A.H.P) as an analysis method for decision 3PL provider selection , which is used as a decision tool by managers and logistics managers. The factors that affect the decision for 3PL provider selection were recorded by the state of the art review and a field research study . (interviews, focus groups from Logistics professional experts).The criteria and subcriteria for decision 3PL provider selection and their weight ranking were provided by the questionnaire in Logistics professionals.

Finally, an 3PL provider selection decision model is provided that can be implemented by managers and decision makers. In the future, this model after its implementation 3PL provider selection it would be examined if it can be developed a new decision model for logistics outsourcing that would be based in this decision model for 3PL provider selection .This new model will be a decision tool for managers that want to choice which of logistics services will product in house and which logistics services will be outsourced .

APPENDIX I

GRAPH 1

Weighting the PRIORITIES of main criteria with respect to goal SELECTION 3PL PROVIDER

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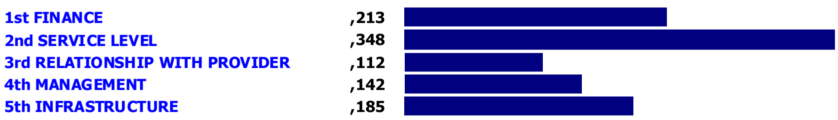
Model Name: SELECTION 3PL PROVIDER

Priorities with respect to:
Goal: SELECTION 3PL PROVIDER



Inconsistency = 0,02
with 0 missing judgments.

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GRAPH 2

Performance Sensitivity for main criteria with respect to goal SELECTION 3PL PROVIDER

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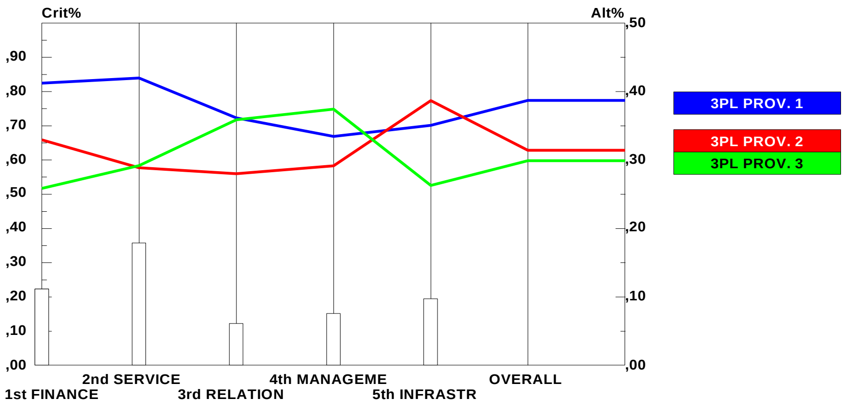
Performance Sensitivity for nodes below: Goal: SELECTION 3PL PROVIDER



Objectives Names

1st FINANCE	1st FINANCE
2nd SERVICE	2nd SERVICE LEVEL
3rd RELATION	3rd RELATIONSHIP WITH PROVIDERS
4th MANAGEME	4th MANAGEMENT
5th INFRASTR	5th INFRASTRUCTURE

Alternatives Names

3PL PROV. 1	3PL PROV. 1
3PL PROV. 2	3PL PROV. 2
3PL PROV. 3	3PL PROV. 3

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Graph 3

Dynamic Sensitivity for main criteria with respect to goal SELECTION 3PL PROVIDER

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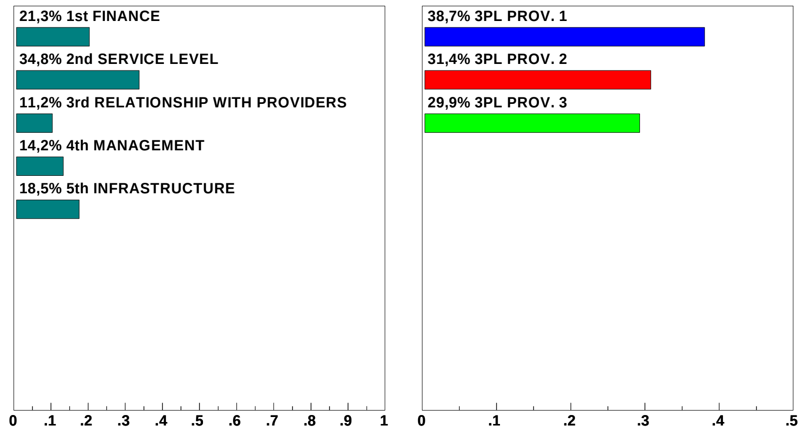
Dynamic Sensitivity for nodes below: Goal: SELECTION 3PL PROVIDER



Objectives Names

1st FINANCE	1st FINANCE
2nd SERVICE	2nd SERVICE LEVEL
3rd RELATION	3rd RELATIONSHIP WITH PROVIDERS
4th MANAGEME	4th MANAGEMENT
5th INFRASTR	5th INFRASTRUCTURE

Alternatives Names

3PL PROV. 1	3PL PROV. 1
3PL PROV. 2	3PL PROV. 2
3PL PROV. 3	3PL PROV. 3

billp

REFERENCES

[1] Clifford .F. Lynch ,2000 “Logistics Outsourcing –A Management Guide”, Council of Logistics Management ,Oak Brook, USA

[2] Martin Murray ,2011, “Selecting A Third Party Logistics (3PL) Provider” ,Free Logistics / Supply Chain Newsletter , About.com Guide http://logistics.about.com/od/strategicsupplychain/a/ select_3PL.htm (JUNE ,14 ,2011)

[3] Harry L. Sink And C. John Langley, Jr.,1997 “ A managerial framework for the acquisition of third party logistics services” **,** Journal of Business Logistics, Vol. 18. No. 2.1997 163

[4] Heung-Suk Hwang , Chiung Moon, Chun-Ling Chuang and Meng-Jong Goan 2005. “Supplier Selection and Planning Model Using AHP”. International Journal of the Information Systems for Logistics and Management (IJISLM), Vol. 1, No. 1, pp. 47-53 (2005) ,47.

[5] van Laarhoven P., Berglund M., Peters M**.** 2000, “Third-party logistics in Europe–five years later”, International Journal of Phy Menon M., McGinnis M., Ackerman K**.** 1998, “Selection criteria for providers of third-party logistics services: an exploratory study” *, Journal of Business Logistics*, Vol. 19, No. 1,

[6] Soon Hu Soh A,2010 ,A decision model for evaluating third-party logistics providers using fuzzy analytic hierarchy process African Journal of Business Management Vol. 4(3), pp. 339-349

[7] Third-Party Logistics Study: Results and Findings of the 2001 Sixth Annual Study

[8] Jharkharia S., Shankar R. ,2007, “Selection of logistics service provider: an analytic network process (ANP) approach” , *Omega*, Vol. 35, No. 3, pp. 274-289

[9] Jao-Hong Cheng, Shiuann-Shuoh Chen, Yu-Wei Chuang ,2008. “An Application of Fuzzy Delphi and Fuzzy AHP for Multi-criteria Evaluation Model of Fourth Party Logistics”, WSEAS TRANSACTIONS on SYSTEMS , Issue 5, Volume 7, May 2008

[10] Joel Hoiland ,2004 , “Selection Factors in Logistics Outsourcing – A View from Third-party Logistics Provider Customers” ,Business Briefing :Global Purchasing & Supply chain strategies , IWLA – The Association for Logistics Outsourcing

[11] Weber, C.A., J.R. Current, A. Desai, 2000. “An optimization approach to determining the number of vendors to employ”,. Supply Chain Management: an International Journal 5 (2), 90-98.

[12] Soon-hoo So ,JaeJon Kim ,KiJu Cheong ,Geon Cho 2006. “ Evaluating the service quality of third party logistics providers using the Analytic Hierarchy Process” , Journal of Information Systems and Technology Management ,Vol. 3, No. 3, p. 261-270

[13] Menon M., McGinnis M., Ackerman K**.** 1998, “Selection criteria for providers of third-party logistics services: an exploratory study” *, Journal of Business Logistics*, Vol. 19, No. 1,

[14] Meade L., Sarkis J. 2002, “A conceptual model for selecting and evaluating third-party reverse logistics providers”, Supply Chain Management: An International Journal, Vol. 7, No. 5, pp. 283-295..

[15] Moberg C., Speh T**.** 2004, “Third party warehousing selection: a comparison of national and regional firms”, Mid-American Journal of Business, Vol. 19, No. 2, pp. 71-76.

[16] Boyson S, Corsi T, Dresner M, Rabinovich E (1999). Managing effective third party logistics relationships: What does it take?. J. Bus. Logistics 21(1): 73-100.

[17] Fu Yao and Liu Hongli ,2007 “Information Systems Outsourcing Vendor Selection Based on Analytic Hierarchy Process”

[18] Kumar, Pravin ,2008, “An integrated model of AHP and TOPSIS for 3PL evaluation” **,** Asia-Pacific Business Review Journal , July-Sept- 2008 ,Volume 4 ,Issue 3

[19]Hasan Karagul ,M. Murat Albayrakoglu ,2007, “Selecting a third party Logistics provider for an automotive company : An Analytic Hierarchy Process model”, International Simposium of AHP 2007, Viña Del Mar, Chile, August 3-6, 2007

[20] Saaty, T.L. 1980, “The Analytic Hierarchy Process”, McGraw-Hill, New York

[21]Forman,E.-Selly,M. 2002,“Decision by Objectives” World Scientific, Singapore.

[22] Chyan Yang,Jen-Bor Huang, 2000 , “A decision model for IS outsourcing” , International Journal of Information Management, 20-2000, p.225- 239

[23] Saaty,T,1990 “Multicriteria Decision making-The Analytic Hierarcy Process”. pp. 121-137 Pittsburg USA, RWS Publications

[24]Saaty, T.L. 1994, “The Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process**”,** Volume VI of the Analytic Hierarchy Process Series, pp. 69-88. RWS Publication, Pittsburgh, PA.

FREIGHT FORWARDING IN MILITARY LOGISTICS AS A STRATEGIC OUTSOURCHING FORM: THE SURWEY ON MILITARY FREIGHT FORWARDING FIRMS IN USA

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Abstract-*The term of logistics is originated from military. There have been a wide range of logistics activities in military operations. Global interdependency is also widespread in military. Acquisition from a foreign country requires some logistics plans like transportation, warehousing, customs for exporting importing and so on. The aim of this paper is to give an overview of freight forwarding operations in military activities and to emphasise the importance of freight forwarder functions in military logistics. In this frame teorical framework of military logistics and freight forwarding concept was examined firstly. Then a field research related with Military Freight Forwarding Firms in U.S. was given place to the study.*

Keywords -Military outsourcing, military logistics, freight forwarding in military

INTRODUCTION

The widespread use of the term "logistics" arose in the military and is more recently being used in the private sector of the economy largely in connection with physical-distribution management.[2]. The importance of military logistics is as much more than in private sector due to the output of all logistics activities are towards the country's defense purposes. Without an efficient strategic, tactical and operational logistics plans and activities, a military operation is far from reaching any achievement.

Logistics is the science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations which deal with [1];

- Design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel,
- Movement, evacuation, and hospitalization of personnel,
- Acquisition or construction, maintenance, operation, and disposition of facilities, and
- Acquisition or furnishing of services.

Military logistics is a science that help to plan, implement various activities of the military force. Every activity is planned accurately by the professionals for a succesful operation. Coordinated movement for a single target can be achieved through the art of military logistics. Military logistics cover material, personnel, services, and facilities of a military operation. Innovation of materials that are effective for defensive purposes is the first process in material designing [3]. The powerful and solid defense system of a country depends on successful logistics operations.

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AIM OF THE RESEARCH

Aim of this study to investigate in contemporary military freight forwarding firms activity in strategic military organizations. In this frame it is also aimed to attract attentions working conditions, difficulties demographic values and working styles of these firms. Secondary aim of the study is to put forwarding point of view outsourching approach as a management style.

IMPORTANCE OF THE RESEARCH

Although there have been numerous of literatures written about military logistics, the studies on freight forwarding in military are very limited due to the fact that the specification of the subject. In the study made by Westfall and Huang [6], they analyzed the freight forwarder performance of two separate Taiwan Armed Forces freight forwarders doing business in West and East Coast of America and found out that there had been major delays occurred in freight forwarding operations in both inbound and outbound. In this respect this study carrying importance in terms of to determine demographic structure, difficulties in transportation and working conditions of freight forwarding companies in strategic countries. Advantages and disadvantages have also been discussed in our research. Therefore U.S. freight forwarder companies which, carrying out most of World military freight forwarding mobility are selected for our research.

MILITARY OUTSOURCHING

Using a third party logistics company to provide logistic support is considered outsourcing. Outsourcing is rapidly becoming one of the dominant practices in commercial businesses today, particularly in logistics. Outsourcing has been defined in a number of ways, but essentially it is, as above, the transfer of a function previously performed in-house to an outside provider. It involves the movement of work, but not often the transfer of responsibility and accountability or oversight, to the external provider [7]. All organizations doing business in any field use logistics service providers company to focus on their core business by outsourcing.

The key reasons to outsource a function are cost and performance. Third-party logistics providers can leverage their core competencies to improve enterprise-wide performance [10]. Privatization and outsourcing are becoming very familiar terms in both the military and civilian industrial sector. Faced with tight budgets, many organizations see these two processes as a quick fix to their budget and manpower problems [7].

The governments' regular policy to give stimulus to the state's economy is privatization. As doing so, the governments can be able focus on the main missions. As the business world is tend to outsourcing so do the governments. Among the departments of the government, the department of defense is the biggest one. Especially in developing and the-least developed countries, the states are economically, defensively and technologically dependent on the developed countries. So they allocate the funds for mostly to defense purposes. In military, outsourcing is not a new concept. The use of contractors and related civilian markets (domestic and foreign) for cleaning, catering, laundry, maintenance and supply, engineering, and support, training/instruction, transportation and many other support functions in military branches has been quite widespread. Contracting-out or outsourcing some service and other functions is a cost-saving, time-saving, manpower-saving and practical method for governments and militaries. Military outsourcing related studies and literatures have cleared out that it is not only the developing but also developed countries' issues.

Improvement of Military Outsourcing

Geoff Harris [13] described the privatization in military in two types, the outsourcing to civilians of various activities which support the military organization, and the use of private military companies for tasks previously carried out by the US military. As to the first, the case for privatization of activities within the military is based on the usual principle – the need, based on budget constraints, to focus on core business and to outsource activities which are tangential to the core. Cardinalli, 2001[7], stressed out that contracting and outsourcing might be an effective force multiplier for recent military operations.

Goods [2] destined for use by the Armed Services are usually produced by private manufacturers, sold to the military through their system, and distributed to Army posts, airfields and other local distribution points. The final customer is the soldier, sailor, marine or airman who may be located in the United States or a distant part of the world. Goods entering the system, which are not consumed are resold as surplus to the private sector of the economy. Hartley [4] investigated the military outsourcing in the perspective of UK experience in his article and cleared out that the UK Ministry of Defence (MoD) and the Armed Forces have considerable experience of outsourcing. This was involves the transfer of activities which were traditionally undertaken 'in-house' by the Ministry and the Armed Forces to private firms. And he concluded that outsourcing is part of the UKs general policy towards privatization.

ACQUISITION OF MILITARY GOODS FROM THE UNITED STATES

Military Supply

The producer phase of a military supply extends from determination of procurement schedules to acceptance of finished supplies by the military services. The consumer phase of a military supply extends from receipt of finished supplies by the military services through issue for use or consumption [14].

Military Supply Chain Management

Military supply chain management is the discipline that integrates acquisition, supply, maintenance, and transportation functions with the physical, financial, information, and communications networks in a results-oriented approach to satisfy joint force materiel requirements [14].

The United States of America is the leading military supplier to many countries in the world. Since, most of the weapon and support systems used by most Europan, Asian, African countries are produced by U.S. manufacturers, those countries are dependent on the U.S. to perpetuate their weapon systems such as fighter aircraft, warships, helicopters, missiles etc. A long supplying, supporting process starts just after the purchase of the weapon system from the supplier country. This process includes supplying the spare parts, maintenance, repair and training and many other functions. The U.S. hosts many countries' military representatives such as military attaches, liaison oficers and agents. Those represantatives play an important role in procurement and acquisisiton activities in the U.S. They provide liaison between the customer government and the providers.

The acquisition from the U.S. is conducted under the regulations of Security Assistance Program by purchasing the spares, servicing the repairables, training the personnel and other kind of supports.

Security Assistance Program

Security Assistance, defined in its simplest terms, concerns the transfer of military defense articles and / or services from the United States to friendly foreign governments and specific international organizations. The United States conducts Security Assistance business with over 150 nations and international organizations around the world. These programs are conducted under two primary U.S. legislative authorities: The Arms Export Control Act (AECA) and the Foreign Assistance Act of 1961 (FAA). Under these authorities, there are several options that we may use to provide the customer with U.S. defense articles and services. The most common options are *Foreign Military Sales (FMS)* and *Direct Commercial Sales (DCS).* There are benefits, limitations and trade-offs associated with each of these options that should be carefully considered for each particular sale. While you usually have a choice in whether to purchase items using FMS or DCS, the U.S. Government may require that FMS procedures be followed for certain purchases [11].

The Foreign Military Sales (FMS)

FMS program is the U.S. Government's program for transferring defense articles, services, and training to other sovereign nations and international organizations. Under FMS, the U.S. government procures defense articles and services on behalf of the foreign customer. Countries approved to participate in this program may obtain defense articles and services by paying with their own national funds or with funds provided through U.S. government-sponsored assistance programs. In certain cases, defense articles, services and training may be obtained on a grant basis. The Defense Security Cooperation Agency (DSCA) administers the FMS program for the Department of Defense (DoD). Foreign Military Sales customers receive logistics support through the same Department of Defense system that supports the U.S. military forces. However, there is no single supply organization. Rather, each U.S. military service has its own unique collection of processes, organizations and terms that also support FMS [8].

There are normally three parties involved in the movement of FMS material; the U.S. Government, the purchaser (customer country military / Ministry of Defense, Armed Forces), and the freight forwarder. Each has specific responsibilities that must be met in order to assure the efficient movement defense articles and assets. And each one plys their important roles for effective logistics operation. The responsibilities of the freight forwarder is our subject in this study and is going to be mentioned then.

For FMS material, LOA (Letter of Acceptance) agreement is made between customer country force and U.S. DoD (Department of Defense) and under that agreement the requisitions are fulfilled by the customer force in a timely manner. According to the Management Security Assistance regulations, the material requested by customer force is sent to the freight forwarder. The freight forwarder is to be listed in MAPAD (Military Assistance Program Address Directory). When the goods are ready to ship from the shipper military depot, the shipment is automatically sent to the "mark for code" address of freight forwarder. MAPAD lists the addresses for FMS shipment and related documents. This is one of the most important requirements for FMS program transportation / distribution. That address is of the freight forwarder for handling the material on behalf of the customer force. MAPAD codes include the address for perishable cargo, for NOA (Notice of Availability) and for source and receiving country and the force's final destination.

The Direct Commercial Sale (DCS)

A DCS is a sale made by U.S. companies directly to an international customer. DCS agreements are not administered by DoD and do not involve a government-to-government agreement. U.S. industry is responsible for obtaining a license from the Office of Defense Trade Controls in the Department of State for each of these sales. The day-to-day rules and procedures for these types of sales are contained in the International Traffic in Arms Regulations (ITAR). Under DCS, it is engaged directly in contract negotiations and program management decisions with a U.S supplier or manufacturer. DCS might be considered when military requirements differ appreciably from standard U.S. configurations. DCS arrangements may also be appropriate when customer government is seeking licensed-production between a U.S. manufacturer and own domestic industry or government seeks a closer relationship with a particular weapon system manufacturer [11].

FREIGHT FORWARDING CONCEPT IN MILITARY

A freight forwarder is an organization that collects shipments from a number of businesses and consolidates them into larger shipments for economies of scale. A freight forwarder often also deals with route selection, price negotiation, and documentation of distribution, and can act as a distribution agent for a business. [5]. Freight forwarders play a key role in supply chain management. Their vital importance has been perceived by all the actors in business world. The suppliers, manufacturers, exporters and importers can focus on their core business by contracting with a freight forwarder, logistics service providers, 3PL's. Freight forwarding also plays very important role in military activities. The main duty of the military is defense the country. To perform that significant mission, all actors in military are required to play their roles with a great care, experience, and sensitiveness.

Freight forwarder operations are some of the most difficult links to manage in the international distribution channel. One of the most critical links in an international distribution channel is the agent who arranges for the physical movement of the goods from the supplier to the country of destination [6]. The freight forwarders perform that vital task for transportation the military goods from the U.S. to the home country which involved in the U.S. security assistance program. They provide the link between the countries and the military depots, weapon system manufacturers and commercial suppliers. The services and responsibilities of the freight forwarders are framed by the contractual agreement made with the customer country. Freight Forwarders have the responsibility and authority to receive, handle, consolidate, store the military goods at its warehouse, and arrange the shipment to the final destination on behalf of the customer country's military.

Freight forwarder doing the military business has the responsibility against mainly two parties, the customer country and the U.S government official agencies. The customer of the freight forwarder is formed with the Ministry of Defense and the Armed Forces (Air Force, Army and Navy).

Freight forwarder is the weakest chain for the customer country during the whole operation. Because during the transportation process from the shipper depot to the final destination, even a minor mistake can not be accepted.

FREIGHT FORWARDER SELECTION

Security assistance countries are responsible for selecting their own freight forwarders. By the law the U.S. military is not involved in the selection process[6]. The selection of a freight forwarder must be made by the FMS customer. DoD personnel are not authorized to recommend a freight forwarder to a purchaser or tell a freight forwarder how to conduct his operations [12]. The contractual agreement is made between the forwarder and the country.

In many cases, the selection of freight forwarder is made from a political base, but often that selection is made by the competitive marketplace. Countries are free to negotiate for the services they feel will best accomplish their mission for a given compensation [6] Since the freight forwarding is a task which highly performance and experience demanding, the military has generally not enough those capabilities to do this business in a foreign country. Those capabilities required to have knowledge on that country's policies, customs regulations, transportations systems and to have adequate capable personnel and many other issues. In freight forwarder selection process, one of the preferences among many other factors is the location. The freight forwarder company is supposed to be situated close to the international sea and airports and an air force base. The west coast and the east coast are the major two convenient regions for freight forwarding within the U.S. There is no involvement of U.S. officials in that FF selection process. But the qualifications are clearly mentioned in regulations for a FF company need to have to handle military freight. The freight forwarding task is authorized by awarded directly to a certain freight forwarder company or by bidding for the contract.

FREIGHT FORWARDER RESPONSIBILITIES / OPERATIONS

Freight forwarder is a private firm under contract to the FMS customer to receive, consolidate, and stage material within the U.S. and arrange for its onward movement. As such, the freight forwarder's responsibilities must be specified in the contract. Freight forwarders vary considerably in size, personnel manning, and capability to process material, documents and data for the purchasing country. However, no matter the size of the freight forwarder or amount of material handled, all freight forwarder should attempt to accomplish the following basic functions [12].

Receiving

The freight forwarder should have sufficient storage facilities and material handling equipment to handle all expected shipments. For FMS shipments, most of the goods sent from the military depot to the FF address by small parcel carriers such as Fedex, UPS, DHL. After receiving the goods the responsibility passes to FF. For some specific shipments, FF arranges the domestic shipment from departure location (manufacturer, military depot or plant) to FF address or directly to the seaport terminal or air force base air terminal. For commercial purchases, the seller company generally has the responsibility to deliver the cargo to the FF address or to the seaport terminal. Direct shipments to seaport or airport terminals are done for specific freight such as explosives, classified, dangerous or over size project cargo.

In-Transit Visibility System

The freight forwarder receives shipping documents and should always match them against actual material receipts. If shipping documents are received and no material is received, the FF should follow up with the indicated point of shipment [12].

Payment of Collect Commercial Bills of Lading

The freight forwarder must have sufficient funds to pay CCBL (collect commercial bill of lading) or, when possible, to make credit arrangements with carriers or appropriate agencies to handle bills for deliveries and to provide "bill to" addresses as necessary for inclusion in the MAPAD (Military Assistance Program Address Directory) [12]

Notice of Availability (NOA)

The freight forwarder should immediately respond to each NOA requesting shipping instructions. The DoD does not store the material to accommodate freight forwarders [12].

Shipment Damage

Very few freight forwarders are permitted to open containers to check for possible damage of contents. Claims must be files against commercial carriers for shortages and visible damages. A freight forwarder should never refuse a shipment destined to the FMS customer. The freight forwarder should accept damaged articles and initiate claim action against the carrier and resolve paperwork discrepancies with the shipper [12].

Repack Recrate and Reinforce

Most freight forwarders are not permitted to open containers they receive from the DoD or other sources. Instead, it must have the capability or repacking the inadequate original container into one that is more suitable for containerization and overseas shipment. If possible, small packages should be consolidated and loaded in sea land type containers to minimize loss, damage or pilferage [12].

Consolidating

Since the goods are received as small parcels the freight forwarder should consolidate them grouping to the final addresses. The final address in customer country is labeled on the box by shipper. Those addresses are of each force’s depot in customer country.

Recording

FF is requested to use the most advanced technology for recording not to loose any box or prevent any mis-shipping. True recording leads to true shipment. Any minor error in recording causes big problems and discrepancies. So, freight forwarder may be requested by the customer country to use most advanced information and tracking systems.

Marking, Labeling, Documentation

The freight forwarder should ensure that all required marking, labeling and documentation is affixed to consolidated shipping containers and is legible for the onward processing of material.

Repairable Return

Purchasing countries return numerous items to DoD organizations for repair and return or repair and exchange. The freight forwarder is responsible for clearing the incoming shipments through U.S Customs and arranging transportation to the repair facility.

Time

To ship the material in a certain time is agreed upon the contract. The freight forwarder is expected to ship in time the freight according to the priorities labeled on the boxes. Otherwise freight forwarder is required to pay some penalties. The priority / urgent freight should be sent by air and the normal ones by sea. So freight forwarder group the material according to priority, final destination (force by force) and mode of transportation.

Many freight forwarders licensed by the United States Federal Maritime Commision are also licensed customs broker. A customs broker facilitates the clearance of cargo imported into the U.S. Frequently, the purchaser's material will need to be returned to the U.S. for testing or repair. Therefore, the freight forwarder selected by the purchaser should also be licensed customs broker and tasked to perform import duties and transportation arrangements to the testing or repair facility in the U.S. [12].

TRANSPORTATION MODES

Road

Road transport is used mainly within U.S. The freight forwarder arrange the shipment when needed for receiving the cargo from the providers warehouse to freight forwarder address or directly to seaport, airport or air force base and generaly from FF to those departure locations.

Sea

Sea transport is used for normal priority freight and big size cargo that can not be loaded into airplane or military air cargo plane . Containers (20-40 ft) are mostly used for sea transport, and rarely other type of containers are also used according to the type and size of cargo. Dangerous cargo is also preferred to be carried by sea.

Air (Commercial Airlines)

For urgent priority freight, at least once or twice a week the cargo is shipped by airplanes' cargo section.

Air (Military Air Cargo Planes)

Some customer countries has routine courier program between their country and U.S. The nearest U.S. Air force base is used for landing , loading and unloading. Under a protocol signed between two countries terminal services, loading unloading services are provided by host nation base personnel . Return material for repair or testing purposes are generally sent back to U.S. by this type of transport. The freight forwarder has a special task in this operation differ from normal freight forwarding activities. The freight forwarder should prepare the air cargo before the aircraft land. Special kind of pallets are used for military cargo aircraft. The freight forwarder must efficiently load each pallet and strap them accordingly to secure for road and air transport. Then all full loaded pallets are required to be ready at the air cargo terminal at the same day and all documentation and customs clearance have to be completed before the aircraft land . After unloading the freight from the aircraft , freight forwarder is responsible to send the return or repairable assets coming from the customer country to the repair facilities.

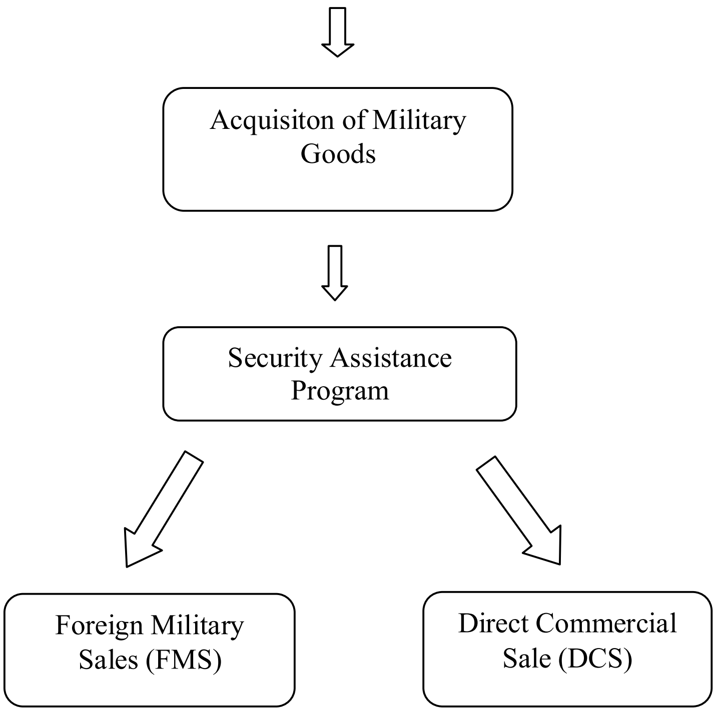

FIGURE. 1
Acquisition Process Chart

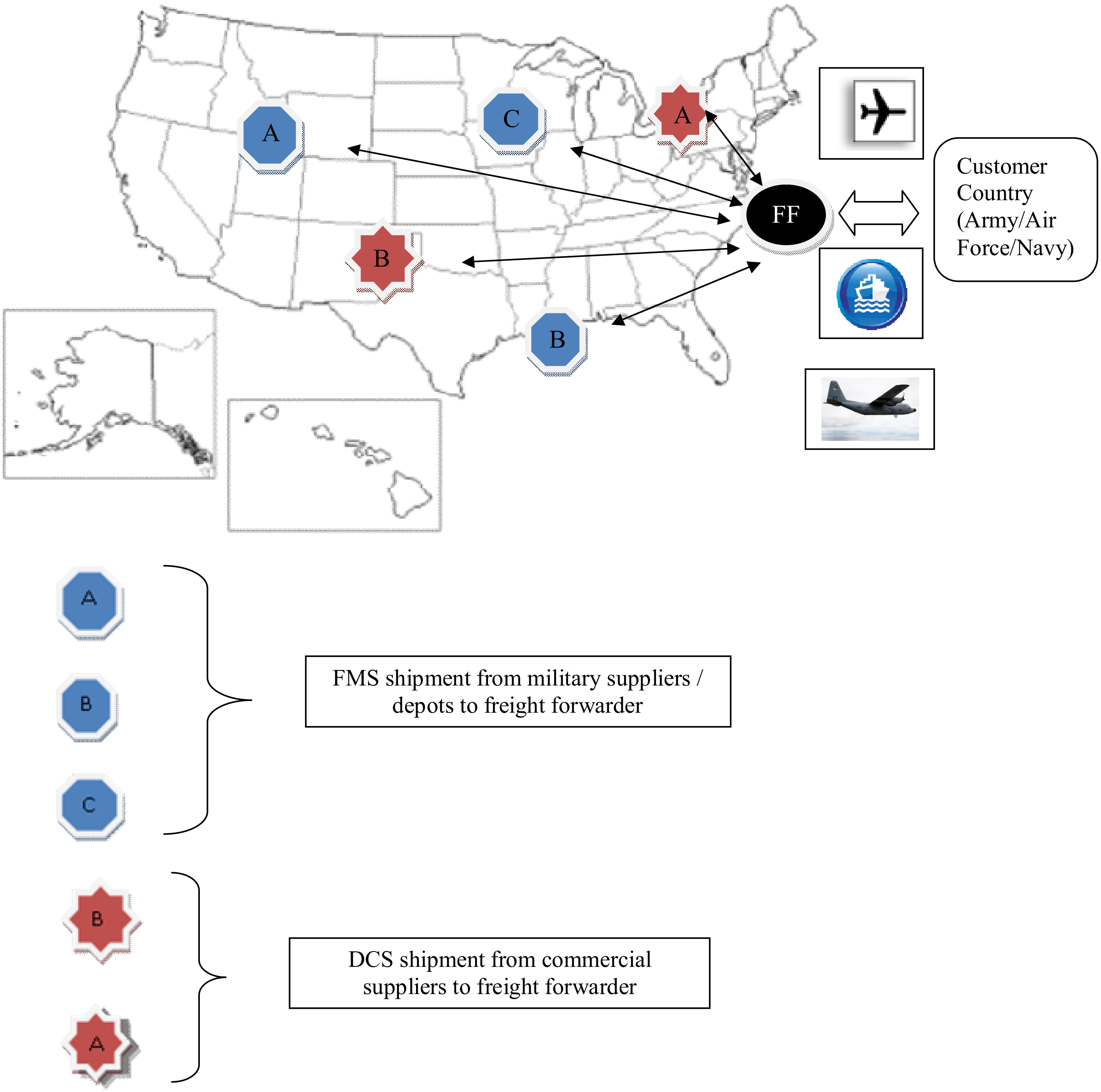

FIGURE. 2
The Movement of Military Goods to Freight Forwarder in U.S.A.

METHOD

The survey related with freight forwarding applications in military, has been realized in freight forwarding companies in U.S. In this frame, sample of the research is three freight forwarding firms which located in New Jersey Newyork, in U.S. Research Qestionaire was sent 5 freight forward company firstly but, only three of them responded.

Questionnaire method and deeply interview method was used as research tools in survey. Descriptive statistic was also used for analyzing of questionnaire results. It has been reached to freight forwarding firms by e-mail mostly. Phone call communication was used for receiving some of complementary information's and discussing. Interviews and e-mail communications was realized with medium and higher level managers of these firms. Because of military experience of outhors in U.S. freight forwarding system, authorr past experiences and obsevations have contributed this study considerebly.

Questions in research scale (Appendix 1) was selected to evaluate demographic information's like firm scale, geographical positions and to determine military operations level and difficulties during freight forwarding applications. Open ended questions are also used for investigating. Two academicians opinion who study on scientific logistics area was received for survey questions and corrections was structured in the questionnaire. Reliability and validity tests also constructed.

FINDINGS

The questionnaire items have been classified in seven main factors according to research aims and the findings are as fallows. Other findings have been given in Item 8 in question-ansver form.

Activity Period of Freight Forwarding Firms in Military Logistics

According to Table 1, most of participant firms %67 have keeping on freight forwarding activity related with military logistics. According to this finding we can express that participant firms are experienced in medium period in fraight forwarding activity in military logistics.

TABLE 1
Activity Period in Military Logistics (Freight Forwarding Activity)

Organizations	Activity Period	Limit Values	Percentage (%)
Firm A	3 years	Under five	33
Firm B	6 years	More Than five	67
Firm C	8 years		

Firms Perceptions about The Term "Military Logistics

It has been understood that firms have different perceptions as related with the term military logistics. One of the firm have considered military logistics as movements of military goods, the other have described military logistics as a "very important issue for a country's defense power" One of the firms has not answered this question.

Firms Opinions about Competencies for Obtaining and Sustaining Freight Forwarder Company Competition in Military Logistics

The firms have also different determinations as relating with this finding. According to Firm A, it is strongly necessary to establish good communication with military authorities and mastering strong company infrastructure and experience. Firm B gives more importance to time management. Differentially Firm C has been emphasizing advanced information technologies, more sensitiveness about contracts and care.

Firms Opinions about Requirement for Being Freight Forwarding Company in Military Logistics

We understand that firms are in similar point of view about requirements. These are; some official licenses, security clearance for classified material by DSS mainly.

Firms Opinions about Differences between Civilian and Military Freight Forward Operations

Managers perceptions of freight forwarders firms related with military and civilian comparison indicate that; loading and unloading activities especially in airline logistics strictly differ from civilian ones. Military authorization process and material classification are also required different in terms of human research expertise than civilian operations. For example one of firm manager expresses that palliating and handling of cargo carried by military air courier, handling the classified cargo in their warehouse in a special cage authorized by DSS. According to other firm representative military cargo airplane loading and unloading, classified and explosive material handling are sensitive subject in military freight forward operations.

Findings about Difficulties in Military Cargo

As we stated Item 5, difficulties are generally focusing on military system characteristics. According to Table 2, difficulties mainly arise from customs issues, license and time related problems. Contractual problems between sides also occupy to place in military cargo difficulties.

TABLE 2
Difficulties in Cargo Transportation in Military Logistics Systems

Organizations	Problem Expression
Firm A	To get license for military cargo takes time, some items in the contract are hard to follow sometimes, and we may have problems with U.S. customs occasionally.
Firm B	For priority shipment we need to act in a timely manner due to the penalty written in the contract.
Firm C	Customs issues for inbound cargo.

Findings about Advantages in Military Cargo

According to firm manager perceptions, advantages in cargo transportation in military logistics systems have been given Table, 3. We understand that firm's opinions are mainly collecting on gaining experience on public and military logistics systems, variation of material handling and operations gives advantages.

TABLE 3

Advantages in Cargo Transportation in Military Logistics Systems

Organizations	Problem Expression
Firm A	We gain some experience on military logistics issues, we can develop governmental and military relations.
Firm B	Variation of material handling and operations gives advantages
Firm C	Experience on military logistics

Other Findings

Other findings relating with freight forwarding activity of firms in military, have been classified in question-answer form in Table 4.

TABLE 4

Other Findings in Question-Answer Form

No	Question	Firm A	Firm B	Firm C
1	Since you have begun doing freight forwarding for military, what kind of (positive or negative) changes happened to your company? (economical, social, environmental, technological, etc).	We hired two personnel for warehouse and office,	Economic and prestige advantageous on our company	No reply
2	Does your company think continue to do this business long time? Explain the main reasons? Why?	Obsuletely, yes	Yes	Yes
3	Do you have any relations or information exchange with other companies who are doing freight forwarding for military? If yes, What kind of issues)	No	Occasinally	No

CONCLUSION

The importance of logistics has been highly perceived by the business world. The freight forwarders' roles in logistics have been widened and well understood day by day. In this article, the significant role of freight forwarding operations in military logistics is aimed to give to the reader after briefly mentioning about the acquisition types of military asset from U.S. The information is gathered from the limited literature and U.S. official web sites and the author's three year experience as a freight forwarder liaison officer in the U.S. Three freight forwarder companies helped us for understand the subject and gave us some vision on military logistics. Further detailed studies on the subject will be a great contribution on the literature.

Field research results of this study indicated that several important points and open areas of improvement in military freight forwarding systems. We can account for those findings as follows.

- Because of short term contract between two sides freight forwarding firms in military are having experienced in medium period generaly.
- Majority of freight forwarding firms think that it is strongly necessary to establish good communication with military authorities and mastering strong company infrastructure and experience for long term company performance and profitability.
- Company in military freight forwarding generaly emphasize advanced information technologies, more sensitiveness about contracts and care also requirable in transportation sector.
- It's strongly understandable that freight forwarding firms give more importance public low related with national logistics system and awere of new improvement in sector.
- Most of difficulties relating freight forwarding activity are gathering in license, custom and contractual issues.
- Many of freight forwarding company evaluate developing governmental and military relations, gaining prestige in sector, variation of material handling and operations skils, delivering mess pruduct as advantages.

REFERENCES

[1]. Department of Defense Dictionary of Military and Associated Terms, (Joint Publication 1-02,). http://www.au.af.mil, 29 May 2011.

[2]. Hauk, James G., Associate Professeur of Marketing Syracuse University, Logistics and Physical Distribution Management in the Military, www.googlebooks.com., 11 May 2011.

[3]. www.ezinearticles.com, 09 Feb. 2011.

[4]. Hartley, Keith, 2011, Centre of Defence Economics, University of York, Military Outsourcing: UK Experience, http://web.cenet.org.cn/upfile/53057.pdf., 9 March, 2011.

[5]. Okeafor, Uche S., 2007, The Role Of The International Freight Forwarder in The U.S. Export Market The Ohio State University 8305374, Bloomsbury Business Library - Business & Management Dictionary, p.249.

[6].Westfall, W.F.-Huang, Te Chun, 1990., Analyzing Freight Forwarder Performance How Well Does Your Stack Up, Taiwan Air Force Pub.

[7]. Cardinali, Richard, 2001. "Does the future of military logistics lie in outsourcing and privatization?", Work Study, Volume 50 . Number 3 . 2001 . MCB University Press . pp. 105-110,

[8]. Military Standard Requisition and Issue Procedures (MILSTRIP), 2005, for Foreign Military Sales (FMS), http://fmsdisadaau.mil.id/index2.php. 28. Feb.2011.

[9]. U:S. ARMY Department of Defense Policy, 2008. The FMS Advantage: Frequently Asked Questions About Foreign Military Sales., http://www.dsca.mil/ pressReleases/fmsadvantagev2. pdf), 11 May 2011.

[10]. Aundre F. P., 2002, "US Army, Transformation– Revolution in Military Logistics"., www.googlebooks.com., 11 May 2011.

[11]. DoD, Security Cooperation Agency Report, 2001, U.S. Security Assistance Program.

[12]. Foreign Military Sales Transportation Policy Report, 2007, Chapter 11, 11-12, (http://www.disam.dsca.mil/DR/11%20Chapter.pdf), 29 Apr. 2011.

[13]. Haris, Geoff, 2008. Civilianising Military Functions, Demilitarising sub-Saharan Africa., (http://www.iss.co.za/pubs/Books/AchievSec_Dec04/Harris2.pdf). 19 March, 2011.

[14]. Molana, Mohammad H., 2009, Military Logistics and Supply Chains, Chapter 11, http://www.springerlink.com /content/h4503568715whg02/fulltext.pdf, 13 May 2011.

APPENDIX 1

Surwey Questions for Military Freight Forwarding Firms

No.	Questions
1.	How long have your company doing freight forwarding for military?
2.	What do you understand from the term of "military logistics"?
3.	What kind of skills or competencies are required for being a freight forwarder of a country's military?
4.	What are the requirements to be able to become freight forwarder of a countries' military logistics?
5.	What type of operations are strictly differ from civilian ones?
6.	What are the main difficulties you encountered?
7.	What are the main advantages and positive effects?
8.	Since you have begun doing freight forwarding for military, what kind of (positive or negative) changes happened to your company? (economical, social, environmental, technological, …etc).
9.	Does your company think continue to do this business long time? Explain the main reasons? Why?
10.	Do you have any relations or information exchange with other companies who are doing freight forwarding for military? If yes, What kind of issues)

INTEGRATION OF STOCK KEEPING AREAS AND INVENTORY PLANNING

Murat Düzgün[1], Mehmet Tanyaş[2]

Abstract – *Inventory are a company's merchandise, raw materials, semi-finished and finished products which have not yet been sold. The derivation of stocking levels throughout the supply chain planning network based upon service level and inventory holding cost inputs. Warehouse is a place in which goods or merchandise are stored. Constructing and fitting out a modern warehouse with all its required equipment and tools require significant capital expenditure. The early warehouse planning and design stage is the key. Mistakes in warehouse capacity planning and layout will decrease warehouse utility and performance while increasing your operational costs. Careful attention should be paid to operational optimization; even a warehouse which operated effectively before may not do so under increasing loads. Special and reserved place(s) for stocks are called "Stock keeping areas". Therefore fixing these places is very important for warehouse design also for all products which will be stored in. Evaluating the values of integrating warehouse and inventory make the decisions easier accordingly. That's why, global warehouse and inventory practical model is handled and solved out for this explanation. Also solution methodology is developed which offer different level of integration of warehouse and inventory decisions. Total cost of the inventory and warehouse systems can be reduced systematically by taking into account the warehouse capacity restrictions in the inventory planning decisions. In this paper is intended for the need of systematic design approach that considers different parameters for warehouse and inventory mainly focused on Stock keeping area issue in warehouses.*

Keywords – Inventory Planning, Warehouse Design, Integration of Warehouse and Inventory Planning, Gap Analysis.

INTRODUCTION

Managers are faced with the need to deliver a high service level with minimal both warehouse and inventory cost. The order picking activity represents 65 % of the total cost and 50% of the workforce of a warehouse (WERC 1986). In the case of distribution warehouses, this proportion is even more important because the main activity is to receive pallets of items from vendors, stock them and deliver customer orders containing different items. In addition, with the improvement in information technology, it becomes possible to develop tools which can help managers to handle warehouse and inventory issues more efficiently. Logistics managers have to tackle problems which can be divided into two broad classes: warehouse management (assigning the products inside the warehouse) and inventory management (how much of each product) problems. Up to nowadays, warehouse and inventory issues are handled in a pyramidal top-down approach where the flexibility of decisions decreases from top to bottom. Strategic decisions are first taken and then create limits to decisions taken at the tactical and operational levels. On top of this, decisions taken at each level of the pyramid are also handled independently and sequentially. (Strack and Pochet, 2010)

In warehouses, specified and reserved place for each stock keeping unit is called "Stock keeping area". Total of these places constitutes total stock keeping field of warehouse itself. Therefore warehouse design and stock optimization are very related each other closely. In this work primarily, we checked out that the impact of Stock and Inventory planning on the Logistic Performance by applying a survey as explained below. So all outcomes that have been gained are evaluated as Statistical Analysis in SPSS™ computer program and then

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finally up to reached results, a sequential decision making methodology has been developed for having dynamic and better Inventory's decisions.

If we look at briefly over the sections, in the second part we will make a brief review of the literature available on the subject, third part will introduce the Gap Analysis Approach, in the fourth part the computational results based on gap analysis questionnaire are given, in the fifth part a description of the methodology used to solve the integrated model is proposed and finally conclusion appear in the sixth part.

LITERATURE REVIEW

Most tactical issues in warehouse and inventory management are tackled independently and sequentially. The models developed and Parameters explained in those three fields are presented separately.

Forward-Reserve Area Models (Strack And Pochet, 2010)

The "Forward-Reserve Problem (FRP)" is the problem of assigning products to the forward and reserve areas in order to reduce the overall work content in order picking. Nowadays, most warehouses are divided into two areas: forward and reserve. The forward area is used for broken-case and full-case picking and the reserve area is used for pallet picking and reserve storage. Once a product is stored in the forward area (reserved area), all picks must be performed from the forward area. When the inventory of an item stored in the forward area reaches its reorder point an internal replenishment is performed (from the reserve area to the forward area).

Hackman and Rosenblatt were the first to address the issues of deciding which product to store in the forward area (assignment issue) and how much to store (allocation issue). They considered a warehouse composed of a small area (forward area) where picking of products is based on an efficient (less time consuming) Automated Storage and Retrieval System (AS/RS). The reserve area is a large area handled through an inefficient manual/semi-automated storage and retrieval system. The question tackled in this article is to decide which and how much product must be stored in the forward area taking into account picking costs and internal replenishment costs and the capacity constraint of the forward area.

Frazelle propose a model that tackles three warehouse decisions; the size of the forward area and the allocation/assignment of products to the forward area. They propose a model which minimizes the total warehouse costs, which depends on the size of the forward area under forward capacity and congestion constraints. They show that the congestion constraint is redundant. Consequently, the optimal quantity assignment/allocation solution can be found based on Hackman and Rosenblatt work.

Van den Berg propose a model to solve the forward-reserve problem in the case of unit load replenishment. Those replenishments can occur during busy or idle pickle periods. The objective is to minimize the number of urgent or concurrent replenishments of the forward area arriving during the busy periods.

Inventory Models (Strack and Pochet, 2010)

The aim of inventory management is to minimize total operating costs while satisfying customer service requirements. In order to accomplish this objective, an optimal ordering policy will be determined by answering to questions such as when and how much to order. The operating costs taken into account are the procurement costs, the holding costs and the shortage costs which are incurred when the demand of a client cannot be satisfied (either lost sales costs or backorder costs). There is two different inventory policies. The first policy implies that the stock level will be checked after a fixed period of time and an ordering decision will be made in order to complete the stock to an upper limit. In the second policy, the stock level will be monitored continuously and a fixed quantity will be ordered when the stock level reaches a reorder point. The order quantity will only be delivered after a fixed lead time and shortage can exist if the inventory is exhausted before the receipt of the order quantity. (Strack and Pochet 2010)

Inventory Planning Parameters (Ganeshan, Boone and Stenger, 2001)

The general structure of supply chain consists of four levels: the market level, the distribution center (DC) level, the manufacturing or plant level and the supplier level. At each level, there must be more than one of each of the entities. Mainly, we are interested in the elect of three key inventory planning parameters on supply chain; I) Forecast methodology (error), II) "Flow Planning" methodology and III) Replanning frequency. Forecast methodology refers to the accuracy of the forecast. A lower forecast error can be assumed to correspond to a better forecast methodology. Flow planning refers to the way in which the product requirements are planned and communicated at the distribution centers.
We identified three key supply chain performance parameters that used in this study: I) Observed service level II) Supply chain cycle time and III) Return on investment (ROI). The observed service level refers to the proportion of demand satisfied at the DCs from inventory. The overall service level of the supply chain is defined as the volume-weighted average of the service levels at each of the DCs that are in operation. The cycle time, meanwhile, refers to the time spent by the product, either as raw material, work-in process or a finished good, in the supply chain. It is simply the profit contribution as the proportion of the total investment in DCs plant warehouses, plants and inventory.

Gap Analysis

Production companies today are faced with a substantially more complex situation than ever before because of the increasing market demands and growing complexity of production. Inventory planning has become a core competency, a strategic weapon that many companies are using to enhance their competitive position. At the same time, the warehouse is undergoing unbelievable challenges that make warehouse excellence harder. These criterias as follows have to be taken care as Ganeshan, Boone and Stenger (2001) said.

1- A significantly larger number of Stock Keeping Units (SKU's),

2- Increased customer service requirements,

3- Demands to reduce inventory and cost,

4- Demands to increase warehouse operating efficiency and space utilization,

5- The need for increased integration of the warehouse within the Total Logistics system,

6- The changes in logistics philosophies from a "push" environment to a "pull"

The planning, managing and improving of today's warehouse and inventory planning operations require a much more professional approach to warehousing than previously adopted. So Inventory Planning Gap Analysis is benchmarking methodology for assessing the utilization of inventory and warehouse infrastructure (systems, people and space) in meeting the mission of the warehouse (shipping perfect orders) also consolidating inventory. Warehouse and Inventory performance indicators are productivity (lines per hour), storage density (case storage capacity per m^2) shipping accuracy (percent lines shipped in error), stock accuracy, travel time and order preparation time. The value in the gap analysis is the statistical presentation of the performance profile. This analysis quickly points out weak and strong points in the performance of a warehouse operations other aspect of the gap analysis can also be used in justifying capital expenditures for new information and/or material handling systems for better and the best operation(s). (Ganeshan, Boone and Stenger, 2001)

For Inventory Planning had been a survey among the some companies and asked the questions as follows to get the results which hoping and trying to have by using likert scale :

QUESTIONs :

A) If you take consideration on Stock Level each as expressed in different level below, what is the impact percentage of them on Logistics Performance ?

1) Market Level,
2) Distribution Center Level,
3) Manufacturing or Plant Level,
4) Supplier Level,

B) If you focus on the Key Inventory Planning Parameters (KIPP) separately below, How much each parameter influences total Logistics Performance independently?

1) Forecast Methodology,
   (Accuracy of the Forecast)
2) Material Flow Planning Methodology,
   (Product requirements are planned and communicated at the distribution centers)
3) Replaning Frequency,
   (How often Materials Management issued)

C) According to answers of the questions that you replied above, What you could tell about up to which level your company's Logistics Performance rised ?

Computational Results

We chose 12 different industrial manufacturing companies in Istanbul and Gebze industrial zones in TURKEY. Asked the questions to 27 Logistic Staff and had answers only 20 person using face to face and in depth interview. All of them have workforce quantity each equal 65 person or more. Questionnaire applied only Logistics Dept.s staff. Main aspect of these companies are having Logistic problems and also high operational costs on warehouse and inventory activities. All of them have agreed on that changing the system and model for their own warehouse management but do not know how to perform.

So we asked the questions and had the results then suitable model and change method will be offered to those companies as flashback.

TABLE 1
Observed Results of the Survey

Logistics Staff	QUESTIONS A1	A2	A3	A4	B1	B2	B3	Logistics Performance C
1	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**1.0**	**1.0**	**2.0**
2	**4.0**	**4.0**	**4.0**	**4.0**	**3.0**	**3.0**	**3.0**	**3.0**
3	**4.0**	**5.0**	**5.0**	**3.0**	**1.0**	**2.0**	**1.0**	**3.0**
4	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	**1.0**	**1.0**
5	**4.0**	**4.0**	**4.0**	**4.0**	**3.0**	**3.0**	**3.0**	**4.0**
6	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**3.0**	**4.0**
7	**5.0**	**5.0**	**4.0**	**5.0**	**3.0**	**3.0**	**4.0**	**5.0**
8	**5.0**	**5.0**	**5.0**	**5.0**	**4.0**	**4.0**	**4.0**	**5.0**
9	**4.0**	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**3.0**
10	**3.0**	**3.0**	**2.0**	**3.0**	**2.0**	**2.0**	**3.0**	**3.0**
11	**4.0**	**4.0**	**3.0**	**4.0**	**2.0**	**2.0**	**2.0**	**4.0**
12	**2.0**	**1.0**	**3.0**	**1.0**	**1.0**	**1.0**	**1.0**	**2.0**
13	**3.0**	**4.0**	**3.0**	**2.0**	**2.0**	**3.0**	**5.0**	**5.0**
14	**5.0**	**3.0**	**5.0**	**4.0**	**5.0**	**5.0**	**3.0**	**5.0**
15	**2.0**	**3.0**	**5.0**	**4.0**	**3.0**	**3.0**	**5.0**	**5.0**
16	**3.0**	**3.0**	**3.0**	**5.0**	**5.0**	**4.0**	**4.0**	**5.0**
17	**3.0**	**5.0**	**4.0**	**5.0**	**3.0**	**4.0**	**3.0**	**5.0**
18	**4.0**	**5.0**	**4.0**	**5.0**	**4.0**	**5.0**	**4.0**	**5.0**
19	**5.0**	**4.0**	**5.0**	**4.0**	**3.0**	**3.0**	**5.0**	**5.0**
20	**3.0**	**3.0**	**3.0**	**3.0**	**5.0**	**4.0**	**4.0**	**5.0**

LEGEND : **(Source : 12 Companies, 20 Logistic Staff) – (Evaluation Alternatives : 1 – 5)**

Comparative evaluation across methods and experiments is important for understanding in data categorization. Carefully analyzing not only empirical evidence but also the test conditions under which classifiers are evaluated, the factors underlying performance variations will become much more transparent and better understood, leading to improved evaluation methodology for certain results.

Specifically, we checked and researched the impact of Inventory on Logistics Performance and operational costs by using Regression Analysis. On Figure 1, we realized the correlation between two parameters (Inventory and Logistic Performance) as Logistics Performance = 1,920 + 0,564 * KIPP.

Our results indicate that Inventory Planning has a significant effect on Logistic performance throughout the key inventory planning parameters. Means that if the KIPP rises up 1 unit, up to that Logistic Performance rises only 0,564. As our methodology section indicated, the supply chain analysis requires data, warehouse design, and flow planning parameters.

This study has covered significant information related to Logistic Performance and Warehouse and Inventory Planning. Results showed that that these parameters have a significant effect on performance. The main theme throughout is that the organization and planning related to the inventory records increases accuracy, better performance and followed by profit(s) also means that inventory planning and hi-tech equipments in warehouse affects company Logistic Performance very deeply.

METHODOLOGY

Inventory Planning Gap Analysis showed that the inventory planning decisions affect the logistic performance. A dimension of the inventory planning decisions is the stock area requirement. The economical order quantity and security stock calculations which are realized in the coverage of the stock optimization are directed at the stock costs at the basis, and it is not directly aimed at the stock area requirement. Although the depot expenditures are stipulated in the inventory holding cost, it has a low degree of influence. Consequently, the stock area is taken up as a separate evaluation criteria in the methodology suggested.

The customer service level is calculated as the rate of the covering of the orders/consumption. Depending on the distribution of the request, the security stock calculation is made in order to cover a certain percentage of the fluctuations. While increasing the security stock increases the customer service level, it also increases the inventory holding cost however it reduces the Stock-out Cost. On the other hand, increasing security stock and average stock increase the amount of area which is needed in the depot as well.

The depot design is a strategic decision, but the inventory planning is a tactical decision. Consequently, planning horizons are different. However, an important part of the depot is the product stock keeping area and the effective usage of this area is very important. This area is the total of the stock areas to be separated for each product. In this frame, it is necessary to take into consideration the customer service level of the products, stock cost and stocking keeping area criteria together in distributing the total area into the products. The flowchart of a methodology which evaluates the criteria stated together and which stipulates the decision maker interaction is seen in the Figure-1.

The methodology starts with the demand estimation belonging to the product and the data of distribution of this estimation, and by means of taking into consideration the inventory holding cost, stock-out cost and order cost, and evaluating the customer service level of 95% and the supply period in the starting, the security stock and total stock cost are calculated. The keeping stock area is specified according to the security and average stock values of the products. The values obtained are presented to the decision maker and, in case it is not considered appropriate, the changes are made at the customer service level and an appropriate solution group is formed.

The decision maker has to evaluate the characteristics of the product, level of the stock cost and the stocking area size of the depot together while taking decision for the customer service level, stock cost and stock keeping area values. It is stipulated in this methodology that the total stocking area may be variable. Consequently, the rental depot usage will ensure this change, instead of self-owned depot usage. In addition to this, beside the stock area, there are corridor, order preparation, value added services area in the depots as well. The area transfer is possible also among these areas. On the other hand, the same product is kept available not only in the pallet stocking areas but also in the parcel stocking areas in the distribution centers in particular. Different service level preferences could be used at different stages.

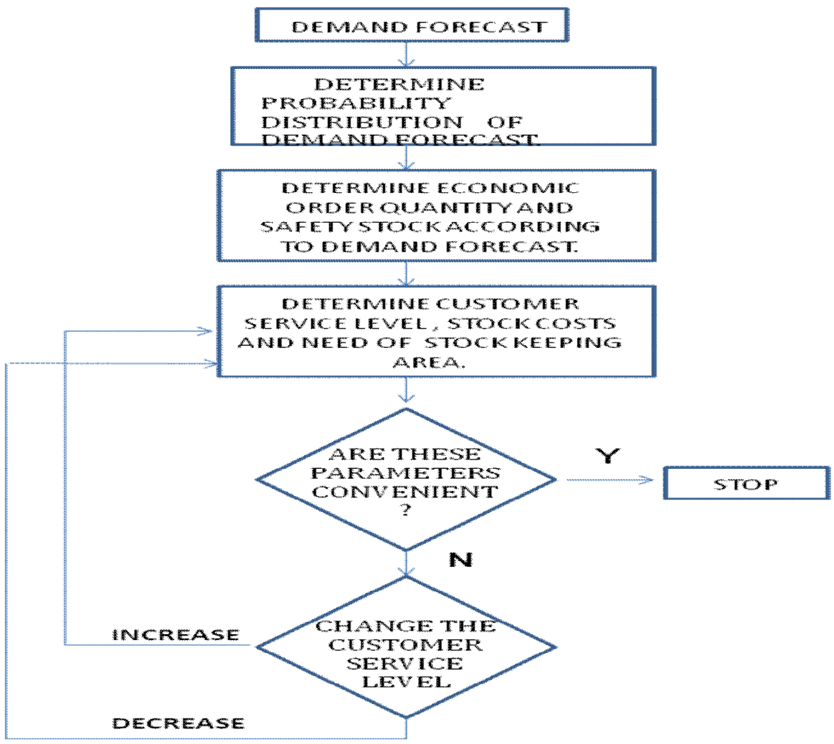

FIGURE. 1

Flow Diagram of Proposed Methodology

There will be different customer service level and stocking area amounts preferences usage will be in question for different products for the scarce resources of the enterprises. The characteristics of the product and even that of its customer, total stocking area and the flexibility of this area, restrictions on the stock costs are important in these preferences.

The suggested methodology is based on a conceptual model which take into consideration the customer service level, stock cost and stock keeping area together. Consequently, a numerical study is not performed at this stage. It is suggested to perform the studies for this purpose and to perform the validation studies of this methodology in the future.

CONCLUSION

Currently, most of the tactical warehouse and inventory issues are tackled independently and sequentially. Our aim through this work was to show the value of integrating more decisions of the warehouse and inventory fields. Consequently, we have presented global models which take into account the replenishment decision at the inventory management level, the allocation of products to warehouse systems and the assignment of products to storage locations at the warehouse management level.

There will be different customer service level and stocking area amounts preferences usage will be in question for different products for the scarce resources of the enterprises. The characteristics of the product and even that of its customer, total stocking area and the flexibility of this area, restrictions on the stock costs are important in these preferences.

Some researches pointed out that observing the impact of changes in the objective cost coefficients on the total savings realized also on the warehouse and the inventory configuration. Few results showed that in most cases changes in the objective cost coefficients were not having a significant impact on the warehouse and the inventory configuration and the total savings realized. The main theme throughout is that the organization and planning related to the inventory records increases accuracy, better Performance and followed by profit(s) also means that Inventory Planning and Hi-tech equipments in Warehouse affects Company Logistic Performance very seriously.

The suggested methodology is based on a conceptual model which take into consideration the customer service level, stock cost and stock keeping area together. Consequently, a numerical study is not performed at this stage. It is suggested to perform the studies for this purpose and to perform the validation studies of this methodology in the future.

REFERENCES

[1] Broulias G.P., Marcoulaki E.C., Chondrocoukis G.P., Laios L.G. (2005), Warehouse Management for Improved Order Picking Performance, Department of Industrial Management & Technology, University of Piraeus.
[2] De Bodt M.A., Van Wassenhove L.N. (1993), Lot Sizes and Safety Stocks in Logistics, Production and Inventory Management 24.
[3] Frazelle E. H., (2002), Warehousing and Material Handling, McGraw-Hill.
[4] Ganeshan R., Boone T. and Stenger A. J. (2001), The Impact of Inventory and Flow Planning Parameters on Supply Chain Performance: An Exploratory Study. International Journal of Production Economics, 71, 111-118.
[5] Mentzer J. T., Konrad B. P. (1991), An Efficiency/Effectiveness Approach to Logistics Performance Analysis, Journal of Business Logistics, Vol. 12, No.1.
[6] Rouwenhorst B., Reuter B., Stockrahm V., van Houtum G.J., Mantel R.J., Zijm W.H.M. (2000), Warehouse Design and Control: Framework and Literature Review, European Journal 122, 515 – 533.
[7] Strack G., Pochet Y. (2010), An Integrated Model for Warehouse and Inventory Planning, European Journal of Operational Research, 204, 35-50.
[8] Tompkins J. A., Smith J. D. (2003), Warehouse Management Handbook, Second Edition, Tompkins Press.
[9] Van den Berg J. P., Sharp G. P., Gademann A.J.R.M., Pochet Y. (1998) , Forward–Reserve Allocation in a Warehouse with Unit-Load Replenishments, European Journal of Operational Research 111 98–113.

DESIGNING SUPPLY CONTRACT WITH QUANTITY COMMITMENTS: A CONCEPTUAL MODEL

Halim Yurdakul[1], İbrahim Zeki Akyurt[2]

Abstract *-- In the complex structure of supply chain, one of the most important means to provide a smooth process during ordering-supplying-inventory management flow is designing a contract that will satisfy both the buyer and the supplier. But, in a stochastic area in which the demand is uncertain, the buyer shall not be willing to be bound to a quantity commitment and, the supplier will have to see the entire horizon including the quantity of goods and the replenishment periods. This study is aiming to establish a design of supply contract which can be useful to help each party to perform cost effectively.*

Keywords – Designing contract, supply chain, quantity commitment, buyer, supplier

INTRODUCTION

In today's ever changing markets, maintaining an efficient and flexible supply chain is critical for every enterprise, especially given the prevailing volatilities in the business environment with constantly shifting and increasing customer expectations. Various sources of uncertainty can be identified in these systems. Based on the timeframe over which these uncertainties affect the system, they can be categorized into short-term or long term uncertainties. Long-term uncertainty refers to raw material/final product unit price fluctuations, seasonal demand variations and production rate changes occurring over longer time frames [1].

The members in the supply chain usually have different goals and interests and those goals and interests always conflict so that the supply chain coordination is not easy to be achieved. On way to align different goals to different members to sign supply agreements may maximize profit or minimize cost of the whole supply chain [2].

The underlying need to make a contract in supply chain is mainly to avoid the negative impacts of the uncertainty and of the spot procurement which includes cost and time Trade- offs. Establishment of fixed costs in the contract enables conformity for both the buyer and the supplier. Hence, the benefits of contracting are lower variable production and transactions costs [3]. Spot purchases from generalized suppliers, and perhaps fulfilled using generalized logistics providers, provide access to a broader competitive market, and allow fine tuning of demand and supply, but possibly at higher unit costs associated with the poorer matching of product specifications and delivery features with the buyer's requirements. While these benefits favor contracting, contracting must be done in advance, and sometimes well in advance, of physical delivery requirements so that investments in capacity or in customization required of suppliers to support contract execution may face increased uncertainty relative to spot market transactions [3].

Contract decisions are made at the beginning of the planning horizon. During the course of the contract period, many uncertain things may happen related to economic conditions, market prices, customer demand, supply availability and system capacity. This renders the decision - makers under significant risks when making contract decisions.

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LITERATURE REVIEW

Anupindi and Bassok [4] observed that the contract used in practice classified the parameters into eight classes: time duration, price, ordering cycle, minimum purchase commitment, flexibility, transportation requirement, quality and shared information. They indicated that the issues needed to be studied deeply including the analysis and the design of contracts. Tsay et al.[5] represented that the main purpose of supply contract is to achieve risk sharing among supply chain members. A few researchers such as Lariviere [6], Arcelus et al.[7], Lee and Chu [8]. explored the risk sharing effects of those contracts on the profits, costs and incentives of supply chain members. There are different types of supply contracts which can be used to achieve certain objectives, such as incentivizing decision makers to place order quantities that maximize expected supply chain profit [2]. Bassok and Anupindi [9] first proposed the minimum commitment under the environment where the demand is uncertain and only single product were traded. They [4] extended their research in 1997 to the environment with multiple products.

Schweitzer and Cachon [10], and a number of authors have shown that the assumption made in most of the analytical literature is that retailers respond to supply contracts by placing orders that maximize their expected profit does exist in the practice. The most commonly analyzed setting is a newsvendor-type experiment with a wholesale price contract. The first to analyze different contract types are Katok and Wu [11], who expose human participants to buyback and revenue-sharing contracts and find that behavior under those more complex contracts is also biased in a similar way (orders tend to be biased away from the expected-profit-maximizing levels towards average demands).

What is A Contract?

A contract specifies the parameters within which a buyer places orders and a supplier fulfills them [12]. In its basic form, a contract represents a legally binding agreement made by two or more parties to complete a specified action at a specific point in time. It represents a *bargain* that is valid in a court. Contracts may be generated to cover the purchase of either goods or services [13]

Agreements required to be evidenced in writing (such as those just listed) do not have to take a specific contractual form. However, at the least, the writing must contain [13]:

- Identification of the other party as the individual responsible for the contract
- Some form of signature of the above
- A clearly identified subject of the contract
- Specific terms and conditions
- Identification of the consideration (as an exchange of value)

A contract may contain specifications regarding quantity, price, time, and quality [12]. The contract used in practice in supply chain classified the parameters into eight classes: time duration, price, ordering cycle, minimum purchase commitment, flexibility, transportation requirement, quality and shared information [14]

Contract Requirements

In order for a contract to be legally enforceable, it is commonly agreed that four key elements need to be demonstrated: mutual agreement, legality, consideration, and capacity [13]. Consideration here means; recompense, payment; the inducement to a contract or other legal transaction [15]. Capacity is; legal qualification, competency, power, or fitness [15].

Reviewing Contracts for Legal Requirements

It is commonly thought that only legal department can draft contracts and in case of a contracting issue it directly goes to the legal department. In some organizations, standard contracts drafted by legal counsel are available for the use when needed. Whenever possible, they should be used rather than the contracts submitted by the supplier since they likely offer more specific protection in the circumstances. It is never a good idea to simply sign a contract presented by other party. Legal counsel provides assurance that the contract conforms to applicable law and regulations and that the organization's liability is minimized. In addition to this, the organization may also want to employ counsel for a number of specific circumstances, such as those listed below [13]:

Intellectual Property Rights: When needed to be certain that the organization does not infringe on any IP rights legally granted to others and that it has properly protected its own IP rights through proper disclosure processes.

> "Buyer will defend or settle any claim brought against the supplier that the Value-Add Solution (provided that the supplier product does not by itself cause such a claim or an infringement) 1) infringes any patent, copyright, trade secret or trademark in the country where the Products are used or sold, or 2) caused other damage, provided the supplier (1) promptly notifies the buyer in writing, and (2) cooperates with buyer in, and grants buyer sole control of the defense or settlement."

Legal Venue: When legal counsel will require language in the contract to determine which state's laws will be considered and in which state's court action will be taken should litigation be required. This can be quite difficult when dealing with international suppliers. In such case a third country's law can be applicable.

Assignability: Legal review may also be required to ensure that the contract will be transferable to any future business interests the organization may acquire (such as through acquisition, merger, or the creation of a subsidiary) and, at the same time, limit the supplier's ability to transfer the contract without prior approval.

Example: "During the term of the Agreement, (The supplier) appoints PARTNER and PARTNER accepts such appointment to have a non-exclusive right to resell, sublicense, lease, rent and provide service for the Product or Products and services in the Territories specified in supplementary agreements to End Users and other PARTNERs or Resellers. PARTNER may represent itself as an Authorized Systems Integrator of the Products. The appointment does not prevent (The supplier) *from selling the Products in the Territory."*

Insurance: For some contracts, the buyer may want to be certain that the supplier carries the proper insurance, such as workmen's compensation, so that additional liability does not accrue to the organization. Legal counsel will often require that the organization obtains copies of the supplier's certificate of insurance as evidence that it is in place. In some cases, in addition to insurance, a performance bond may be required. These bonds are usually purchased to insure against the buyer's loss should the supplier default in providing the agreed upon services.

Reviews and Claims: Under certain circumstances, the buyer may wish to include a process for review should there be a dispute regarding the contract. This benefits both parties. Reviews are generally a form of mediation and often simply refer questions and decisions to more senior management or to corresponding company counsel. In government environments, however, the process is generally more formal and will often involve an actual review board convened for the express purpose of reviewing supplier protests and claims.

Parol Evidence: The rule of *parol evidence* prevents the use of oral testimony to alter a written contract. This means that any oral promises made by the supplier during the contracting process must be put in writing or they will not apply. Only the written contract can be used as evidence of an agreement. As a result, it is extremely important to review the deliverables with legal counsel to ensure that all commitments are accurately reflected in the document. The buyer should be certain that this is clearly written into the contract to avoid disputes when field personnel become involved and begin to make *ad hoc* changes.

Reservation of Rights: The legal counsel will also want to similarly review any clauses that specifically limit the organization's rights to the full performance of the contract. This will include a requirement that no changes can be made in the contract without the express consent of the buyer.

Liability Limitations: Suppliers typically want to limit liability to replacement of a product or service under the terms of the warranty. Depending on the circumstances, however, this may limit your organization's rights to claim *incidental damages* such as transportation or special handling costs. In some cases, *consequential damages*—including lost revenue or profit, damage to property, or injury to persons—may be in order. Clauses covering these conditions are often contentious and best left in the hands of your attorney.

Example: "To the extent (Supplier) is held legally liable to Customer, (The supplier)'s total liability is limited to: payments described in Sections 10. h) and 16. b) above; damages for bodily injury; direct damages to tangible property up to a limit of U.S.$1,000,000; other direct damages for any claim based on a material breach of Support services, up to a maximum of twelve (12) months of the related Support charges paid by (buyer) during the period of material breach; and other direct damages for any claim based on a material breach of any other term of these (The supplier) Terms and Conditions of Sale and Service, up to a limit of U.S.$1,000,000 or the amount paid to (Supplier) for the associated Product, whichever is less."

Liquidated Damages: It will often be impossible to calculate the actual monetary damage or loss suffered under certain circumstances. In such situations, the parties will agree to a predetermined amount—known as liquidated damages—to be paid in the event of default. This is also a contentious process and so requires input from legal counsel. It is important to determine a reasonable amount for damages in any particular case so that it will be upheld if the argument goes to court.

Regulated Materials: Laws governing the transportation, use, and disposal of regulated and hazardous materials require special attention since these substances can create exceptional liability for the organization. Special legal and technical expertise is definitely required when dealing contractually with any material that might fall under these regulations. These are high risk areas and, at the minimum, require that the roles and responsibilities of the parties be clearly defined.

Force Majeure *Force majeure* identifies acts or events that are outside the control of the parties involved, such as wars, natural disasters, strikes, and the like. Typically, either one or both parties to a contract are relieved of performance when such uncontrollable actions occur and are not held liable for damages. It is important, however, to be certain proper legal language is included in the contract since there are no automatic provisions covering this.

Example: "If the parties cannot fulfill their obligations according to the terms of the Contract completely, property and in time because of force-majeure, they are somewhat free from the execution responsibility of the given obligations. In this case the term of execution of the services are prolonged to the term of the force – majeure."

Miscellaneous Provisions

Example: "Should any provision of this agreement, be or become ineffective or if this agreement is incomplete, this shall not affect the validity of the remaining provisions of this agreement. The ineffective provision shall be replaced by a provision that achieves as nearly as possible the business purpose of the ineffective provision."

Duration Of The Contract

Example: "This Agreement shall become effective on the date first written above and shall continue for a period of one (1) year. This Agreement shall be renewed automatically for an additional one (1) year term unless either party gives written notice of termination to the other sixty (60) days prior to expiration.

Termination

Example: “Termination for Convenience: *Either party may terminate this Agreement, without cause, on sixty (60) days prior written notice.”*

“Termination for Cause: *Either party may terminate this Agreement at any time upon written notice if the other party (i) is in material breach of its obligations hereunder and fails to cure such breach within thirty (30) days following written notice of such breach, or (ii) becomes insolvent or files or has filed against it a petition under bankruptcy or insolvency law which remains c after ninety (90) days, makes an assignment for the benefit of creditors or takes any similar action under applicable bankruptcy or insolvency law.*

Contract Types Used in Supply Chain

Effective supply chain management requires collaboration and coordination between independently managed business entities along the supply chain. This function is generally governed by supply chain contracts [16]. Supply chain contract is a coordination mechanism that provides incentives to all of its members so that the decentralized supply chain behaves nearly or exactly the same as the integrated one [17]

One of the available procurement strategies used to hedge financial risk is the application of *long-term contracts* such as futures and forward. **A futures contract** is an exchange-traded contract requiring a clearinghouse or an exchange institution for guaranteeing a standard and formal transaction, while **a forward contract** is an over-the-counter contract privately agreed upon or negotiated between two parties [18].

A long-term contract is constructed by price, quantity, and time of delivery in the future, which are all agreed upon between supplier and buyer. Once financially settled, the financial risk in terms of lost revenue faced by the buyer is partially shifted to the supplier as an obligation to deliver the product in the future. Nonetheless, the buyer still faces the risk of generation inadequacy due to demand uncertainty and inability to adjust the quantity [18].

An option contract is another tool used in implementing a procurement strategy. While futures and forwards are based on an obligation as contracted, options offer the right to buy or sell an asset at a specific price and on a certain date, referred to as *call option* or *put option*, respectively. There are two price structures in an option, i.e., an initial payment which is an up-front fee called *reservation price* or *option premium*, and a variable payment which is an additional unit price for a variable amount of usage called *exercise price* or *strike price*. The date of delivery specified in the contract is known as *exercise date*, *expiration date*, or *maturity* [18].

A flexible commitment agreement between a buyer and a supplier is to assist both of them to face the uncertainty that is associated with the external demand. It is assumed that the retailer's position in the chain enables him to better forecast the future demand by the customers. Therefore, the retailer is expected to help the supplier by providing him with advanced information in the form of future commitments. These are estimates of his future orders for a given number of future periods [19]. Now, given a vector of cost and penalty parameters that reflect the flexible arrangement that is proposed by a supplier and facing uncertain demand, the retailer's challenge is to find an optimal ordering policy [19].

CONCLUSION

In this study we outlined what a contract is and reviewed design of a contract which includes the prospective solutions to the disagreements at the very beginning and signed by both parties in order to implement sustainable trade-offs during the relationship in supply chain. By doing this, we analyzed contract types used in supply chain and we also analyzed how to build a contract, which aspects have to be included in it in order to have a legally valid contract and also commercial points which enable a healthy process for both buyer and the supplier. We aimed also that this study will be an applicable reference for the further researches on contracting in supply chain as a framework.

REFERENCES

[1] Anshuman Gupta, Costas D. Maranas, “Managing demand uncertainty in supply chain planning”, Department of Chemical Engineering, The Pennsylvania State University.
[2] Cachon, G. 2003. “*Supply chain coordination with contracts*”. Handbooks in Operations Research and Management Science: Supply Chain Management, edited by Steve Graves and Ton de Kok. North-Holland.
[3] Paul R. Kleindorfer _ D.J. Wu, Contracting via Business-to-Business
Exchanges for Capital-Intensive Industries The Wharton School, University of Pennsylvania, Philadelphia, PA 19104, This Version: January 31, 2002
[4] Anupindi, Bassok, “Supply Contracts with Quantity Commitments and Stochastic Demand”, in *Quantitative Models in Supply Chain Management* by S. Tayur, M. Magazine, and R. Ganeshan (Eds.), Kluwer Academic Publishers, 1998.
[5] Tsay et al, “Strategic Inventories in a two-period Cournot Duopoly”, Vijayendra Viswanathan Jaejin Jang, University of Wisconsin-Milwaukee, May 4, 2009
[6] Martin A. Lariviere, Gerard P. Cachon, „Contracting to assure supply: How to share demand forcasts in a supply chain” the Warthon School, university of Pennisilvania, Philedelphia 19104
[7] F. J. Arcelus, T. P. M. Pakkala, G. Srinivasan, “A Purchasing Framework for B2B Pricing Decisions and Risk-sharing in Supply Chains” 2007
[8] Wai Hung Julius Chuand Ching Chyi Lee, “Strategic information sharing in a supply chain”, Faculty of Business Administration, Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Shatin, NT, Hong Kong
[9] Yehuda Bassok, Ravı Anupındı , “Analysis of supply contracts with total minimum commitment”, Department of Industrial Engineering and Management Sciences, Northwestern University,Eevanston, 60207
[10] Schweitzer, M., G. Cachon.” Decision bias in the newsvendor problem with a known demand distribution: experimental evidence” *Management Science,* 2000
[11] Elena Katok, Diana Yan Wu, “Contracting in Supply Chains: A Laboratory Investigation”, Smeal College of Business, Pennsylvania State University, University Park, Pennsylvania 16802, School of Business, University of Kansas, Lawrence, Kansas 66045
[12] Chopra and Meindl, “Supply Chain Management: Strategy, Planning, and Operation” Prentice-Hall, *2004*
[13] Sollish, Fred; Semanik, John, “The Purchasing and Supply Manager’s Guide to the C.P.M. Exam” Harbour Light Press, San Fransisco- London
[14] Ruey-Shan Guo, David M. Chiang, Hung-Jen Lo and Fan-Yun Pai, Design of Supply Chain Contract by Consideration of Risk Pooling and Risk Sharing, Department of Business Administration, National Taiwan University, Taipei 106, Taiwan
[15] Webster’s New Collegiate Dictionary 150th Anniversary Edition, G.& C. Merriam Company, Springfield, Massachusetts, USA
[16] Feng, Martel, D’Amours, Beauregard, “A stochastic programming approach for coordinated contract decisions in a make –to-order manufacturing supply chain”, Cirrelt, March 2010
[17] Charles X. Wang, “A general framework of supply chain contract models”, School of Management, Syracuse University, NY, USA
[18] F. T. Sparrow and D. J. Gotham, Modeling Power Portfolio with Supply Contracts for Mitigating Risks of Serving Uncertain Demand V. Siriariyaporn Midwest ISO, Inc., Carmel, IN, Purdue University, West Lafayette, IN
[19] Aharon Ben Taly, Boaz Golanyy, Arcadi Nemirovskiy, Jean-Philippe Vialz
Supplier-Retailer Flexible Commitments Contracts: A Robust Optimization Approach
March 4, 2003

METAHEURISTICS AND HYBRID HEURISTICS USED IN CAPACITATED LOT SIZING PROBLEM: A REVIEW OF APPLICATIONS

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Abstract *--- The proofs for complexity theory showed that Capacitated Lot Sizing Problem (CLSP) and extensions derived from the fundamental structure are NP-hard problems. Algorithms to solve CLSP optimally suffer from combinatorial nature of the problem. Due to this NP-hard nature of the problem, Capacitated Lot Sizing Problem (CLSP) has been widely studied in the literature for more than 50 years and various algorithms are used to find near optimum solution within the different aspects. The difficulty in solving CLSP depends on two different tight constraints. Additionally, the problem itself has so many variations with respect to product structure, setup time, overtime, backlogging, lead times, time windows, planning horizon etc. The resulting combination of these variations becomes more complicated. As a result, most of the solution approaches consist of different types of metaheuristics and hybrid heuristics. There are a number of different heuristic techniques to solve CLSP nearly optimally. The aim of this paper is to review basic types of CLSP and solutions proposed to solve the problem. This paper will help researchers that aim to study on this field to understand the fundamentals of the problem.*

Keywords --- Lot Sizing, Metaheuristics, Production Planning and Control, Literature Review

INTRODUCTION

The capacitated lot sizing problem pertains to the efficient utilization of resources, and provides an economic production schedule with pre-determined parameters. It is intended to determine the periods where production should take place and quantity of production to satisfy constraints of overall systems and meet the objectives formed by decision makers in the systems.[1] Companies are continuously looking for the ways to improve their performance and decrease overall costs of production planning operations. The CLSP problem is a tactical level medium range decision making problem that directly affects medium term efficiency and profitability of manufacturing system. One of the prior reasons why it is studied widely is complexity of the problem structure. CLSP and extensions derived from the original structure are NP-hard problems [2]. Whenever a setup is incorporated to structure, even finding a feasible solution becomes NP-complete. [3]

Mostly, related problem is formulated with the objective of cost minimization including costs such as; production, setup, holding, overtime, backlog etc. Generalized mathematical model formulation of problem will be introduced in following sections in detail. The standard capacitated lot sizing problem (CLSP) generally deals with two tight constraints. One of them is inventory balance equation. The constraint says that the amount of inventory in the next time period must equal the current inventory plus what is produced or purchased minus what is sold as demand. Most of the heuristics proposed for dynamic lot sizing problem satisfies inventory balance equation [2]. The other constraint is the capacity restriction. Limited resources yield an upper bound value for capacity calculations. Processing time of operations, setup and parts feeding are biggest time consumptions in production planning activities. Most of models take processing time and setup facts into account to satisfy related constraint. Lot sizing problem contains several extensions in respect to production environment and supplier buyer interface. These extensions may be classified as "fundamental

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cluster” and “extension cluster”. Fundamental cluster reflects main characteristics associated with problem structure. Explaining a lot sizing problem without clarifying fundamental aspects is not valid.

Due to the fact that, lot sizing problem contains so many different hardly solved extensions, it has attracted the attention of many researchers. At first, researchers have focused on fundamental aspects, and formed some dynamic programming based solution strategies without violating constraints. Since then, literature has expanded rapidly and resulted in an explosion in the number of studies. Reference [4] classifies lot sizing problems based on demand type and resource constraint and concentrates on capacity dimensions of problem structure. The aspects explained in this survey are limited to ones that are fundamental. Reference [5] extends review by including different environmental characteristics such as; parallel machines environment, sequence dependent setup etc. It is not adequate to understand problem characteristics by just focusing on problem structure. Reference [6] gives detailed information on solution strategies associated with lot sizing problem. Heuristics and Metaheuristics used are reviewed and it is found out that due to complexity level of lot sizing problems, metaheuristics approaches are most commonly applicable solution strategies. In this respect, Reference [7] surveys application of genetic algorithms in lot sizing problems. Genetic algorithms are found to have better performance in terms of solution quality and speed than the results obtained by exact solutions and other heuristics. [7]

PROBLEM STRUCTURE AND LITERATURE REVIEW

As mentioned above problem structure is described by means of fundamental and extension clusters. Fundamental cluster consist of four different aspects, while extension may be formed with five different extension strategies. Definition of a lot sizing problem is made by using; number of units to be planned (single-item, multi-item), number of periods (single-period, multi-period, rolling horizon), product structure (single-level, multi-level) and capacity requirement (capacitated, uncapacitated). These aspects are fundamental structures of lot sizing problems. Based on current features of multi-item lot sizing problem, primal literature can be shown as a tree in FIGURE 1:

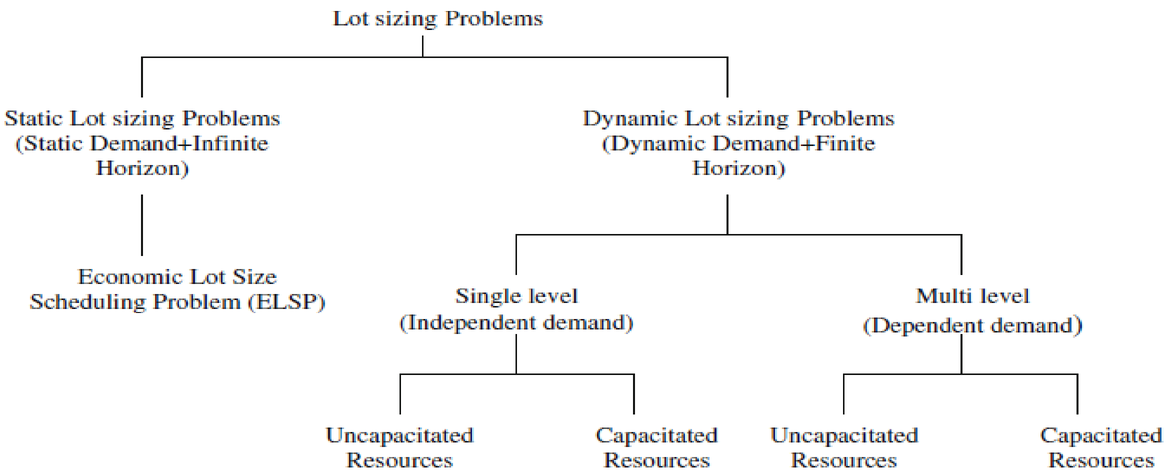

FIGURE 1
Multi-item Lot Sizing Problems Fundamental Classification [7]

Literature studies in CLSP are mostly based on analysis of problem state or solution methodologies. There is a lack of bilateral comparison of problem type and solution method that is proposed. In this study, both problem structure and solution method is included in survey analysis. As mentioned before, fundamental and extension aspects are reflected in survey analysis. Additionally, solution strategies are grouped into exact methods, metaheuristics and hybrid heuristics.

There are so many different types of each cluster. Hence, TABLE 1 is established to understand the required parameters within the each cluster. Survey will be based on three fundamental points of view.

TABLE 1
Aspects and Abbreviations for Literature Review

1. Problem Structure	**2. Solution Strategies**
A: Product structure	**X: Exact solution methods**
A1: Single-level products	X1: Fix and Optimize Algorithm
A2: Multi-level product with BOM	X2: Branch and Bound Algorithm
B: Number of item to be planned	X3: Network flow analysis
B1: Single-item	X4: Mixed integer models
B2: Multi-item	**Y: Heuristic and Metaheuristics**
C: Planning horizon	Y1: Simulated Annealing
C1: Single-period (Infinite planning horizon)	Y2: Genetic Algorithms
C2: Multi-period (Finite planning horizon- Dynamic Demand)	Y3: Tabu Search
C3: Rolling horizon	Y4: Memetic Algorithms
D: Capacity consideration	Y5: Lagrange Relaxation
D1: Capacitated	Y6: Ant colony optimization
D2: Uncapacitated	Y7: Particle Swarm Optimization
E: Machine/Cell setup	Y8: Local search techniques
E1: Setup in each period	**Z: Hybrid techniques**
E2: Setup carryover	
E3: Sequence dependent setup	**3. Application area**
E4: No applicable setup	Logistics
F: Overtime decisions	Production
F1: Unbounded overtime available	
F2: Capacitated overtime	
F3: No applicable overtime	
G: Backlogging issues	
G1: Unit time-independent backlog cost (excluding loss-of-goodwill), homogenous	
G2: Unit time-dependent backlogging cost (with loss-of-goodwill), non-homogenous	
G3: No backlog permission	
H: Production and Purchasing lead times	
H1: Production lead time	
H2: Purchasing lead time	
H3: Neglected lead time	
I: Time windows	
I1: Demand time windows	
I2: Production time windows	
I3: Planning horizon time windows	
I4: No time window	

Generalized lot sizing problem structure is multi-item multi-period capacitated dynamic lot sizing problem. The abbreviation CLSP (Capacitated Lot Sizing Problem) refers to this generalized problem structure. As mentioned above, generalized CLSP makes some assumptions that must be specified [7], [8], [9];

1. Deterministic dynamic demand is given as an input to modeling system and must be met for each finite planning horizon.
2. Only one item *i* can be produced at a time.
3. There are several resources that limit the upper bounds of production capacity. These must be reflected in the model. Additionally, Setup times and costs are associated to modeling procedure.

With this level of abstraction, generalized mathematical model may be formulated. Objective function is a cost minimization formula with two tight constraints [8];

$$z = Min\ \sum_{\forall t} \sum_{\forall i} (c_{i,t} X_{i,t} + h_{i,t} I_{i,t} + s_{i,t} Y_{i,t}) \quad (1)$$

$$s.t.\ \ I_{i,t-1} + X_{i,t} - I_{i,t} = D_{i,t} \qquad \forall i, \forall t \quad (2)$$

$$\sum_{\forall i,k} (cp_i X_{i,t} + ts_{i,t} Y_{i,t}) \leq b_{k,t} \qquad \forall t \quad (3)$$

$$X_{i,t} \leq \left(\sum_{\forall t} \sum_{\forall i} (D_{i,t}) \right) Y_{i,t} \qquad \forall i, \forall t \quad (4)$$

$$X_{i,t} \geq 0,\ \ I_{i,t} \geq 0,\ \ Y_{i,t} = 0{,}1 \qquad \forall i, t \quad (5)$$

Variables;
$X_{i,t} = production\ lot\ size\ of\ item\ i\ in\ period\ t$
$I_{i,t} = inventory\ volume\ of\ item\ i\ in\ period\ t$
$Y_{i,t} = binary\ variable\ indicating\ setup\ for\ item\ i\ in\ period\ t$
Parameters;
$c_{i,t} = unit\ production\ cost\ of\ item\ i\ in\ period\ t$
$h_{i,t} = unit\ holding\ cost\ of\ item\ i\ in\ period\ t$
$s_{i,t} = unit\ setup\ cost\ of\ item\ i\ in\ period\ t$
$D_{i,t} = independent\ demand\ of\ item\ i\ in\ period\ t$
$ts_{i,t} = setup\ time\ required\ for\ item\ i\ in\ period\ t$
$cp_i = unit\ processing\ time\ of\ item\ i$
$b_{k,t} = available\ capacity\ of\ resource\ k\ in\ period\ t$

The model assumes that there are total of *N* items with single-level product structure. The objective function formulated by (1) aims to minimize total cost of production, holding and setup. As mentioned before, most of studies in literature set objective function as cost minimization. Constraint (2) reflects inventory balance equation for each product and period. Due to the fact that, there are a number of different resources, capacity limitations formulated by constraint (3) consist of production time and setup time with a upper bound of resource limitation of such resource *k*. Constraint (4) is a control parameter to let $Y_{i,t}$ obtain a positive binary value with non-negativity constraint. Objective function (1) is mostly used to control whether step taken makes an improvement or not in that iteration.

TABLE 2 summarizes most recent studies in generalized lot sizing literature. By analyzing the current literature and review template, researchers on this subject may discover areas that are not studied by any other researchers. In the following section, facts obtained from survey will be explained and results will be served as guideline.

TABLE 2

Lot Sizing Problem Literature Review

Year	Authors	Problem Structure																										Solution Strategies												Application area	
		A		B		C			D		E				F			G			H			I				X			Y								Z	Log.	Prod.
		1	2	1	2	1	2	3	1	2	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	1		
1996	Tempelmeier and Derstroff [37]		*		*		*		*		*						*			*	*						*		*						*				*		*
1998	Özdamar and Birbil [27]	*			*			*	*		*					*				*			*				*				*	*	*						*		*
1998	Özdamar et. al. [30]		*		*		*		*					*			*			*			*				*												*	*	
1999	Kadıpaşaoğlu et. al. [25]	*			*			*		*	*						*			*	*	*					*											*		*	
2000	Barbarosoğlu and Özdamar [9]		*		*		*		*			*					*			*			*				*				*										*
2000	Özdamar and Barbarosoğlu [8]		*		*		*		*		*						*			*			*				*				*				*				*		*
2000	Hung and Chien [22]		*		*		*		*			*					*			*			*				*		*												*
2000	Özdamar and Bozyel [29]	*			*		*		*			*				*				*			*				*				*	*	*						*		*
2000	Meyr [26]	*			*		*		*				*			*			*		*	*					*			*								*	*		*
2001	Haugen et. al. [21]	*		*				*		*				*			*			*		*				*		*													*
2001	Belvaux and Wolsey [12]	*		*			*		*			*					*			*			*				*	*												*	
2002	Xie and Dong [39]		*		*		*		*		*					*				*			*				*					*								*	
2002	Özdamar et. al. [28]	*			*		*		*		*						*		*	*			*				*				*	*	*						*		*
2003	Chen and Chu [16]		*		*		*		*		*						*			*	*	*					*								*						*
2003	Nam and Park [41]	*			*		*			*				*			*			*			*				*				*										*
2004	Berretta and Rodrigues [13]		*	*			*		*			*					*			*			*				*							*		*					*
2004	Robinson and Lawerence [36]	*			*		*		*			*					*			*			*				*								*						*
2005	Sambasivan and Yahya [33]	*			*			*		*				*			*	*			*	*		*											*					*	
2005	Jeunet and Jonard [24]		*		*	*				*				*			*			*			*				*										*				*
2006	Toledo and Armenteno [38]	*			*		*		*		*						*			*		*					*								*						*
2006	Pitakaso et. al. [31]		*		*		*		*		*				*					*			*				*	*								*			*	*	
2006	Yenisey [40]		*		*		*			*				*			*			*	*	*					*			*											*

Year	Authors	Problem Structure																										Solution Strategies												Application area	
		A		B		C			D		E				F			G			H			I				X			Y								Z	Log.	Prod.
		1	2	1	2	1	2	3	1	2	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3	4	1	2	3	1	2	3	4	5	6	7	8	1		
2007	Hwang [23]	*		*				*	*					*			*		*				*		*					*											*
2007	Pitakaso et. al. [32]		*		*		*			*				*			*			*			*				*									*					*
2008	Süer et. al. [35]	*			*		*		*			*				*				*		*					*					*									*
2008	Quadt and Kuhn [5]	*			*		*		*			*					*	*				*				*		*										*	*		*
2008	Ferreira et. al. [17]	*			*			*	*				*				*			*		*					*					*	*			*				*	
2008	Absi and Kedad-Sihdom [10]	*			*		*		*		*						*		*		*	*					*	*													*
2008	Tempelmeier and Buschkühl [36]		*		*		*		*			*					*			*			*				*								*						*
2009	Han et. al. [19]		*	*		*				*				*			*			*			*				*										*				*
2009	Süral et. al. [1]	*		*			*		*			*					*			*			*				*		*						*				*		*
2009	Conteras et. al. [8]	*			*			*	*					*			*			*	*	*					*								*			*	*	*	
2009	Gaafar et. al. [18]	*		*				*		*				*			*		*				*				*			*	*								*		*
2009	Sahling et. al. [34]		*		*		*		*			*				*				*			*				*	*													*
2010	Almeder [11]		*		*		*		*		*				*					*			*				*	*								*			*		*
2010	Helber and Sahling [20]		*		*			*	*		*					*				*	*	*					*		*												*
2010	Brahimi et. al. [14]	*			*		*		*			*					*			*		*		*	*										*						*
2010	Almada-Lobo and James [42]		*		*		*		*				*				*			*			*				*										*				*

CONCLUSION

Results obtained from the survey analysis should be listed to understand dynamics of current lot sizing studies in the literature:

- Due to high complexity of problem, each study has expanded one aspect of problem structure. Hence, it became possible to model analytically and solve it in polynomial time.
- Time windows, backlogging strategies, sequence dependent setup activities, price dependent demand, product returns, perishable goods, multi-level product structures and rolling planning horizon systems are not studied widely. There is still an obvious potential in such areas.
- There is a great increasing trend in the number of studies which deal with inter-relations between lot sizing and scheduling, lot streaming, routing, network design etc. These extensions make it much more challenging to solve the problem. On the other hand, this helps to apply new heuristic and metaheuristics to solve huge problem sizes in polynomial time.
- It is observed in the survey that most of the solution strategies are based on metaheuristics or hybrid heuristics. Metaheuristics Simulated Annealing, Genetic Algorithms and OR technique Lagrangean Relaxation are apparently most appropriate techniques for related problem type. It is found out by most of researchers that these techniques require less computational time and result in very good performances in optimality tests.
- Combination of heuristics (constructive) and metaheuristics (improvement) in one algorithm also yields proper results. On the other hand, most of solution strategies based on hybrid techniques do not include any dominance properties to limit search space.
- Most of studies in literature review use hypothetical data. There are so many abstractions in modeling and performance analysis phases. As a result, there is an obvious lack of real-time production and logistics application. Additionally, it is observed that studies are mostly applied in production systems. Logistics systems such as warehouses, docks etc. are not incorporated to lot sizing systems.
- Explicitly incorporating uncertainty (stochasticity, fuzziness) will undoubtedly result in more complex models. However, power of metaheuristics and hybrid heuristics opens an interesting avenue for future researches.

Popularity of lot sizing problem has been increasing since Economic Order Quantity (EOQ) was first proposed by Harris in 1913. We believe that lot sizing and extensions derived from original structure will continue to attract attention of researchers. This paper aims to help researchers on this field to understand fundamental characteristics, solution strategies of lot sizing problems and future search opportunities.

REFERENCES

[1] Süral, H., Denizel, M., Wassenhove, L.N., 2009: Lagrange relaxation based heuristic for lot sizing with setup times. European Journal of Operational Research, 194, p. 51-63.

[2] Bitran, G.R., and Yanasse, H.H., 1982: Computational complexity of the capacitated lot size problem. Management Science, (28), 1174-1186.

[3] Garey, M., Johnson, D., 1979. Computers and Intratractability: A Guide to the Theory of NP-Completeness. Freeman, San Francisco, CA.

[4] Bahl, H.C., Ritzman, L.P., and Gupta, J.N.D., 1987: Determining lot sizes and resource requirements: A review, Operations Research, Vol. 35, no.3, pp. 329-345.

[5] Quadt, D., Kuhn, H., 2008: Capacitated Lot Sizing with Extensions. 4OR, (6), pp. 61-83.

[6] Jans, R., and Degraeve Z., 2008: Modelling Industrial Lot Sizing Problems: a Review. International Journal of Production Research, Vol. 46, no.6, pp. 1619-1643.

[7] Gören, H.G., Tunalı, S., Jans, R., 2008: A review of applications of genetic algorithms in lot sizing. Journal of Intelligent Manufacturing, Vol. 21, no.4, pp. 575-590.

[8] Özdamar, L., Barbarosoğlu, G., 2000: An integrated Lagrangean relaxation-simulated annealing approach to the multi-level multi-item capacitated lot sizing problem. International Journal of Production Economics, (68), pp. 319-331.

[9] Barbarosoğlu, G., Özdamar, L., 2000: Analysis of solution space-dependent performance of simulated annealing: the case of the multi-level capacitated lot sizing problem. Computers & Operations Research, Vol. 27, pp. 895-903.

[10] Absi, N., Kedad, S.S., 2008: The multi-item capacitated lot sizing problem with setup times and shortage costs. European Journal of Operational Research, Vol. 185, no. 3, pp. 1351-1374.

[11] Almeder, C., 2010: A hybrid optimization approach for multi-level capacitated lot sizing problems. European Journal of Operational Research, Vol. 200, no.2, pp. 559-606.

[12] Belvaux, G., Wolsey, L.A., 2001: Modelling Practical Lot Sizing Problems as Mixed-Integer Programms. Management Science, Vol. 47, no.7, pp. 993-1007.

[13] Berretta, R., Rodrigues, L.F., 2004: A memetic algorithm for a multistage capacitated lot sizing problem. International Journal of Production Economics, (87), pp. 67-81.

[14] Brahimi, N., Perez, S.D., Wolsey, S.A., 2010: Polyhedral and lagrangean approaches for lot sizing with production time windows and setup times, Computers & Operations Research, Vol. 37, pp.182-188.

[15] Buschkhül, L., Sahling, F., Helber, S., Tempelmeier, H., 2008: Dynamic capacitated lot sizing problems: A classification and review of solution approaches. OR Spectrum, Vol. 32, pp. 231-261.

[16] Chen, H., Chu, C., 2003: A lagrangean relaxation approach for supply chain planning with order/setup costs and capacity constraints. International Journal of Systems Science and Systems Engineering, Vol. 12, No. 1, pp. 98-110.

[17] Ferreira, D., França, P.M., Kimms, A., Morabito R., Rangel, S., and Toledo, C.F.M., 2008: Heuristics and Metaheuristics for lot sizing and scheduling in soft drink industry: a comparison study. Studies in Computational Intelligence, Vol. 128, pp. 169-210.

[18] Gaafar, L.K., Nassef, A.O., Aly, A., 2009: Fixed quantity dynamic lot sizing using simulated annealing. International Journal of Advanced Manufacturing Technology, Vol. 41, pp. 122-131.

[19] Han, Y., Tang, J., Kaku, I., Mung, Y., 2009: Solving uncapacitated multilevel lotsizing problems using a particle swarm optimization with flexible inertial weights. Computers and Mathematics with Application, 57, pp. 1747-1758.

[20] Helber, S., and Sahling, F., 2010: A fix-and-optimize approach for multi-level capacitated lot sizing problem. International Journal of Production Economics, Vol. 123, pp. 247-256.

[21] Haugen, K., Lokketangen, A., Woodruff, D., 2001: A progressive hedging as a metaheuristic applied to stochastic lot sizing. European Journal of Operational Research, 132, pp. 116-122.

[22] Hung, Y., Chen, C., Shih C., 2003: Using Tabu Search with Ranking Candidate List to Solve Production Problems with Setup, Computers and Industrial Engineering, 45, pp. 615-634.

[23] Hwang, H.C., 2007: Dynamic Lot Sizing Model with Production Time Windows. Naval Research Logistics, Vol. 10, pp. 1002-1018.

[24] Jeunet, J., Jonart, N., 2005: Single point stochastic search algorithms for the multi-level lot sizing problem. Computers & Operations Research, Vol. 32, pp. 985-1006.

[25] Kadıpaşaoğlu, S.K., Xiang, W., Khumawala, B.M., 1999: Batch scheduling in a multistage, multiproduct manufacturing system- an application, International Journal of Operations & Production Management, Vol. 19, No.4, pp. 421-436.

[26] Meyr, H., 2000: Simultaneous lot sizing and scheduling by combining local search with dual reoptimization. European Journal of Operational Research, 120, pp. 311-326.

[27] Özdamar, L., Birbil, Ş.İ., 1998: Hybrid Heuristics for the Capacitated Lot Sizing and Loading Problem with Setup Times and Overtime Decisions, European Journal of Operational Research, 110, pp. 525-547.

[28] Özdamar, L., Birbil, Ş.İ., Portman, M.C., 2002: Technical note: New results for the capacitated lot sizing problem with overtime decisions and setup times. Production Planning and Control, Vol. 13, no 1, p. 2-10.

[29] Özdamar, L., Bozyel, M.A. 2000: The capacitated lot sizing problem with overtime decisions and setup times. IIE Transactions, Vol. 32, no. 4 pp. 1043-1057.

[30] Özdamar, L., Bozyel, M.A., Birbil, Ş.İ., 1998: A hierarchical decision support system for production planning (with case study). European Journal of Operational Research, 104, pp. 403-422.

[31] Pitakaso, R., Almeder, C., Doerner, K.F., Hartl, R., 2006: Combining population-based and exact methods for multi-level capacitated lot sizing problems, International Journal of Production Research, Vol. 44, no. 22, pp. 4755-4772.

[32] Pitakaso, R., Almeder, C., Doerner, K.F., Hartl, R., 2007: A MAX-MIN ant system for unconstrained multi-level lot sizing problems. Computers & Operations Research, Vol. 34, pp. 2533-2552.

[33] Sambasivan, M., and Yahya, S., 2005: A lagrangean based heuristic for multi-plant, multi-item, multi-period capacitated lot sizing problems with inter-plant transfers. Computers & Operations Research, Vol. 32, pp.537-555.

[34] Sahling, F., Buschkhül, L., Tempelmeier, H., Helber, S., 2009: Solving a multilevel capacitated lot sizing problem with multi-period setup carryover via a fix-and-optimize heuristic. Computers & Operations Research, Vol. 36, pp. 2546-2553.

[35] Süer, G.A., Badurdeen, F., Dissanayake, N., 2008: Capacitated Lot Sizing by using Multi-chromosome Crossover Strategy. International Journal of Intelligent Manufacturing, Vol. 19, 273-282.

[36] Tempelmeier, H., Buschkhül, L., 2009: A heuristic for the dynamic multi-level capacitated lot sizing problem with linked lot sizes for general product structures. OR Spectrum, Vol. 31, pp. 385-404.

[37] Tempelmeier, H., and Derstroff, M., 1996: A Lagrangean-based Heuristic for Dynamic Multilevel Multiitem Constrained Lotsizing with Setup Times. Management Science, Vol. 42, No.5, pp. 738-757.

[38] Toledo, F.M.B., Armentano, V.A., 2006: A lagrangean based heuristic for the capacitated lot sizing problem in parallel machines. European Journal of Operational Research, 175, pp. 1075-1083.

[39] Xie, J., Dong, J., 2002: Heuristic Genetic Algorithms for General Capacitated Lot Sizing Problem. Computers and Mathematics with Application, 44, pp. 263-276.

[40] Yenisey, M.M., 2006: A flow network approach for equilibrium of material requirement planning. International Journal of Production Economics, Vol. 102, no. 2, pp. 317-332.

[41] Nam, D., Park, C.H., 2003: A multi-objective simulated annealing: A comperative study to evolutionary algorithms. International Journal of Fuzzy Systems, vol. 2, no. 2, pp. 87-97.

[42] Almada-Lobo, B., James, R., 2010: Neighbourhood search meta-heuristics for capacitated lot-sizing with sequence-dependent setups. International Journal of Production Research, vol 48, is 3, pp. 861-878.

AN APPLICATION OF FLEET ASSIGNMENT MODEL FOR A SAMPLE OF THE INTER-CITY BUS SCHEDULE

Gonca Tuncel[1], Engin Bıcak[2], Esra D. Durmaz[3]

Abstract – *Transportation systems have increased in complexity due to both tighter financial constraints and new technological developments today. On the other hand, competition implies that quality, timely and cost-effective service must be provided in order to stay profitable in a highly dynamic environment. Recently, a growing number of transportation companies have begun to realize the strategic importance of planning and management of operations. In this study, the basic fleet assignment model, which is encountered in airline operation planning process, was adapted and applied to a sample of the inter-city bus schedule. The fleet assignment problem deals with assigning two or more bus fleet types, each having a different capacity, to a schedule of inter-city bus trips based on equipment capabilities and operational costs. The proposed assignment system is formulated and solved as an integer programming problem. Computational results for periodic schedules on the real-world data sets are presented to illustrate the model performance.*

Keywords – *Fleet assignment model, Integer programming, Inter-city bus, Routing/Scheduling*

INTRODUCTION

Technology development, globalization and enhancement in quality of our lives drive the improvement in the transportation industry. Transportation is the movement of people and goods from one location to another, and it plays an important role in economic growth and social development of any society. The major modes of transport are airways, railways, roadways, and waterways. Road transport is currently the major mode of passenger and freight transportation in Turkey. At present, more than 90 percent of both passenger transport and freight transport is performed by roadway transportation in Turkey. Passenger transport is divided into public and private transportation. Public transportation is scheduled services on fixed routes which are commonly dominated by buses, the cheaper mode of road transport. The price driven competition and high quality service standards in inter-city transportation market is growing recently depending on the increasing number of inter-city bus carriers. The process of designing highly efficient and cost effective transportation networks is a crucial task for passenger transport.

In this study, *fleet assignment problem*, one of the decision making problems which is encountered in airline operation planning process, is adopted and applied to the operation planning of a bus company. The bus company excludes local services between several cities in Turkey. Hane's basic fleet assignment model [1], which is a mixed integer programming model, is used for solving the problem. The mathematical model describes all functional constraint groups simply and let the user to add additional constraints describes the case under consideration. The inter-city schedule is produced by considering an existing set of trips, expected traffic revenue, available resources such as buses, drivers' base, and associated operating cost.

The remaining sections of this paper are organized as follows. In the next section, we will first give a brief literature review on the fleet assignment problem in airline industry, then a short summary of several studies

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on inter-city bus transportation. In Section three, an integer programming model is presented for the fleet assignment problem of an inter-city bus company which still uses a trial-and-error process to solve their assignment problems, without optimization from a systemic perspective. The problem is solved using LINGO optimization software, and the computational results are given for the relevant problem. Finally, the conclusion of the present work is presented in the last section.

LITERATURE REVIEW

One of the most important problems in aircraft scheduling process is the fleet assignment problem, which results with data for next planning stages, such as vehicle routing and crew scheduling. For more convenient solutions in operation planning process, it is important to assign the fleet types to flight legs efficiently. Besides, fleet construction and parameters have major effects to the operational costs for airline companies. The problem of designing and implementation of transportation networks has been extensively examined in the literature used and referred to in this study, and a number of analyses have been published. Some of these studies are given below in chronological order.

Pollack's integrated model [2] aims to maximize the profit, passenger capacity and service number to particular nodes. It defines the flight legs and aircraft types as independent variables and matches them in particular periods. Abara [3] built an integer programming model for the problem and this model enables to match more than two fleet types. This model deals with the problem by specifying a limit on the number of connection variables that are considered for each flight using connection-based network structure. Model finds the optimal assignment of aircraft types to the connection arcs by the objective function and has four fixed constraint groups and one optional constraint group. Hane's mixed integer programming model [1] analyzes the fleet assignment problem like a multi-commodity network flow problem. The proposed model based on the time-space network structure aims to minimize the cost and it is widely applied in the airline industry. This model can be developed by including the cost factors as additional constraints to the basic model. Ruchmeir and Kontogiorgis [4] formulized the model as a mixed integer multi-commodity network flow problem and performed an application in US Airways. The model has some additional crew-based side constraints. Barnhart [5] developed string based integrated models which include fleet assignment problem and solved the model with branch and price approach. In this approach, a linear programming relaxation is solved at each node by using column generation. As distinct from other models, developed model has maintenance constraints. Ioachim *et al*. [6] introduced a new type of constraint for schedule synchronization. They decomposed the problem and applied the column generation for solution. Sherali *et al*. [7] analyzed the fleet assignment models and algorithms, then presented a tutorial on the basic and enhanced models.

Although there has been increasing research on airline scheduling process including fleet assignment, few references consider bus routing/scheduling and fleet assignment problem which deals with inter-city cases. However, planning and management of a bus transportation system effects operational efficiency, thus it is crucial to a company's profitability and competitiveness in the market.

Salzborn [8] discussed some rules for scheduling a bus system consisting of an inter-town route with interchanges. Yan and Chen [9] developed a model to help Taiwan inter-city bus carriers in timetable setting and bus routing and scheduling. This time–space network model considers bus movements, passenger flows, and relationships between passenger trip demands and bus trip. Yan *et al*. [10] focused on the stochastic disturbances arising from variations in daily passenger demand and developed two heuristic algorithms to solve the proposed model. Yan and Tang [11] considered the passenger choice behaviors and uncertain market demand. They formulized a non-linear integer model and developed a solution algorithm for solving this NP-hard problem. Hasan and Hammad [12] proposed a new assignment system, which maximizes the utilization of any bus in the fleet, for Saudi Public Transport Company. This system first assigns buses to the trip schedule, and then assigns drivers to the scheduled buses. Matta and Peters [13] formulated the scheduling problem as a set covering model with resource allocation constraints and solved the problem with a branch-and-price procedure.

The studies reviewed above demonstrate the importance of efficiently and effectively design of transportation networks. This paper studies the operation planning of a private bus company providing connections between several cities in Turkey. An integer programming formulation is presented for the fleet

assignment problem, and an optimal solution of a sample problem is presented. The mathematical model minimizes the total operation cost and provides the operating assignment of the buses to the scheduled trips.

APPLICATION OF THE ASSIGNMENT MODEL

Basic fleet assignment model aims to assign optimum fleet type to the flight legs in fixed flight schedule under the related constraints. Hane's model [1] is a mixed integer programming model which is constructed based on the time-space network structure. Basic constraint groups which intend to minimize the cost of fleet assignment to the flight legs are as follows:

(i) Cover constraints ensure that each fleet type is assigned to exactly one flight leg.

(ii) Flow balance constraints assure the conservation of flow at all flight legs for each fleet type, which provides the continuity of a schedule.

(iii) According to the availability constraints, the total number of assigned aircrafts should be less than or equal to the number of aircrafts available.

Proposed Integer Programming Model

In this section, an integer programming model is formulated for the real-life fleet assignment problem of an inter-city bus company in Turkey. Inter-city bus schedule studied in this study comprises a list of 24 major trips in two days over six cities (Ankara, Antalya, Eskişehir, İstanbul, İzmir, and Uşak) utilizing 27 buses. The company operates with five different fleet types for inter-city trips; NEOPLAN STARLINER, NEOPLAN TOURLINER, MAN LION'S COACH, MEGA MAN FORTUNA (2+1) and SETRA 431 DT. The notation used in the formulation is as follows:

$N = \{1, 2, \ldots, n\}$: set of stations (nodes) in the network
$K = \{1, 2, \ldots, k\}$: set of fleet types or bus types indexed by k
$F = \{1, 2, \ldots, f\}$: set of bus trips (travels) scheduled
$B(n)$: set of travels which are started in point n
$S(n)$: set of travels which are ended in point n
c_k : cost of assigning fleet type k to travel f
x_{fk} : 1, if fleet type k is allocated to bus trip f
x_{fk} : 0, if fleet type k is not allocated to bus trip f
y_k : number of available buses for fleet type k

The mathematical model formulation is given below.

Objective function

$$Z_{\min} = \sum_{f\in F}\sum_{k\in K} c_{fk} x_{fk} \tag{1}$$

Subject to

$$\sum_{k\in K} x_{fk} = 1 \qquad \forall f \in F \tag{2}$$

$$\sum_{f\in S(n)} x_{fk} - \sum_{f\in B(n)} x_{fk} = 0 \qquad \forall n \in N,\ k \in K \tag{3}$$

$$\sum_{f\in F} x_{fk} \le y_k \qquad \forall k \in K \tag{4}$$

$$x_{fk} = \{0,1\} \qquad \forall f \in F, k \in F \tag{5}$$

The objective function of the proposed model minimizes the total cost of assigning the various fleet types to the bus trips in the schedule. Constraint group (2) is the trip-cover constraint so that each bus trip is assigned to exactly one fleet type. Constraint group (3) is flow balance constraint group, which ensures that a bus will be ready for the next assignment in each node. Thus, the delays or disruptions can be prevented. Constraint group (4) is availability constraint whereby the number of assigned buses in fleet type *k* should not exceed the fleet size (i.e. the available number of buses in that fleet). Constraint group (5) expresses the binary decision variables.

Experimental Results

Given a service schedule, with departure and arrival times indicated, the mathematical model presented above determines which bus trip should be assigned to which bus types in order to optimize the objective function. The data for the last quarter of 2009 is used in this application. To facilitate problem solving, we make the following assumptions:

- A periodic scheduling horizon of two days is considered.
- The passenger trip demand is taken as fixed parameter which is equal to the seat capacity of each bus type (i.e. we assume that each bus operates at full capacity)
- Operational costs are accounted for usual travel conditions without any disruptive factors or delays on the routes.
- Fuel cost is taken as 2.65 TL / liter, which is the price on 29 December 2009.

The complete schedule incorporating 24 bus trips and their arrival/departure times for two days are presented in Table 1.

TABLE 1
Travel Plan for 2 Days

	1. day				2. day			
	Departure	**Duration**	**Arrival**	**Trip**	**Departure**	**Duration**	**Arrival**	**Trip**
Uşak-İzmir	04:00	02:45	06:45	f1	04:00	02:45	06:45	f11
İzmir-Ankara					06:30	08:00	14:30	f12
İzmir-Uşak	08:00	02:45	10:45	f2	08:00	02:45	10:45	f13
İzmir-Eskişehir	09:00	06:45	15:45	f3				
İstanbul-Ankara					10:00	06:00	16:00	f14
İzmir-Ankara					10:00	08:00	18:00	f15
İzmir-İstanbul	10:00	06:00	16:00	f4				
İstanbul-Uşak	12:15	08:00	20:15	f5				
Uşak-Antalya	12:30	04:30	17:00	f6	12:30	04:30	17:00	f16
İstanbul-Ankara	13:00	06:00	19:00	f21	13:00	06:00	19:00	f23
Ankara-İzmir								
Eskişehir-İzmir	17:00	06:45	23:45	f7				
Ankara-İstanbul					17:30	08:00	01:30	f18
Antalya-Uşak	18:30	04:30	23:00	f8	18:30	04:30	23:00	f19
Ankara-İzmir					22:00	08:00	06:00	f20
İstanbul-İzmir	22:00	08:00	06:00	f9				
Ankara-İstanbul	23:59	06:00	05:59	f22	23:59	06:00	05:59	f24
Uşak-İstanbul	23:59	08:00	07:59	f10				

Schedule design is usually the first step in the planning process of inter-city bus carriers, and it is the basis for the other decisions like fleet assignment and crew scheduling. It determines the travel network, including departure times and departure/arrival terminals. The basic fleet assignment model is then solved based on this transportation network with fixed bus routes and departure times. Figure 1 shows the routes which are derived from the scheduled trips considered in this research.

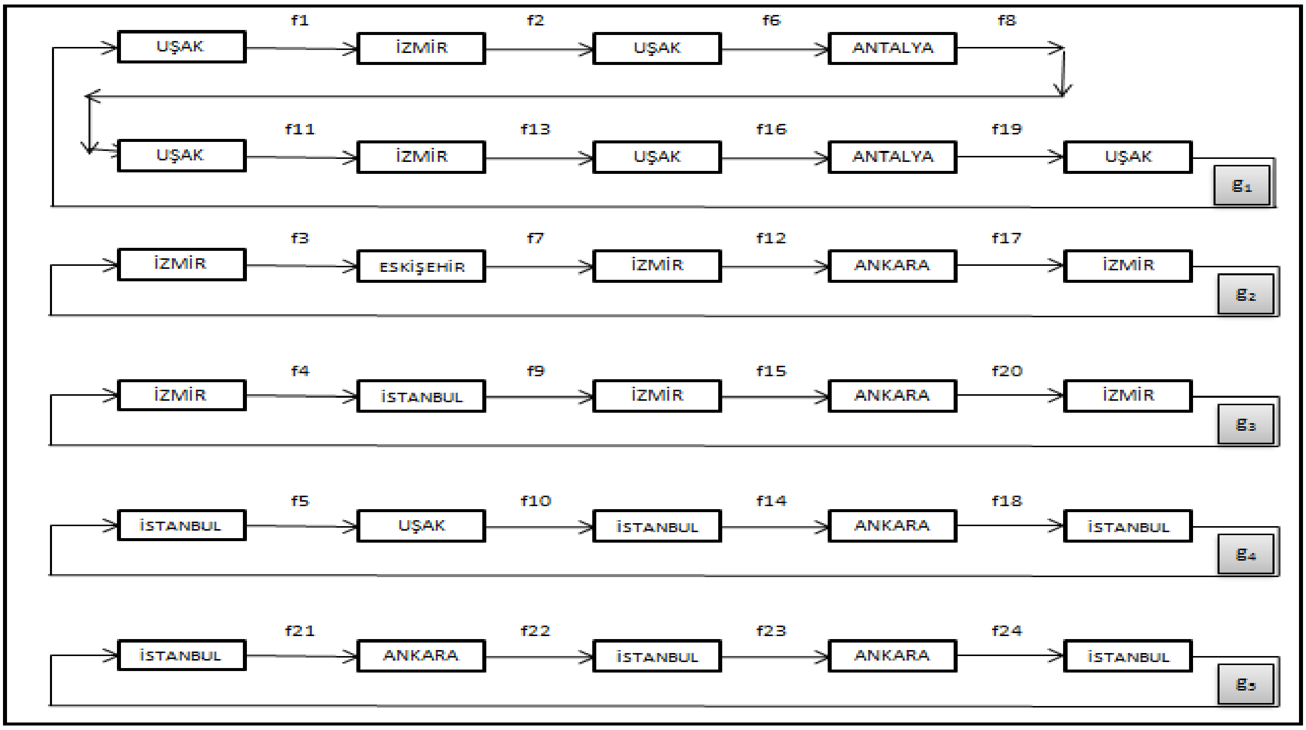

FIGURE. 1
Bus Routes for the Travel Plan

The operation cost of each bus operating the given schedule consists of the following two parts:

(i) The first is the direct (variable) costs which are divided to travel distance (e.g. fuel costs) and the total number of seats for each bus type (e.g. service cost including food and drink offered in the bus)

(ii) The second part is the fixed cost which is counted for each trip such as driver/service personnel costs, passenger terminals/station expenses, highway and bridge charges which depends on the regular route of each bus.

Based on the cost analysis, we obtained the total operating costs including direct and fixed expenses for each bus movements between the cities in the network. The related costs for the considered fleet types are displayed in Table 2.

TABLE 2
Cost Matrix for Travels and Fleet Types

LINE	Trip No	TOTAL COST ACCORDING TO THE BUS FLEET TYPE				
		Fleet type 1	**Fleet type 2**	**Fleet type 3**	**Fleet type 4**	**Fleet type 5**
Uşak-İzmir	f1	352.46	323.85	329.44	347.13	387.95
İzmir-Uşak	f2	348.46	319.85	325.44	343.13	383.95
İzmir-Eskişehir	f3	640.35	588.10	599.52	640.29	694.29
İzmir-İstanbul	f4	950.05	883.36	899.33	953.12	1015.37
İstanbul-Uşak	f5	725.82	663.80	677.84	729.64	785.47
Uşak-Antalya	f6	422.92	385.49	393.31	419.96	464.86
Eskişehir-İzmir	f7	605.35	553.10	564.52	605.29	659.29
Antalya-Uşak	f8	459.92	422.49	430.31	456.96	501.86
İstanbul-İzmir	f9	809.91	741.55	756.92	813.24	876.66
Uşak-İstanbul	f10	954.05	887.36	902.33	957.12	1019.37
Uşak-İzmir	f11	352.46	323.85	329.44	347.13	387.95
İzmir-Ankara	f12	814.91	746.55	761.92	818.24	881.66
İzmir-Uşak	f13	348.46	319.85	325.44	343.13	383.95
İstanbul-Ankara	f14	687.10	630.23	642.29	684.04	749.20
İzmir-Ankara	f15	814.91	746.55	761.92	818.24	881.66
Uşak-Antalya	f16	422.92	385.49	393.31	419.96	464.86
Ankara-İzmir	f17	809.91	741.55	756.92	813.24	876.66
Ankara-İstanbul	f18	652.10	595.23	607.29	649.04	714.20
Antalya-Uşak	f19	459.92	422.49	430.31	456.96	501.86
Ankara-İzmir	f20	809.91	741.55	756.92	813.24	876.66
İstanbul-Ankara	f21	652.10	595.23	607.29	649.04	714.20
Ankara-İstanbul	f22	652.10	595.23	607.29	649.04	714.20
İstanbul-Ankara	f23	652.10	595.23	607.29	649.04	714.20
Ankara-İstanbul	f24	652.10	595.23	607.29	649.04	714.20

After solving the model with LINGO 11.0, the optimum result is obtained with a minimum assignment cost as 14,312.75 TL which represents the total cost of the periodic bus trips in two days. Computational results, which include current number of buses and assigned buses, are presented in the Table 3. It should be noted that the planning process concerns only bus type, not a particular bus.

TABLE 3
Summary Results of the Application of the Assignment Model on the Sample Bus Schedule

FLEET TYPE	AVAILABLE NUMBER OF BUSES	NUMBER OF ASSIGNED BUSES	ASSIGNMENT RATE	ASSIGNED TRIPS
1	10	8	80 %	f3,f6,f7,f8,f16,f18,f19,f23
2	8	8	100 %	f4,f5,f9,f10,f12,f15,f17,f20
3	4	4	100 %	f14,f21,f22,f24
4	4	4	100 %	f1,f2,f11,f13
5	1	0	0 %	-

The implementation results showed that the operational constraints were satisfied, and the total number of fleet types to cover the whole schedule was 4 with the optimal assignment policy. This means that a substantial saving of 11 % in the total number of needed buses. Even though fleet type 1 has a great number of buses among the other types, its assignment rate is 80 %. On the other hand, fleet type 5 was not assigned to any bus trip. It can be explained by the cost of the bus type which is higher than the other fleet types. The presented fleet assignment model can help the company to improve the quality of decisions to match bus-fleet-trip. Decision makers can also be use the mathematical model with expert systems and multi-objective approaches to implement the most profitable results in a dynamic environment.

CONCLUSION

In recent years, a growing amount of literature has been produced dealing with passenger transport. In this paper, we studied the fleet assignment problem with a fixed schedule. We conducted a case study using real operating data from an inter-city bus company in Turkey. A mathematical model was proposed to assign fleet types on several bus trips so that the total travel cost is minimized while satisfying practical constraints for a given bus schedule. The problem is formulated as an integer programming model and solved using LINGO software. The model will help the company to choose an appropriate alternative for periodic fleet assignment in order to construct a flexible inter-city bus transportation network with assigned buses. As a future research, we plan to extend the mathematical model to take into account uncertain passenger demands as an external input, which can be described by imprecise expressions.

REFERENCES

[1] Hane, C.A., Barnhart, C., Johnson, E.L., Marsten, R.E., Nemhauser, G.L., Sigismondi, G., 1995, "The fleet assignment problem: Solving a large-scale integer program", Mathematical Programming 70, 211–232.

[2] Pollack, M., 1977, "Some elements of the airline fleet planning problem", Transportation Research Volume 11, Issue 5, 301-310.

[3] Abara, J., 1989, "Applying integer linear programming to the fleet assignment problem", Interfaces 19 (4), 20–28.

[4] Rushmeier, R.A., Kontogiorgis, S.A., 1997, "Advances in the optimization of airline fleet assignment", Transportation Science, 31, 159–169.

[5] Barnhart, C., Kniker, T.S., Lohatepanont, M., 2002, "Itinerary-based airline fleet assignment", Transportation Science, 36, 199–217.

[6] Ioachim I., Desrosiers J., Soumis F., Belanger N., 1999, "Fleet assignment and routing with schedule synchronization constraints", European Journal of Operational Research, 119, 75–90.

[7] Sherali, H.D., Bish E.K., Zhu X.,2006, "Airline fleet assignment concepts, models, and algorithms", European Journal of Operational Research, 172 ,1–30.

[8] Salzborn, F.J.M., 1980, "Scheduling Bus Systems with Interchanges", Transportation Science, 14, No 3. 211-231.

[9] Yan S., Chen H., 2002, "A scheduling model and a solution algorithm for inter-city bus carriers", Transportation Research, Part A, 36, 805–825.

[10] Yan S., Chi C., Tang C., 2006, "Inter-city bus routing and timetable setting under stochastic demands", Transportation Research, Part A, 40, 572–586.

[11] Yan S., Tang C., 2009, "Inter-city bus scheduling under variable market share and uncertain market demands", Omega, 37, 178 – 192.

[12] Hasan M.K., Hammad A.A., 2010, “Intercity Bus Scheduling for the Saudi Public Transport Company to Maximize Profit and Yield Additional Revenue” J. Service Science & Management, 3, 373-382.
[13] Matta R., Peters E., 2009,”Developing work schedules for an inter-city transit system with multiple driver types and fleet types”, European Journal of Operational Research, 192, 852–865.

CITY LOGISTICS APPLICATIONS, STRATEGIES AND CHALLENGES: A CASE STUDY for İZMİR

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Abstract — *City logistics is a process in which individual enterprises optimize regional logistics and transport behaviour considering traffic congestion, environment, energy consumption and other factors which are placed under the framework of market economy. The main aim of the study is to provide a detailed literature review on city logistics and to investigate the case of Izmir city by considering the main factors affecting the city logistics applications. This paper is in qualitative nature including a detailed literature review on city logistics and the second part of the study presents the findings of the semi-structured interviews conducted with the representatives such as Izmir Metropolitan Municipality and important logistics service providers regarding the city logistics applications in Izmir. Since city logistics concept is rather new in the literature as well as the applications in specific cities in Turkey, it is believed that this study will provide a starting point in analysing an overall evaluation of the relevant parties involved in city logistics by discussing city-specific variables.*

Key Words —*city logistics, Izmir, interview, municipal management*

INTRODUCTION

In recent years, along with the rapid development of city logistics, increasing investments to the environment, reinforcing the competiveness of the urban economy and optimizing the economic structure for the modern logistics became crucial terms. Furthermore, because of being essential part in the name of national economy and the most economic mode of service in the process of industrialization, the logistics sector is growing continuously on a global scale [3].

City logistics is a process in which individual enterprise optimizes regional logistics and transport behavior considering traffic congestion, environment, energy consumption and other factors which are placed under the framework of market economy. It deals with the distribution in urban areas with the aim of improvement of efficiency of transportation, reducing the traffic congestion and mitigating the environmental effects. In addition, it has more complex processes than enterprise logistics and applies, focuses public environment, passenger transportation, consumers, logistics facilities, related policies within the borders of a city. Besides, larger scale causes requirement of the complex operations and various type of problems. In the terms of research, city logistics is a new field brought by the moving growing quantities of transportation within metropolitan areas. Because of the much of the activities take place in the close to major transportation terminals such as ports and rail yards, cities have always been crucial for both producers and consumers of transportation activities [11.]

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LITERATURE REVIEW

City Logistics and Urban Freight Distribution

A city does not only receive the goods, but also delivers them. The movement of people, goods, information within the local metropolitan area is critically important to the functioning of the cities. Moreover city logistics activities comprise a wide range of travel modes with considerable variation in technology, cost, operating characteristics, geographical extent, market share and the socioeconomic makeup of their riders [6]. With the experimental programs, networking activities, national urban freight programs by the support of the European Union, the research results are most developed in Europe.

There are hundreds of supply chains, one for each economic sector within the framework of a city. Freights can be provided via the private carriage where the delivery is performed by the manufacturer's own employees or by the independent carriers which have their own fleets. These two types of services provide transportation in equal amounts in a typical European city. On the other hand, in the developing countries, the private carriage is more dominant. Transportation strategies are mainly depended on local economic, geographic, and cultural characteristics. Since the cities have various types of built environment, their logistics and freight activities changed. For instance, Chicago maintains its role as the major rail hub for the North America. On the other hand Los Angeles primarily focuses on the integration of the truck operations with the ports of Long Beach and Los Angeles after the negative effects of air pollution. Urban freight distribution systems contain various types of supply chains which depend on urban settings, structure, characteristics [1].

Independent Retailing performs wide range of retailing activities which mainly contains single stores. Moreover, it also carries out the informal activities to the contacts such as street stalls. The stores mainly do not have receiving facilities; as a result of this if the storefront parking area is not available the delivery trucks often tend to double parking.

In contrast to the independent retailing Chain Retailing focuses larger shops such as ''Big Box ''stores where tend to be placed in suburban locations. By the effect of this customers and larger delivery trucks can

find parking area for themselves. Especially shopping malls are organized along this paradigm. This provides the consolidated transportation especially when the part of the large chain has its own distribution centers. Food Deliveries concern the transportation of the perishable goods with usage of specialized supply chains. This distribution system maintains the thermal integrity of the shipments via the cold chain logistics. Restaurants, grocery stores are the mainly locations to supply. Especially the fast-food restaurants rely heavily on this system. Furthermore, outdoor and central markets are essentially important as they performs the supplying the fresh foods for the urban population in developing countries.

Because of the slight improvements in the commercial life, the movement of parcels has increased on par with the companies specialized in these freight distribution services. UPS, DHL, TNT, FedEx are today's popular firms of these processes and they act as delivery integrators with the combination and decomposition of the shipments. These processes start and end with the trucks such as vans or mid-sized trucks. Moreover operations proceed via the networks which are designed for the strategically located distribution centers. In addition, the international processes are generally performed by the parent companies which are called as air freight integrators.

Continuous restoration and repair of the urban framework always requires the supplying of the related materials in construction sites. Various contractors and freight flows are involved depending on the stage of the construction process. These supply chains contain the shipment of large volumes because of their tonnages. As a result, the operations are performed by the heavy trucks which create local congestion.

Garbage Collection and Disposal activities can be also placed in the recycling operations and it concerns the waste logistics, collection, disposal of the wastes which are generated by the daily urban activities.

Trucks and Vans are one the most used instrument during the urban freights all around the world. Findings indicate that the ratio of the requirement of the trucks decreases when the city size rises. This result supports the idea that very large cities are more efficient in terms of urban freight delivery. A European city generates about 1 delivery or pick-up per job per week, 300 to 400 truck trips per 1000 people per day and 30 to 50 tons of goods per person per year. In less developed countries, rural migration and population growth have led to very rapid urbanization, while the public supply of infrastructure and transport services has lagged behind

Stakeholders in the City Logistics

In the structure of the urban freight transport there are several types of parties, stakeholders who take active roles. They have their own objectives and thus behave to reach these aims. Stakeholders in city logistics can be divided as; freight Carriers, shippers, residents, administrator and urban expressway operators. The stakeholders in the system interact each other during the operations. All their decisions, strategies affect each other and return them to as a result. For instance, if the freight carriers transports late, the shippers can charge delay penalty and increase the delay penalty for the subsequent delivery. Also if the trucks of the freight carriers evacuate NOx and its emissions exceed predefined limit the residents make complaint against to administrators. In the terms of objectives the freight carriers aim to increase profit with the reduction of the transportation costs. Shippers share the same objective with freight carriers however they try to pay the operational costs which are occurred by the performance of the freight carriers. On the other hand residents want to live in desired environment with the reduction of negative impacts on the living environment from the traffic while the administrators aim to revitalization of the city. Because of the objectives of the all stakeholders in the cities all the members of the system interacts and make decisions which affect directly or indirectly to other parties in the chain [9]

Environmental Effects of City Logistics

Because of the various types of reasons urban freight distribution tends to more pollution than long distance freight transport. Before everything, on the average the urban transportation vehicles are older. Trucks' life ends during the drayage operations between port or terminals and urban distribution centers. Moreover, it is estimated that the average speed of the urban transportation vehicles 75 km per hour and it is slower in the comparison to the long distance freight transport operators. The main reasons are the traffic congestion and restrictions. Constant acceleration and deceleration and vehicle idling are results of the same reasons and the density of the delivery points and traffic lights in the lines of city. The urban transportation is a one of the big reason for the NOx emissions in the larger countries of Europe. In addition to these, the noise pollution, greenhouse gas emissions are the other serious environmental effects of urban transportation. In Dijon, France, freight transport consumes 26% of the total road traffic-related TOE Along with this, according to the calculations, during the morning rush hour in Bordeaux, France, freight transport traffic added five decibels (dB (A)) to the noise from the circulation of private cars [6].

The vehicles used during the city logistics operations can be considerably old. In 2004 in Dublin, a fourth of all vehicles were performing from the 1994 when the only 15% of vehicles were just active since a year or less. Besides 40% circulating vehicles in Milan are more than 10 years old. Additionally, road safety is another crucial term for the environmental effects of urban transportation. Although the trucks cause the small share of accidents in cities the results are serious. In 2005 approximately 14% of collisions resulted in serious damages on London roads. Afterwards these events, the policy for the increasing the bicycle usage was made.

Key Challenges in City Logistics

Along with the supply chain management, city logistics requires the understanding of urban geography as well. There are several types of challenges which occur during the city logistics activities and causes deceleration of operations or other negative results.

Congestion is a challenge frequently appears during the operations. Especially in the peak hours, road infrastructures in urban areas are commonly congested. Also repetitiveness is a considerable issue as a regular flow of deliveries must be maintained in spite of peak hour congestion, and therefore many freight distribution activities should be realized during the night if possible.

Because of the largest density of the population the passengers movements, urban areas became primary dimension for commuting and peak hours. Also the freight operations and passenger movements do not mingle effectively. The peak hours especially commuting causes problems to freight operations

Parking is the one of the famous problems especially in the framework of the city structure. Many facilities, stores have limited space and capacity for the parking in the high density areas. As a result of this, the intending for the usage of smaller cars may decrease the rates of this problematic situation.

Because of the real estate is at a premium in urban areas, stores tend to have limited warehousing space and are of smaller size in the name of efficiency. As a result of this cargo load contradiction occurs within the borders of city. Also Urban freight distribution concerns the smaller volumes with time-sensitive operations which is necessary to replenish a constant demand without any delays or waste. As a result of this, the requirement of high frequency of deliveries with the consideration of high sales volumes occurs. Naturally stores, facilities in central areas would benefit from the economies of scale by the results of the larger deliveries however the design and framework of the city does not permit this advantage. This is the essential result of the why retailing sectors often establish in suburban areas.

The movement of the goods in the lines of the urban area is mainly decided by the characteristics of the Land usage. Besides the deliveries to industrial, commercial and logistics facilities depend on the number of vehicle-kilometers particularly when the supplying the stores, industries and households [8]

TABLE 1
Main Issues and Challenges in the City Logistics System

Issues	Challenges
Freight Volumes	Capacity of urban freight transport systems (congestion) Lower driving speeds and frequent disruptions (reliability) Passengers / Freight Interferences (conflicts) Distribution sprawl (space consumption)
Nature or Freight Distribution	Frequency and repetitiveness Cold chain (shipment integrity) E-commerce (home deliveries)
Environmental Issues	Mitigate environmental externalities (emissions, noise) Waste and recycling
Policy and Regulation	Access and zoning Land use, freight distribution clusters

Source: [8]

Because of the cities are the large consumers of the final products, the reverse logistics operations require to be focused more day by day in order to collection of wastes and recycling processes. Growth in the home deliveries of parcels which emerged from the development of e-commerce also provided both efficiency and effectiveness. The operations can be provided via the home delivery trucks in a line instead of the customer visits [8].

City Logistics in the world

In Europe 80% of the people live in urban environment. Public transport, cars, cyclists and pedestrians all share the same infrastructure within the city logistics activities. Also urban transport accounts for 40% of CO2 emissions of road transport and up to 70% of other pollutants from transport. Today, Cities such as London, Stockholm, Athens, Kaunas, Gdynia and others have active sustainable mobility policies in place as an alternative to trucks. In comparison to the countries in Europe, Germany is the leader in the rates of auto car per person.

Generally EU aims to integrate the needs of environment and transportation policies. With this, dated in 6th October 1999 by the Council of Europe’s report contains strategies for achieving this goal. According to this strategy, the incentive for usage of the transportation modes which are much more environmental friendly in the operations of the Multimodal, Bulk and Integrated logistics operations are provided. Also the research for the applications which provide to decrease of the CO2 emission and to make every parties conscious in order to decrease of the negative side effects of the transportation activities are proceeded. According to the researches for the dispersion of the vehicle types used among the countries, the usage rate of green transportation vehicles emerge and increase from the developing countries to developed countries. And, because of the most developed researches and policies made in Europe, the European cities are in the leader position in the green logistics rates. On the other hand in the US the Australia the private ownership of the motor vehicles is considerably in the higher levels in comparison to other countries however their public transportation services are few. Furthermore, in the terms of usage of pedestrian China is the leader country around the world. [1]

Hub Logistics System

Hub or link mainly refers to passenger traffics, logistics activities, capital flow, information flow and the other economic entities which are placed within the city itself. In the name of promoting and regional development, functions of hub city play crucial role. Furthermore, they are integrated into regional economic centers. Consequentially, it is the regional logistics hub of the control points, and its own logistics system capacity which determine the level of development of the regional logistics. According to well-known scholar at Harvard University Porter (2002), functions between the competition in cities, countries and regions which are factors for competitive advantage are for the production factors, demand conditions, related and supporting industries, and enterprises strategy to evaluate the quality of competition. Also the government role has crucial importance along with the stated factors.

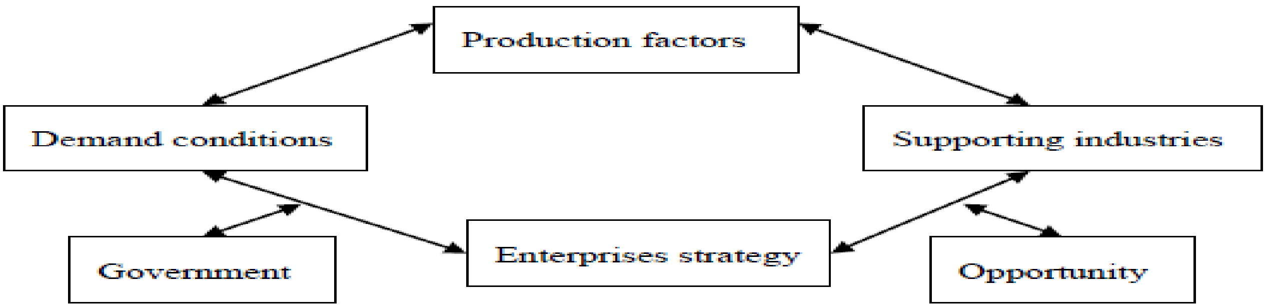

FIGURE 1
Diamond Model
Source: [10]

Logistics is a dynamic term and wide production, service factor which has continuously changing factors around it. As a result of this, it contains the human, technical, infrastructure elements and uses, integrates them. The development of the logistics industry depends on the 3 essential of the flows of logistics and scope of the regulations. Nodes are the basic entities of the logistics and which are the basic hardware platform of city logistics. Also they contain broad input which directly determines the level of city logistics.

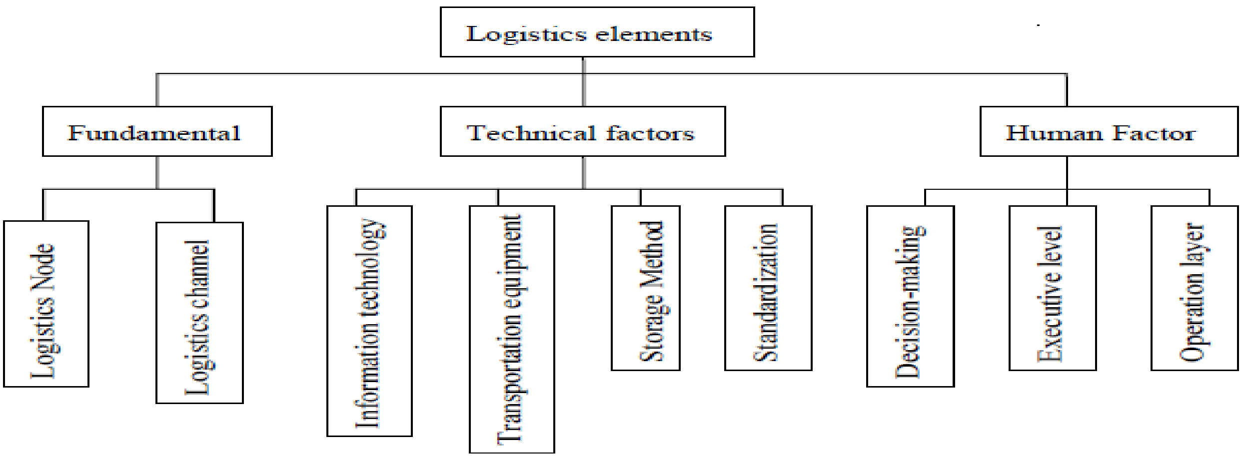

FIGURE 2
Logistics Elements

Source: [10]

Before everything, logistics progresses must focus on the changes in the production and consumption. Also Logistics node processes must rely on the city's integrated networks. The factors in the traffic control also affect the layout of the nodes and logistics lines. Furthermore logistics node location should be chosen in a point where meet the ecological city planning and environmental requirements of life.

City Logistics in Metropolis

Metropolis is the heart of local, national, even global economy. It has the densest population and the most centralized business activities. To satisfy the demand of daily life and business in metropolis, large amounts of goods flow in and out city every day. Such continuous goods flow keeps city prosperous. So, the efficiency of urban logistic delivery determines the economic competence of one city [7].

With the development of the economy and the e-commerce, home deliveries became essential part of the commerce life. Home delivery related e-commerce attracts customers and investments day-by-day. As a result, these two concepts can be considered as the crucial aspects in order to measure the efficiency of city logistics activities. As distinct from the agricultural and industrial logistics, operation times of city logistics proceed in hours even minutes. It is very clear to see that the traffic congestion is one of the most problematic factors of the life in metropolis. Also Off-peak freight and night-time delivery may avoid the negative effects of it however the term of flexibility is crucial for the today's logistics sector and fixed hours causes the stop of development the systems rely on demand. Today, many researchers and the parties in the logistics sector support the idea of construction of Underground Logistics System (ULS). It can help to solve problems of the city logistics, congestion, pollution however its high costs and inconvenient construction conditions prevent to establish. Today, urban rail transit is just be considered as the most convenient and economical system of passenger transport. Along with this, the rail transit is stable and fast, and its network almost covers every corner in city, thus passengers can rapidly reach their destination by taking urban railway train. Furthermore, rail transit is very crucial mode for green logistics because it has no negative effects on environment. Researches reveal that these characteristics meet the needs of an ideal city logistics system

Liu et al. (2008) emphasize that the Urban Rail Transit Based Logistics System will be the ideal model for city logistics. Before establishing this system essential criteria must be considered. First of all, the independent system on railways must be provided. As a result of this, system will avoid the negative effects of bad weather conditions or congestion. Also the stations and dense distribution of lines must be constructed in order to decrease the distance between customers and system.

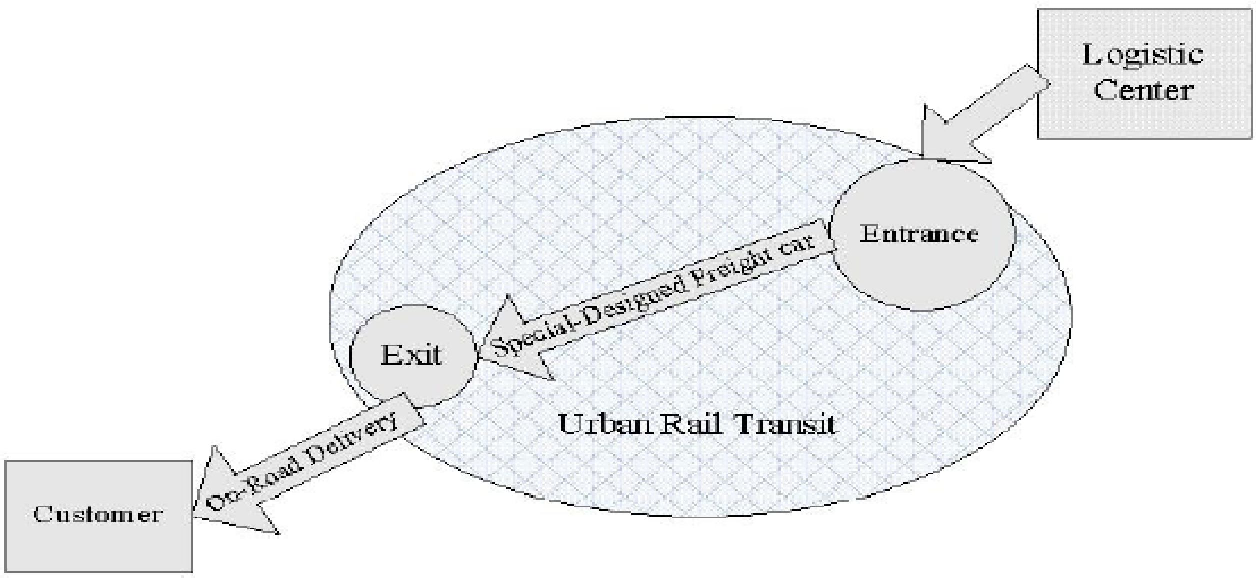

FIGURE 3
Outline of URTBCLS

Source: [7]

Along with these criteria, the electricity driven train which has no pollution effect must be used during the operations in the name of green logistics. Eventually the optimum frequency rate for services should be applied in order to meet the demand of the passengers, customers.

METHODOLOGY

The methodology of the research can be divided into two parts. The first step was literature review which was also used in order to provide a point of view and better understanding about the city logistics in wide aspects. During this part, many of the articles and publications were reviewed. Afterwards the related data obtained by the literature review, the questions were generated for the semi-structured interviews. The main aim of the interview is to obtain better understanding of the relationships and view of stakeholders in the system, the main challenges, and problematic situations in the city logistics activities of Izmir. All the questions in practice were adapted according to the related parties. The first step of the semi-structured interviews were conducted with Izmir Metropolitan Municipality representatives as; one headmaster of transportation and planning, one headmaster of transportation and coordination, one administrator of signalization, one city planner and the engineers, team members who work for the projects of directorate of public transportation services. The average experience rate of the participants was calculated as 7 in the terms of years. In the following step, the view and relationship of the three important logistics service providers of the Izmir are questioned with the same method. The companies were international operators, freight forwarders and well known companies not only in the Izmir but also in Europe as well. The first representative for the companies was a CEO of well known international logistics service provider who was also one of the initial members of both UND in Turkey and Chamber of Commerce of the Izmir. The other participants of the service providers were three customer representatives, one truck supply expert and two operation executives. Their average experience rate was calculated as approximately 12 years. In the name of the better understanding not only the service providers were questioned but also the service user companies were questioned as well. Three experts from the one of the important plastic trade company in Izmir which has the biggest factory in the Cigli Ataturk Organized Industry were also interviewed. The representatives included one sales key account manager and two employees who work in procurement department. In the last step of the interviews twenty residents who were randomly selected from the different occupational clusters in different locations of Izmir were also questioned in order to complete and generate the map of the stakeholder relationship in the city logistics activities in Izmir

During the interviews two main questions were asked and the relationship between the parties was analyzed. In the first step the main challenge which prevents development of the city logistics activities of Izmir was considered. In the second part the main question was which city logistics factor should be focused in order to develop of Izmir's transportation activities. The maximum time was defined twenty minutes per interview and none of them passed the limit.

Characteristics of Izmir

Izmir is the third biggest city of Turkey and has many functions over the commerce, industry and logistics. The surface area is 11,973 Km^2 and its population is approximately 3.8 million. Significant part of the international trade activities are performed via the Alsancak port where is the one of most important location for container shipment in the name of Turkey. The %91 export processes are made by this port and it is located at the convenient point where is close to the Adnan Menderes Air port and Aegean free trade zone. According to the last variables of 2010, Izmir constitutes of the % 14 export rates and %11 import rate of the Turkey. There are 291 international transportation approximately 1700 inland transportation companies in Izmir. Also all the custom agency companies are placed near to the Alsancak Port. Metro services proceed via the railway line which its length is 11.6 km. On the other passengers can use train which its line reaches the 80km and passes the different side of the city. All these activities such as the bus services, ferry routes, train and metro services are maintained by the Izmir Metropolitan Municipality. The passenger transportation, traffic control, design of the networks, control and the other crucial activities are performed by related

Municipal. As it is well known, there is a tolerably relationship between the development of city, congestion and its systems. Besides, public transportation system performs effectively only on the intense and developing areas which focus on the city passages. In this respect Izmir has these types of areas where are upon the measurement criteria of the world. Along with this, the environmental factors, pollution, noise nuisance are the important terms to be considered for the development of city logistics. In the current situation, researchers agreed and confirmed that there is an air pollution in critical levels which lies especially from Bornova to Alsancak. It is caused by the mainly of industrial factors and sulfur dioxide also partied are observed. Moreover in the same lines, there is also serious NOx emission which is occurred by the transportation activities. Furthermore the structural adjustment of a city and the application of the design plans made by the city planners play crucial role in the transportation activities. Designs vary upon the characteristics of the countries. For instance in a typical European country the compact model is usually used and it focuses the city activities around the city center. In contrast to this, in the US and Australia the cities are usually designed according to the sprawl model which aims to high level of ownership of motor vehicles. The planners made a 'north and south linear design' for the Izmir which lies between Menemen and Cumaovasi [4]

FINDINGS

The Analysis of the Interviews with the Representatives of the Izmir Metropolitan Municipality

According to the answers of the interviews, 7 representatives of the Izmir Metropolitan Municipality emphasized that the main challenge is parking problems which slowdowns the development of the Izmir's city logistics activities. This problematic situation was also examined during the literature review and it was observed as the one of the general challenge around the world. On the other side 6 participants answered the question as the current situation of Alsancak Port. According to them the main reasons of this, the location of Alsancak port, need of restoration and cost of non-use of some parts. Moreover Izmir Metropolitan Municipality never uses optimization routing for the design of the roadways. They claim that, the infrastructure of the city is already constructed and it is not needed. Also if there is any problematic situation, the underpass or overpass will be built at the appropriate point. In the second question, 8 participants pointed out the importance of the environmental policies and they claimed these as the first thing to be considered in order to provide development of the Izmir city activities. Also they said that the emissions, noises pollution should be prevented and usage of the electricity driven vehicles in the future will be solution of these problems. Two respondents remarked the construction of the nuclear power plant in a right location of Turkey to provide enough electricity. In their future plans, Izmir Metropolitan Municipality aims to regenerate the boats and ferries in order to decrease the transportation times for passengers. More over they also believe the parking problem can be only solved by the incentives for the usages of public transportation systems. Because of this the integration between the ferry-bridge, bus stops, and train station should be provided as possible as can.

The Analyses of the Interviews with Logistics Service Providers

5 representatives of the companies emphasized that employees should use public transportation or companies should provide services in order to prevent to traffic congestion in specific times. And other two of them indicate the obligation of the operation hours for the trucks. The real challenges of the Izmir city logistics activities are defined in various types of answers. But their common point shows the necessity of the integration especially of a Logistics Village. All of the participators strongly emphasized that there is no enough establishment, infrastructure. They also believed the restriction of the operation hours is not a solution but it is just the undermining the economic improvement. 4 Of the experts showed Cesme as the example in order to reinforce their idea. In this lines even though there are more than 250 thousand people in the city there is no any congestion because of the design of the whole structure. They also specified the non-existence of the same design in Izmir and they believe its necessity. Other representatives indicated the location of Izmir Alsancak Port, UND and UKAT areas for Truck operations slow down the operations and cause the congestion in Alsancak.

The analyses of the Interviews with Logistics Service Users

Similarly 3 of the experts gave the same results with the logistics service provider representatives. According to all of them there is a lack of design and infrastructure for the logistics operations. They believe integration with the logistics activities and the separation of the networks from the city center to extern area should be made by the Izmir Metropolitan Municipality. Moreover they indicate that there should be railway system which provides transit pass to multimodal systems and integrated with the factories between logistics providers.

The analyses of the Interviews with Residents

During the interviews with 5 participators told their complaints about the problems of the signalization. In the terms of depth details, they appear the results of the too many traffic control lights or the wrong signal times. When the city grows the traffic intensity also increases. As a result of this in some area the signal changes according to their time should be changed and controlled by the Izmir Metropolitan Municipality. 7 of the resident emphasized the lack of the metro and train networks. More over they also said their operation schedules are not accurate, and never arrives or leaves the specified time. The rest 5 respondent believes the main problems are caused by the drivers and the solution can only be obtained by the improvements in the education. And the 3 residents believe that parking problems are the primary challenge for the Izmir's city logistics activities.

Discussion of the Findings

After the all the interviews are conducted the relationships between the stakeholders are obtained and the real challenges which slow down the city logistics activities of Izmir are analyzed. Figure 4 indicates the dispersion of the respondents in amounts according to their answers for the main reason of the challenges in the city logistics activities of the Izmir and it contains the all 6 main challenges which were obtained by the results of the interviews. Although residents and Izmir Metropolitan Municipality representatives answered the questions in various types the user and provider companies reached consensus. According the firms' experts the main problem affects the development of the city logistics activities is lack of design in the system. This situation is also related to integration necessity between the system parties. The remaining part of the interviews provider companies' respondents referred the current situation of Alsancak Port as well but they focused the main problem in big picture and they stated it is just one of the steps which should be taken in the solutions

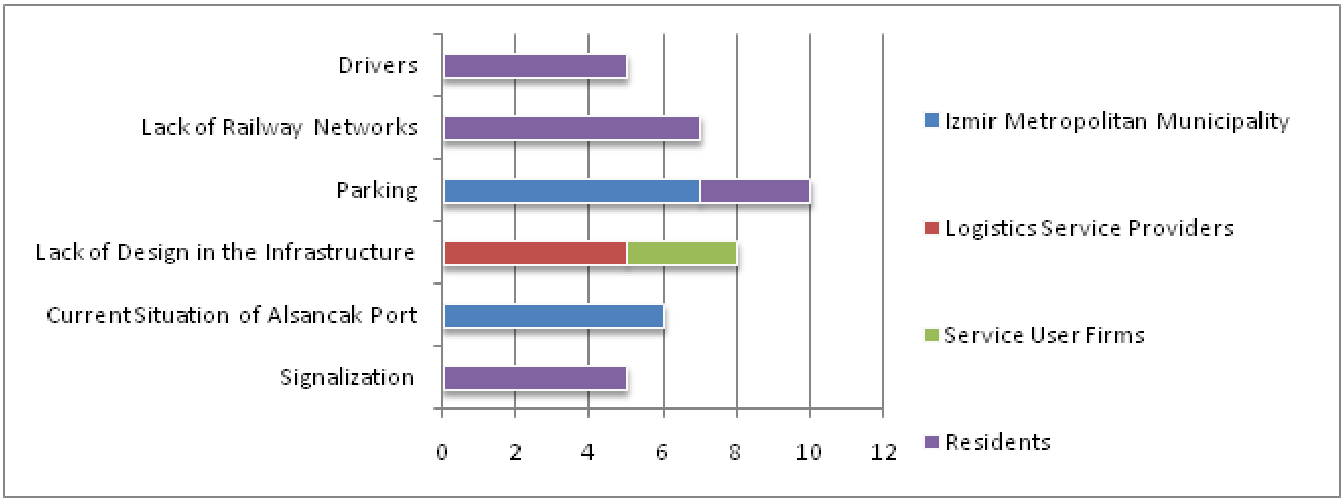

FIGURE 4
The Dispersion of the respondents to their answers for the first main question
(Authors)

On the other hand 6 of the participator from the Metropolitan Municipality approach the related circumstance as a primary concern. However 7 of them emphasized parking problems is crucial factor to be considered before the others. Furthermore most of residents believe that train and metro systems requires new network system and stations. Along with this, the inaccuracies in the operation schedules which cause to deceleration of the passenger transportation are also analyzed. Besides 5 of the residents are complainant for the signalization and the lack of the traffic design especially for the traffic lights. This problematic situation has negative side effects for both drivers and passengers. In the full participation the percentages for the 6 major challenges to affect the development of the Izmir's city logistics activities are stated in the figure 5.

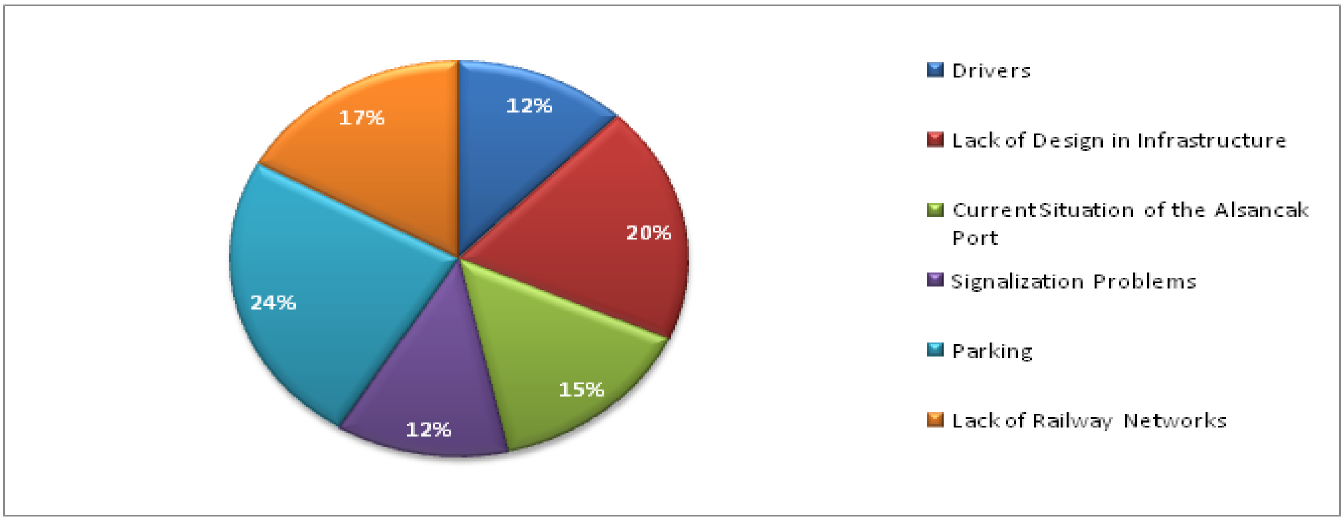

FIGURE 5
The Percentages of the 6 Main Challenges to Affect the City Logistics Activities of the Izmir
(Authors)

Generally there is no significant difference between most of the factors. However parking problem percentage is 2 times bigger than both signalization and drivers caused negative situations. At the same time it is one of the crucial factors which were analyzed in our literature review as well. Most of the Izmir Metropolitan Municipality believes that this problematic circumstance's negative effect can be decreased by the incentives to usage of the passenger transportation. In order to achieve this integration between the passenger transportation should be provided in the optimum points, locations. However the solutions for this challenge which are lack of design in the infrastructure and railway networks follow it as queued problematic situations. All the main demands of the stakeholders and the relationships within the city logistics activities are generated and shown in figure 6.

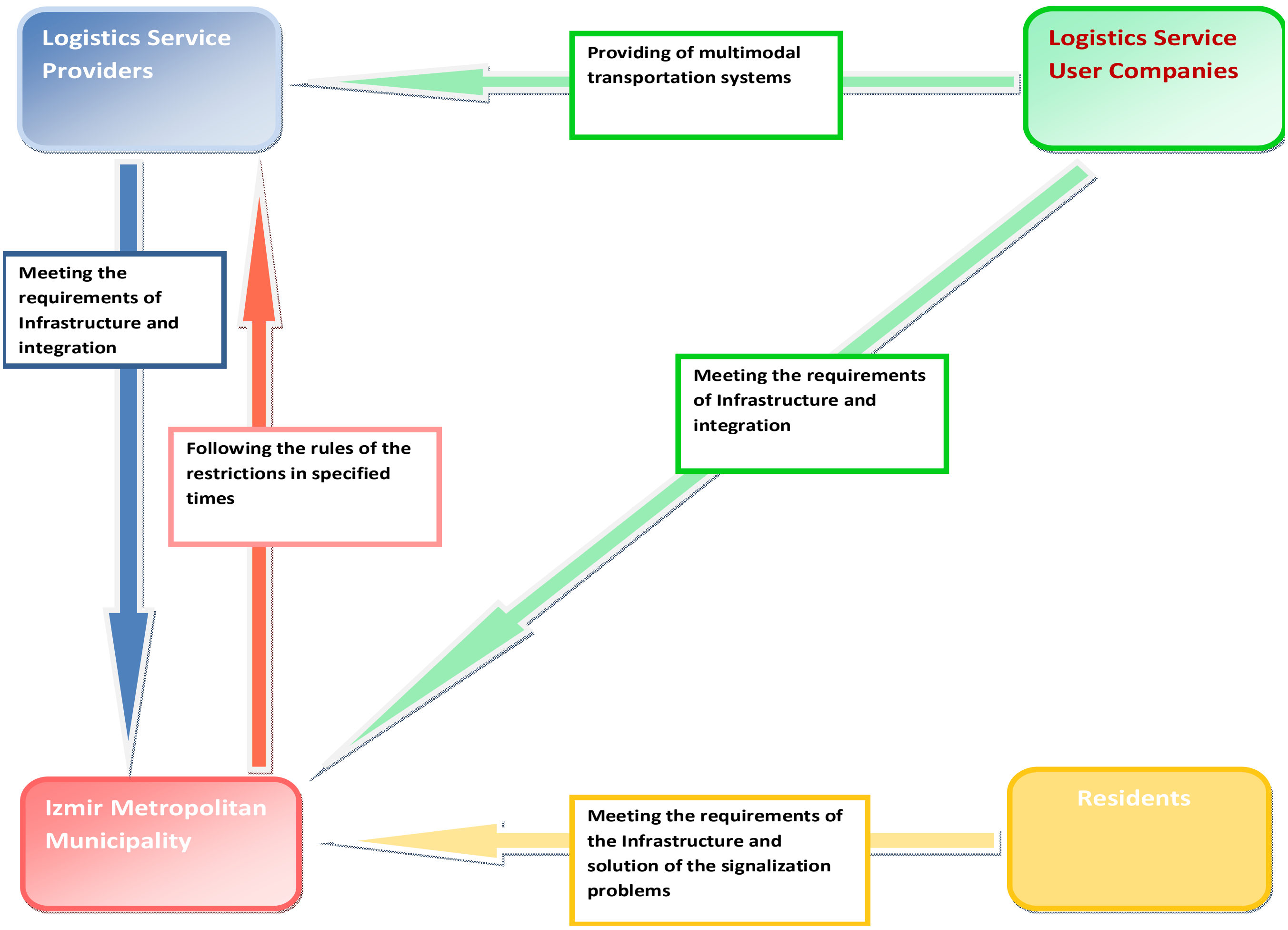

FIGURE 6
Demand Relationship of the Stakeholders in City Logistics Activities of Izmir
(Authors)

According the interview findings, three stakeholders demand and emphasize the integration of the transportation activities from the Izmir Metropolitan Municipality. It is completely design related situation and firm representatives mostly indicate the establishment of the Logistics village. With this, they strongly believe producers and the transportation companies should be close to each other as possible as they can with combined transportation systems. More over experts state that companies are ready to invest but they want the related support and permission from the Izmir Metropolitan Municipality. As a result companies believe the challenges will considerably reduce in the whole system if the required steps are taken by the Metropolitan Municipality in order to carry the logistics activities to external area from the passenger transportation and the city center. On the other hand the necessity of the educational activities, control of the location, amount and the signalization problems of the traffic lights are specified by the residents. In addition to this the lack of railway networks in the metro and train route are also referred. Afterwards the examination of results, 18 participators of the whole 41 emphasized the necessity of design and integration. Especially the logistics provider and the user companies in Izmir indicate the importance of integrated transportation activities and demand the separation of networks from the intense city centre.

CONCLUSION AND SUGGESTIONS

The main aim of the study is to provide a point of view and better understanding about the city logistics. On the other hand during the research period the challenges and the points must be considered within the city logistics activities of Izmir were questioned. City logistics is a process in which individual enterprise optimizes regional logistics and transport behavior considering traffic congestion, environment, energy consumption and other factors which are placed under the framework of market economy. During these activities the stakeholders, parties in the network try to find efficient way for themselves. There are various types of challenges in the structure of the city logistics. They are mainly; congestion, parking, commuting and peak Hours, cargo load contradiction, and land usage. Along with these, due to being environmental friendly, the usage of the electricity driven trains are suggested by the researchers and urban rail transit based logistics system is generated in theory. When the main policies through the city logistics activities are examined, pollution is the first issue considered by the Europe. In terms of the methodology, the semi-structured interviews were conducted with the participants from the various types of departments within Izmir Metropolitan Municipality, logistics service providers, transportation activity user companies and the residents. After the interviews it is specified that the main challenge is parking problem which slowdowns the Izmir's city logistics activities. Also it is stated that the environmental policies are the first concern which should be considered in the name of development the Izmir's city logistics processes. On the other hand the rest of the stakeholders emphasize the requirement of the strong framework for both logistics operations and public transportation. Companies see the restrictions as the undermining the economical development. Also they indicate that in order to provide better logistics activities there should be high level of integration and logistics village in the future. Furthermore it is an interesting point even the residents advocates many different points no one of them concerned the environmental problems

This research completed the in the limited time and began with the exploratory methods. As a result of this, research can be taken a step further with the enough time and it can be reinforced with the quantitative data and new research methods.

REFERENCES

[1] Benk, S., 2007. ‘‘Kentiçin Ulaşım Sonucu Oluşan Negatif Dışsallıklar ve Önleme Yolları’’, Ünal Aysal Tez Değerlendirme Yarışma Dizisi İstanbul 2007, 84-87

[2] Cui, L., Zhang,H. and He, M., 2010. ‘‘Economic Factors Influencing City Logistics Demand in China’’, ICLEM 2010: Logistics for Sustained Economic Development, 4133

[3] Duan, A.Ş, Yang, J. and Deng, M., 2008. ‘‘The Research on the Organization Mode of Urban Rapid Logistics Transport System's Cooperative Development’’, 2008 International Seminar on Future Information Technology and Management Engineering, 1-4

[4] Duvarcı, Y., Selvi, Ö., Günaydın, H., M., and Gür, G., 2008. ‘‘İzmir'deki Ulaştırma Projelerinin Kentsel Eğilimlere Etkileri’’, İMO Teknik Dergi, 2008 4293-4318,

[5] Grant, D.,B, 2004. ‘‘UK and US Management Styles in Logistics: Different Strokes for Different Folks?’’, International Journal of Logistics: Research and Applications, Vol. 7, No. 3

[6] Hanson, S. and Giulano, G., 2004. ‘‘The geography of urban transportation’’, the Guilford press New York London third edition 2004, 59-84

[7] Liu, Y., He, K., Liu, J. and, Xu, Y., 2009. ‘‘Analysis of the Concept of Urban Rail Transit Based City Logistics System’’, International Conference on Smart Manufacturing Application April. 9-11 2008, 1-5

[8] Rodrigue, j., P., Comtois, C. and Slack, B., 2009. ‘‘The Geography of Transport Systems’’, Routledge May 18th 2009, 240-360

[9] Taniguchi, E. and Tamagawa, D., 2005. ‘‘Evaluating City Logistics Measures Considering the Behavior of Several Stakeholders’’, Journal of the Eastern Asia Society for Transportation Studies, Vol. 6, pp. 3062 – 3076

[10] Zhang, P. and Xie, F., 2010. ‘‘Evaluation Index System of the Hub City Logistics System Layout’’, ICLEM 2010 Logistics for Sustained Economic Development, 3933

[11] Zhang, Q. and Wu, Y., 2009. ‘‘Research on the City Logistics Development Evaluation System Based on Fuzzy Mathematics’’, IEEE January 2009, 4244-4639

TRANSPORT SAFETY AND THE IMPLICATIONS OF TURKISH TRANSPORTATION INDUSTRY

Ali Özgür Karagülle[1],Didem Büyükarslan[2]

ABSTRACT

Transport safety, is an important headline in the European Union's agenda. Laws and regulations, regarding to transportation, compose the 10 percent of the EU legislation system. This situation closely related to the economic importance of the transportation for the Union which accounts for 10 percent of GDP and 30 percent of the total amount of investments. Because of the multinational structure of the Union, it has to cope with different kind of problems related to safety issues. Not just the specific measures tailored for transportation modes but also a more comprehensive system ought to be applied. Supranational structure of European Union brings along the need for cooperation and institutional governance. This paper examines the policies attached to transport safety issues and their reflections on Turkey. In addition to state level policies, implications and development tools for corporate will be studied. As a candidate country, EU strategies are vital for Turkey, especially in cases where long-term respond for harmony is inevitable. Therefore this study analyses the perceptions of the EU countries about the transport safety issues and the current position of Turkey.

Keywords- transport safety, road safety, transportation management, transportation policy

INTRODUCTION

Globalization practices create interdependency between transportation dynamics and state authorities. Transportation refers more than of goods and people. In this developing process, sustainability is one of the most important factors that need further consideration. Creating sustainable transportation systems brings along the increased safety levels. As one of the state based services, transportation safety is promoted by public organizations that work closely with private sector as well in order to set efficient measures and effective improvements. Besides, transportation and its sustainability are important for economical unions.

Transportation safety has its own components which are individuals, vehicles, infrastructure and processes. Therefore, targets for improving safety are based upon these components. Considering the individuals as a component of transportation safety, raising the consciousness emerges as a component of transportation safety, raising the consciousness emerges as a tool for improvements. In order to raise the consciousness, establishing education programmes and campaigns against alcohol and drug usage can be evaluated as the most common ways. Secondly, technical developments for vehicles and providing better infrastructure systems for roads can be considered as supportive ways for increasing safety levels in transportation. Moreover, all these stated measures needs state based control mechanisms especially in the case of transportation of goods. Legal regulations serve as primary factors as they set restrictions and penalties as well as providing education and certification services.

Transportation Safety in European Union

Transportation is crucial for European Union as transport networks connect the member countries each other physically. In 2007, total goods transport activities in the EU27 are estimated to have amounted to 4.228 billion tonnes/km and total passenger transport activities in the EU27 by any motorised means of transport are estimated to have amounted to 6.473 billion per km or on average

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October 27-29, 2011, Izmir, TURKEY

13.092 km per person [1].[3] Furthermore, these networks act as bridges between EU and rest of the world. Therefore, EU put the emphasis on safety related issues to provide a sustainable and fully integrated network. On the other hand, mobility is perceived as a right within the Union. People should have the right to travel and the mobility is the key point that reinforces the EU concept. This right of increased mobility is also valid for the corporate firms. Flow of goods in the European zone is closely tied to the sustainability of transportation networks.

To increase the safety level for transportation, European countries work under the umbrella of European Union. Under a Council Decision of 1993, Member States have the obligation to communicate to the Commission data on road accidents resulting in death or injury that occur within their territories with a view to setting up a Community data bank, the CARE database [2]. With this implication for member countries, the Union aims to deal with problem of limited data about accidents.

Despite the fact that transportation is like the vein system of the Union, safety is still on debate. Transport crashes in the EU killed about 39.200 EU citizens in 2001, caused over 3.3 million casualties and cost over 180 billion Euros, around twice the total EU budget for all activity [3].These numbers are not equally distributed to transportation modes. Road transportation has the greatest share with 94 percent hence; particular emphasis is given to road transport[4]. EU set a target of reducing these causalities by 50 percent. This target points out to a maximum 27.000 deaths whereas in 2010 the realized number 34.900. The realized numbers for reducing the casualties are presented in Table1.

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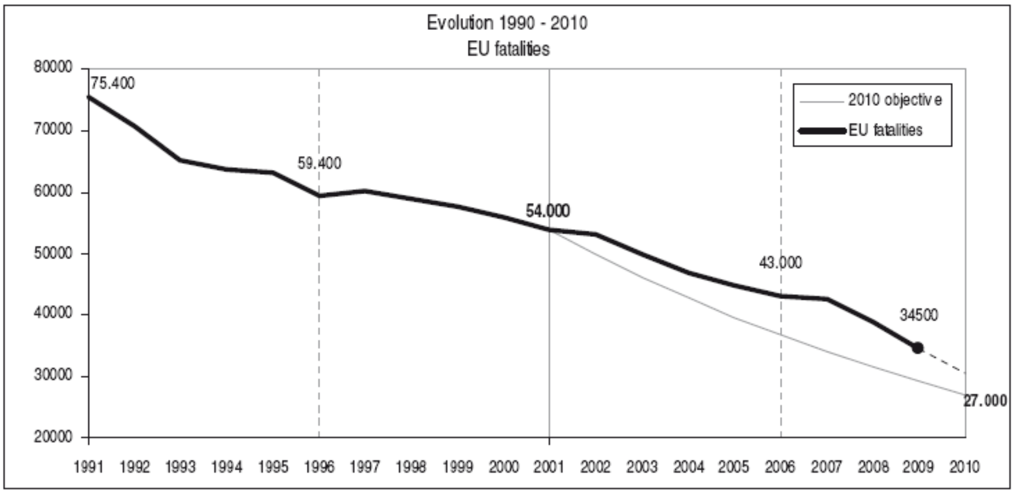

FIGURE1
Percentage change in road deaths between 2001 and 2009
Source: Citizens' summary EU road safety guidelines 2011-2020

While European Union has been far from realizing its target, the situation in Turkey is not better off. As a candidate country, Turkey aims to improve the road safety as well. The average of traffic accidents is Europe is calculated as 47.705 in 2004 while this number is 77.008 for Turkey[5]. Moreover, this number increased to 1.053.346 in 2009. Considering this situation, European Union Transport Safety Council recommended that further actions within the competence of the EU itself (mainly vehicle safety regulations) are taken and that an EU road safety subsidy fund is created for financial incentives that support and trigger national road safety actions and measures with a proven effectiveness [6]. Financial support will create an integrated funding system for transportation within

[3] http://ec.europa.eu/transport/publications/statistics/doc/2009_energy_transport_figures.pdf

the member countries. Vehicle safety regulations will contribute to reduce the accident numbers by improving vehicle safety. However, road transportation itself has different components based upon the vehicles. Therefore, vehicle safety regulations should reflect to different shares of vehicle in accidents. In the case of European Union, the majority of this share belongs to cars. The distribution of the shares is provided in Figure 2.

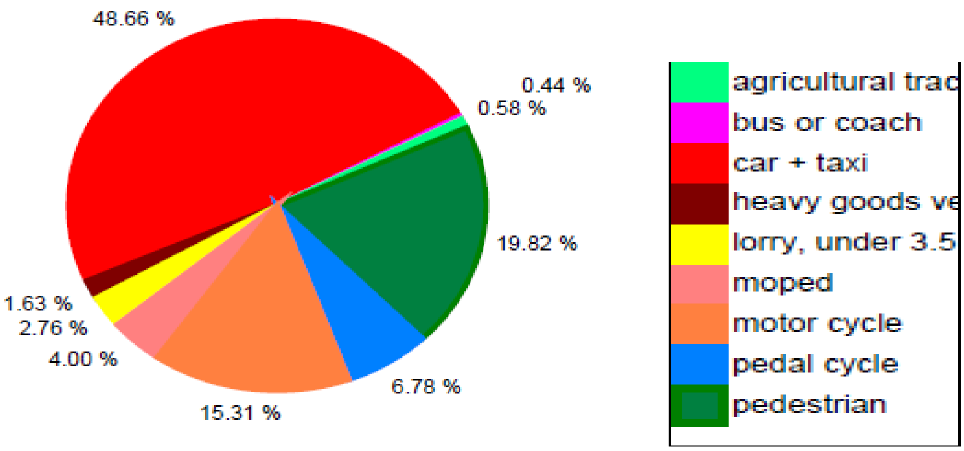

FIGURE 2
Fatalities by Transport Mode: EU
Source: http://www.etsc.eu/oldsite/statoverv.pdf

As can be seen from Figure 2, cars and taxis constitute almost the half of the fatalities in road transportation. Motorcycles, another emerging issue for road transportation regarding g their share of 15 %. This fact is also stated by EU Transport safety commission by recommending that priority setting for transport safety must recognise the very high fatality risk of motorised two-wheelers (15 times the average road risk per kilometre travelled) [7].

The Union have set some objectives in order to deal with the problem of low safety levels in road transportation. The first one is improving education and training of road users. This education has two dimensions: training programmes for driving licences and post licence training for professional drivers. The second objective is Increasing enforcement of road rules. This objective can be realized through new Technologies for vehicle safety and coordinated control mechanism within the Union. Safer road infrastructure is the third goal of the European Union. This objective can be realized up on the condition of providing dedicated funds and their continuous control. The Union perceives the safer vehicles as another objective for safer transportation hence, it encourages the research and development progresses of new technologies such as electric cars. Besides these measures, it is important to take action after accidents. Improve emergency and post-injuries services is one of the objectives of the Union and as a result the Union has been working on a global campaign for stressing the importance of the first aid. Finally, because of the aging population of Europe, protecting vulnerable road users is perceived as an objective for road safety. This objective contains the cyclists, powered-two wheelers and pedestrians as well. Considering this objective, European Union address the role of monitoring and protective measures for vulnerable road users. The Union also declared that working with non-governmental organizations will contribute to the process.

Road Transportation Safety in Turkey

In Turkey %92 of total of passenger transport and %89 of total of freight transport performed by road and 5 million people employed in road transport sector [8]. As a candidate country for European Union, EU acquits about transportation is considerably important. Transportation within the context of environment is one of the most challenging phases for Turkey because of the heavy requirements for infrastructure [9]. [4] However, transposed regulations upon today are mostly concern with the competitiveness, open market and standardization of certification. Accordingly, Turkey puts two regulations into force for transportation which are Road Transport Law in 2003 and Road Transport Regulation in 2004.

In the transportation sector, there are also some regulative projects for the operational progress that are funded by EU. Within this twining progress of two acquits, a project was realized between Turkey and European Union.'' Assistance to the Turkish Road Transport Sector Project'' with the Netherlands and Germany started in 2006, to assess the training needs of the ministries and public administrations involved in the implementation of the road transport legislation; prepare and implement a training programme to enhance human resources management capabilities. As a result of this project, 1500 mobile data terminals and 10 mobile control offices for roadside checks were purchased [10].

Turkey puts the emphasis on transport safety by declaring national targets for safer transportation goals for 2006-2013. In this 5 years time, it is aimed to reduce the vehicle based accidents regarding the vehicle safety component of transportation safety. This recommendation is also supported by United Nations Road Safety report. In this report, it is stated that state aims to have divided highway network for 15.000 km. This recommendation was given considering that due to the Government Policy; the construction of dual-carriageways was initiated in order to replace the existing low-standard roads. Approximately 7.000 kilometres dual-carriageways have been constructed[5]. Dual carriageways are perceived as significant concepts for improved safety in Turkey. The reason for that is the type of accidents in Turkey. The summary of type of fatalities is provided in Table 1. Head-on collision has the greatest share in number of accidents resulted by death or injury hence, dual carriageways can serve as measure for this problem.

TABLE1

Type of accidents resulted by death or injury : Turkey 2005

TYPE OF ACCIDENT	URBAN AREA		RURAL AREA		TOTAL	
	ACCIDENTS	%	ACCIDENTS	%	ACCIDENTS	%
Head-on Collision	20 .960	38,33	5.342	23,65	26.302	34,04
Rear-end Collision	5.222	9,55	2.699	11,95	7.921	10,25
Collision to the vehicle not moving	2.216	4,05	419	1,86	2.635	3,41
Collision to unmoving substance	4.812	8,8	1.424	6,93	6.377	8,25
Collision to pedestrian	14. 877	29,47	1.565	5,41	16.098	20,83
Collision to animal	174	0,32	241	1,07	415	0,54
Overturning	2.869	4,81	4.329	19,17	7.198	9,32
Run-off	3.151	5,76	6.620	29,31	9.771	12,64
Person falling out of the vehicle	363	0,66	118	0,52	481	0,62
Substance falling out of the vehicle	42	0,08	32	0,14	74	0,1
TOTAL*	54 686	100	22. 586	100	77.272	100
(*) :More than one type is marked in an occurrence of an accident.						

Source: Approximation of the EU Road Transport Acquis in Turkey

In 2010, the ratio for head-on collision was reduced to 6% as a result of improvement in infrastructure[11].Besides, for the vehicle safety, Turkey has been planning to use Intelligent Transportation Systems(ITS), in order to set the maximum and minimum speed levels automatically.

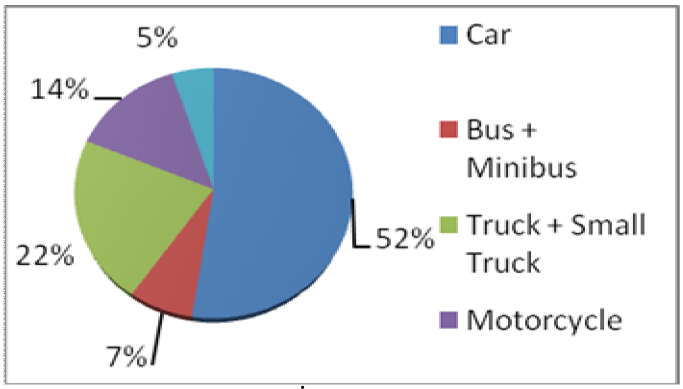

FİGURE3

Accidents involved in death and injury: Turkey

Source: Traffic Statics Book, 2010

In Turkey, the situation for road transportation is similar to the case of EU in terms of the share of cars. With a share of 53 % they have the greatest share in accidents. On the other Turkey differs from

European Union for buses. Bus as of a vehicle, can be evaluated both in city and intercity transportation and a share of 7 percent is considerable compared to the case of EU. This situation addresses that Turkey should take action and set measures to prevent accidents that the buses involved. They are also crucial because buses are generally used in public transportation which means that they carry considerable numbers of passengers. Two-wheel vehicles have a significant share in the accidents similar to EU case. Therefore, recommendations of European Union Transport Safety Council are important for Turkey as well. In addition to these factors, trucks should be considered as an urgent problem. Their share of 22 % signals a clear danger for road transportation. Vehicle safety measures are highly important for this type of vehicles and the state should give importance to improve of truck based transportation.

Nevertheless, in the case of Turkey, the most important variable in fatalities emerges as the driver. Data about the drivers' ratio in total faults is provided in Table 2. Considering the driver ratio to total faults, the greatest share belongs to them. Rather than vehicle based safety regulations educating drivers can still be evaluated as the primary goal.

TABLE2

Control Authorities in Turkey

	Control Authorities					
Items to be controlled	State Police	Local Police	Customs	Transportation Ministry	Auth.Technical Experts	Other bodies
Traffic regulations and driving licences	X					
Authorisations for carriage of passengers				X		
Special authorisations and other related documents				X		
TI documents or TIR carnets						X(4)
Weights and dimensions						X(2)
Certificate for carriage of perishable goods (ATP)						X(1)
Documents on veterinary and phytosanitary control						X(1)
Technical conditions of motor vehicles						X(3)
Regulations on driving hours and rest periods	X					
Regulations: transportation of dangerous goods				X(5)		

(1)Ministry of Agriculture and Rural Affairs
(2)Traffic control is performed by Ministry of Public Works and Settlement, General Directorate of Highways
(3)Ministry Industry and Trade
(4) The Union of chambers and Commodity Exchanges
(5) After ADR's entry in force

Source: http://www.euromedtransport.org/image.php?id=1509

Turkey has been working on enhancement of the transportation policies regarding its candidate position for European Union. The Union acts as a major guide for transportation safety by providing data, effective monitoring, and collective working for measures and systemic reporting. Nevertheless, reasons of the accidents can differ between Turkey and European Union as can stated in the study. Considering this fact, regulations and improvements should be made based on actual situations rather than fully transpositions. EU funds and monitoring systems are important for Turkey as a model whereas it also has specific problems such as accidents involving trucks.

REFERENCES

[1] EU ,2009, Energy and Transport in Figures. Brussels, p. 95
[2] EU ,2010, ‘’Commuication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Commitee of the Regions’’, p.6
[3] EU, 2003, ‘’Cost Effective EU Transport Safety Measures’’, p.9
[4] Trafik Hizmetleri Başkanlığı, 2004, ‘’Trafik İstatistik Bülteni 2004Yılı ‘

[6] EU, 2003,’’ Transport Safety Performance in the EU: A Statical Overview’’, p.29
[7] EU ,2010, ‘’Commuication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Commitee of the Regions’’, p.6
[8] Isık, İ.,2007, ‘’Approximation of the EU Road Transport Acquis in Turkey’’, p.25-28
[9] Büyükarslan D., AB Üyelik Sürecinde Türkiye Ulaştırma Politikaları ve Bir Model Önerisi
[10] Isık, İ.,2007, ‘’Approximation of the EU Road Transport Acquis in Turkey’’, p.25-28
[11] Yüce, O.,2007, ‘’General Directorate of Highways’’, p.20-22

LEAGILE SUPPLY CHAINS ON SEAPORTS

Sibel Bayar Çağlak[1], Gülsüm Aydın[2] and Güler Bilen Alkan[3]

Abstract — *Seaports have a complex structure which requires supply chain strategy. Leanness and agility are important on seaport's management today. That's why, leagile supply chain strategy has been applied on seaports nowadays. Leagile is a strategy which is combination of the lean and agile paradigms within a supply chain. Lean means to eliminate unnecessary processes in supply chain. Also, agile means to focus on flexible and effective on supply chain. In this study, it has been presented general information about leagile supply chain. In addition, leagile supply chain on seaports has been explained.*

Keywords —Lean, agile, leagile, supply chain, seaport,port

INTRODUCTION

A seaport can be considered a single organizational unit that provides a service to ships. However, when its internal workings are analyzed in detail, it is clear that there are *multiple* services being produced and demanded within a port area [1]. Seaports have serviced a widely network such as handling of cargo, warehousing, vessel's services etc. Because of complex structure of seaports, effective supply chain strategy has required in the seaports. That's why; the use of leagile supply chain strategy is decisive in an efficient supply chain in the ports.

In this paper, we describe leagile supply chain strategy on seaports. Firstly concept of leagile supply chain strategy and then use of the strategy on seaports has been explained.

LEAGILE SUPPLY CHAIN

Leagile is the combination of the lean and agile paradigms within a total supply chain strategy by positioning the decoupling point so as to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the marketplace.' [2]-[3]. In additional to decoupling point is the point in the material flow streams to which the customer's order penetrates [3]-[4]. Figure 1 has shown a leagile supply chain. As seen; leagile supply chain has occur material supply, lean processes, decoupling point, agile processes and satisfied costumer respectively. Also, leagile supply chain has included a complex form [3].

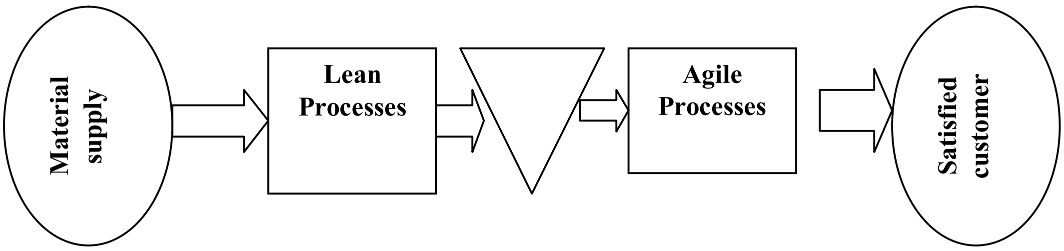

FIGURE. 1
Leagile Supply Chain.

In this context, concepts of agility and leanness have been described. Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a *volatile* market place [2]. The main characteristic of agile organizations is flexibility [5]. Also, it requires the agility to respond, quickly, to market

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changes in terms of volume and variety [6]. Leanness means developing a value stream to eliminate all waste, including time, and to ensure a *level* schedule [2]. Lean logistics is the logistic dimension applied to lean manufacturing [6]- [7]. Its main goal is to deliver the right material, in the right location, in the right quantity, and with the right quality [6].

In order to summarize, lean offers customers good quality products at low price by removing inventory and waste from the manufacturing process, agile manufacturing is on the other hand a strategy for rapidly entering niche markets and being able to serve the specific needs of customers on an individual basis [8]-[9].

Also, leagile has occurred concepts of lean and agile paradigms. We explain differences this concepts. Therefore Table 1 shows comparison of attributes between the supply chains lean, agile and leagile [2]-[3]-[6]-[10]-[11]. As shown Table 1; leagile supply chain has occurred optimization of lean and agile supply chain. For example profit margin has been aimed low by lean supply chain, high by agile supply chain and moderate by leagile supply chain. As seen, leagile supply chain is a form which developed and combinated lean and agile supply chain. As shown Table 1; aims of leagile supply chain is to be flexibility and deliver the right material, in the right location, in the right quantity, and with the right quality because of combination of lean and agile supply chain [2]-[3]-[6]-[10]-[11].

TABLE. 1
Comparison of Attributes between the Supply Chains Lean, Agile and Leagile.

Distinct Attributes	**Lean Supply Chain**	**Agile Supply Chain**	**Leagile Supply Chain**
Market demand	Foressable	Volatile	Volatile and unforesseable
Product variety	Low	High	Medium
Products life cycle	Long	Short	Short
Customers's drivers	Cost	Avaliability and response time	Service Level
Profit margin	Low	High	Moderate
Dominant cost	Physical cost	Marketing Cost	Both
Inventory penalties	Long- term contracts	Immediacy and Volatile	No storage space
Shopping policy	Product shopping	Guaranted capacity	Inventory at final retailer
Information Enrichement	Highly diserable	Compulsory	Essential
Forecasting Mechanism	Algorithm	Advisory	Both
Local products	Commodities	Fashion products	Products that customer demand
Response time compresion	Essential	Essential	Desirable
Losses elimination	Essential	Desirable	Arbitrary
Fast reconfiguration	Desirable	Essential	Essential
Strenght	Arbitrary	Essential	Desirable
Quality	Market qualifier	Market qualifier	Market qualifier
Cost	Market winner	Market qualifier	Market winner
Response time	Market qualifier	Market qualifier	Market qualifier
Service level	Market qualifier	Market winner	Market winner
Information Enrichement	Highly diserable	Compulsory	Essential

LEAGILE SUPPLY CHAIN ON SEAPORT

Traditionally, ports have been defined as areas made up of infra and superstructures capable of receiving ships and other modes of transport, handling their cargo from ship to shore and vice-versa and capable of providing logistics services that create value-added [12]-[14]. However, from the logistics point of view, ports are logistics systems along the supply chain which have to respond to pull logistics; their action will contribute towards the reduction of inventory levels along the logistics pipeline, a fall in associated costs, and the fulfillment of tighter customers' requirements through high service levels within shorter lead-times [13]-[14].In this context, we have explained ports as a logistics system on Figure 2 [14].

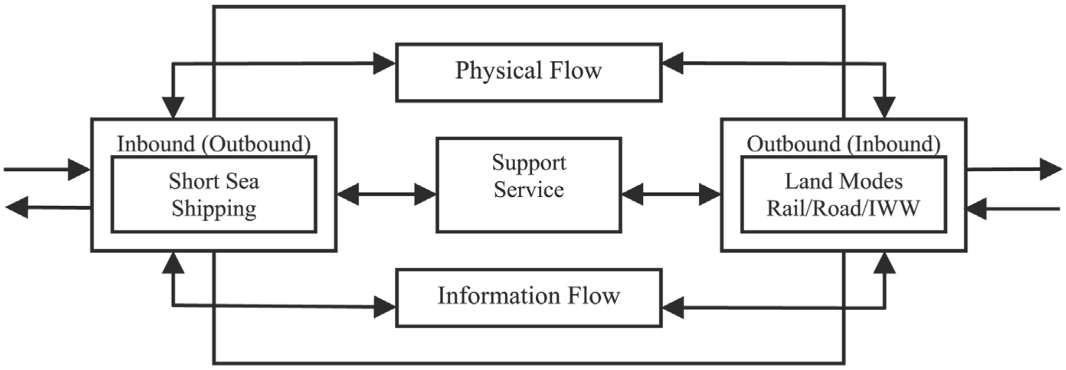

FIGURE. 2
Ports as a Logistics System

Also shown Figure 2, developing effective supply chains requires the integration of all companies in the supply chain, ports being just one of the partners. It has been recognized that ports have an important role to play in the integration of supply chains and ports have, in many cases, extended their operations to include logistics activities in various forms [15]. Physical and information flows have occurred in the ports.

TABLE. 2
Economic Functions of the Port

	First Generation	**Second Generation**	**Third Generation**	**Fourth Generation**
Started period	Before 1960	After 1960	After 1980	After 2000
Principle cargo	Conventional cargo	Conventional and bulk cargo	Bulk and unit cargo containerization	Specialized in a specific type of cargo like containers
The port development position and strategy	Conservative junction of sea and inland transportation	Expansion transportation and production center	Industrial principle and international trade chain connecting transportation	Itself converting into the industry
Activity scope	(1) Cargo handling storage, navigation assistance	(1) + (2)Cargo type change ship related industry- enlargement of port region	(2) + (3) Cargo information, cargo distribution, logistics activity, formation of terminal and distribution center	(1)+ (2) + (3)+ (4) Regional distribution and logistics center (5) Consultancy service on port project
Structure formation and specificities	-Everybody acts individually in the port - Port and its user maintain informal relation	-Relation between port and its user become closer -Emergence of slight correction among port activities - Negative cooperation, relation between port and self-governing community	-Formation of port cooperation system -Trade and transportation chain -Relation between port and self-governing community becomes closer -Extension of the port structure	-Port corporatization from port authority -Changes from Monoply market to Oligopoly market structure internally and externally
Charterer of productivity	-Invention of cargo distribution -Individual supply of simple services	-Processing -Cargo complex services -Increase of the value added	-Cargo flow and information -Cargo distribution and information -Combination of services and distribution -Value added	Tradeoff between economies of scale and economies of scope
Core factor	Labor/Capital	Capital	Technical- Know How	Information sharing
Principle cargo	Conventional cargo	Conventional and bulk cargo	Bulk and unit cargo containerization	Specialized in a specific type of cargo like containers
The port development position and strategy	Conservative junction of sea and inland transportation	Expansion transportation and production center	Industrial principle and international trade chain connecting transportation	Itself converting into the industry
Activity scope	(1) Cargo handling storage, navigation assistance	(1) + (2)Cargo type change ship related industry- enlargement of port region	(2) + (3) Cargo information, cargo distribution, logistics activity, formation of terminal and distribution center	(1)+ (2) + (3)+ (4) Regional distribution and logistics center (5) Consultancy service on port project

In this section, economic functions of seaports have been explained. Table 2 has shown economic functions of the port on generation. As seen Table 2, ports have developed step by step at each generation. Forth generation ports development positon and strategy are itself converting into the industry Cargoes have specialized and information sharing is important for fourth generation ports [16].

At the present time, fourth generation seaports, which define physically, separated but linked through common operators or through a common administration have developed in parallel with technological, operational and administrative developments and importance of cost, quality and flexibility have increased at the seaports [15]-[17]. Therefore, integration of the ports has increased into the supply chain according to last times. Figure 3 has been shown increasing integration of ports into supply chain. Although, ports role was low value added in global supply chain at 1960's. After 2000's ports have been vertical integration with global logistics markets and nowadays, lean and agile and leagile logistics have trend on ports [15].

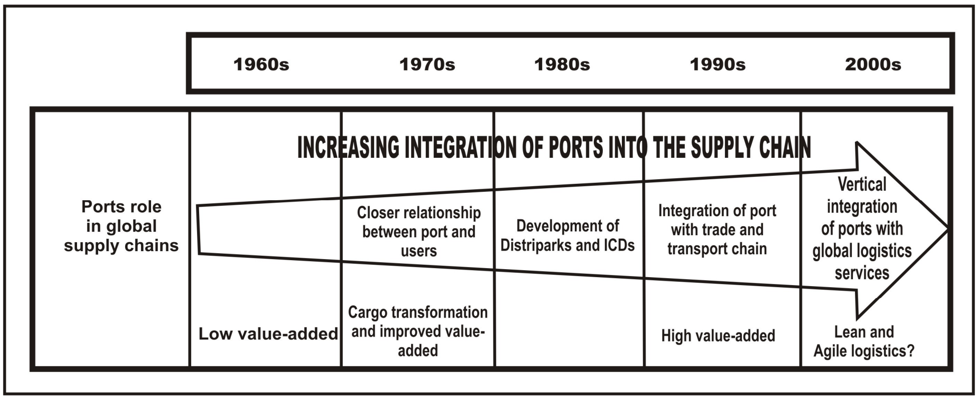

FIGURE. 3
Increasing Integration of Ports into Supply Chain

As shown Table 2 and Figure 3, ports are more complex than other generation. That's why; leagile supply chain has increased value on ports. Although seaport operations are complex, need for speed, quality and decreased cost have increased. Therefore, seaports have need effectively of a supply chain. Leagile supply chain has answered this demand. Due to complexity of new generation seaports, they have need flexibility, avoidance from waste cost, leaness and agility [15]-[16].

CONCLUSION

Today, both agile and lean supply chain have required in new generation seaports. Seaports have provided flexibility on agile supply chain and increased speed in operational functions and lean supply chain has been eliminated waste cost and provides advantage of cost. As seen, speed, quality and decreasing of cost are the most important concepts in world trade. In the trade, seaports have a key role. Not only agile, but also lean supply chain is important role on seaports. Leagile supply chain is combination of lean and agile. In this context, leagile supply chain must operate on seaports.

REFERENCES

[1] Trujillo and Nimbela, 1998, "Privatization and Regulation of the Seaport Industry," Policy Research Working Paper, No 2181, December 1998, World Bank: Washington D.C.

[2] Naylor,J., B., Naim,M., M., and Berry, D., 1999, "Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain", International Journal of Production Economics 62 1999,pp: 107-118.

[3] Mason-Jones, R., Naylor, B., and Towill, D., R., 2000, "Lean, agile or leagile? Matching your supply chain to the marketplace", Int. J. Prod. Res., 2000, Vol. 38, No. 17, pp:4061- 4070.

[4] Hoekstra, S., and Romme, J., 1992, "Integral Logistics Strictures: Developing Customer- Orientated Goods Flow" (New York: Simon and Schuster).

[5] Christopher,M., 2000, "The agile supply chain, competing in volatile markets", Industrial Marketing Management 29, pp:37-44.

[6]Boschi, A., A., Raimundo, J.,S., and Fusco,J, P, A, 2010, "Leagile supply chain - modelling the new paradigm", Symposium of Innovation in global manufacturing - New models for sustainable value capture 23 - 24 September 2010, Cambridge.
[7] Baudin M. ,2004, "Lean Logistics - The Nuts and Bolts of Delivering Materials and Goods", Productivity Press, New York, NY.
[8] Maskell, B.,2001, The age of agile manufacturing. Supply Chain Management. 6 (1), pp: 5-11.
[9] Banomyong, R., and Supatn, N., 2004, "Comparing lean and agile logistic strategies: a case study", Thammasat Business School – Thammasat University, Bangkok, Thailand, 2000.
[10] Olhager, J. 2003, "Strategic positioning of the order penetration point". International Journal of Production Economics 85, pp: 319-329.
[11] Bruce, M. Daly,L., and Towers, N., 2004, "Lean or agile: A solution for supply chain management in the textiles and clothing industry?" International Journal of Operations and Production Management 24(2), pp:151-170.
[12] Charlier, J.J. and Ridolfi, G. ,1994, "Intermodal transportation in Europe", Maritime Policy Management, Vol. 21 No. 3, pp. 237-50.
[13] Ainsworth, S.A.,1992, "The impact of information technology on warehouse operations", Cardiff University, Cardiff.
[14] Paixa˜O A.,C.,Marlow,P.,B.,2003, "Fourth generation ports – a question of agility?", International Journal of Physical Distribution & Logistics Management Vol. 33 No. 4, 2003 pp. 355-376
[15] Pettıt, S., J., and Beresford, A., K., C., 2009; "Port development: from gateways to logistics hubs" ,Marıt. Pol. Mgmt., June 2009, Vol. 36, No. 3, 253–267
[16] Liu, W., Xu, H., and Zhao, X., 2009, "Agıle Servıce Orıented Shıppıng Companıes In The Contaıner Termınal, Transport 2009", 24(2),pp:143-153.
[17] Marlow,P.,B., and Paixa˜O A.,C., 2003, "Measuring lean ports performance", International Journal of Transport Management Volume 1, Issue 4, 2003, pp. 189-202

AGV APPLICATIONS FOR SHORT SEA CONTAINER TERMINALS

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Abstract *– Container terminal authorities have been forced to find more efficient techniques to improve the performance in order to deal with huge amounts of containers processing by the dramatic growth in the freight volumes. Advanced technologies like automated guided vehicles (AGV) and automated lifting vehicles (ALV) have been recently used in container terminals to improve efficiency owing to their abilities on the repetitive nature of the terminal operations. Contrary to deep sea container terminals, short sea container terminals like in Turkey are built as artificially filled near the coasts because of their low berth deepness. The most common layouts in the short sea container terminals are Π, L, Ψ or π berth typed. In this paper, an object oriented simulation model is developed for berth type Π and used to demonstrate the impact of automation on the performance of the short sea container terminals. Indeed, we concentrate on the effects of AGV dispatching rules on the determined performance criterion of total container handling in quay cranes. The results of the simulation show that AGV dispatching rules and terminal layouts have significant effects on the performance of the terminals and the number of the AGVs used.*

Key Words *– AGV dispatching rules, object oriented simulation, short sea container terminals*

INTRODUCTION

Today, almost all overseas shipping of furniture, toys, footwear, clothing, auto parts, electronics components, and computers is done via standardized 20", 40", and 45" long steel containers aboard deep-sea container vessels. In addition, the amount of fruit, vegetables, fish, meat, and general foodstuffs shipped in refrigerated containers is increasing. In today's just-in-time global supply chain, improving the efficiency of container shipping processes is more important than ever.

In seaports, container terminals are the places where container vessels are loaded and unloaded, and where the containerized cargo is temporarily stored while awaiting a future transportation.

These facilities can be classified as automated and non-automated considering the equipment technologies used. In automated container terminals, container info and automatic control technologies are used. These kinds of terminals have been established in Western Europe countries where work force is expensive. So, these terminals are more efficient than the others and also, the operation costs of these terminals are less than others. Moreover, in non-automated container terminals, the operations are carried out under the human control. In contrary, this kind of terminals has been established in South-East Asia countries where work force is cheaper (Steenken et. al., 2004).

In container terminals, three types of services such as import, export and transit are executed according to container trade types. One of these services is for import during which containers come by vessel and exit from gate; the other one is for export during which containers come by external transporters (XTs) and exit from berth by vessel; the last one is for transit during which containers come by vessel and exit by another vessel.

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Different equipments are used while these services are being executed. In Fig. 1, services executed in a container terminal, transportation and handling operations and the equipments used during the operations are shown. Basically, three types of equipments are used in terminals. These equipments are; firstly quay cranes used for unloading/loading the container from/to vessel, secondly yard cranes used for stacking containers at yards for unloading/loading the container from/to transporter vehicle, and lastly the transporter vehicles used for transportation operations between berth and yard.

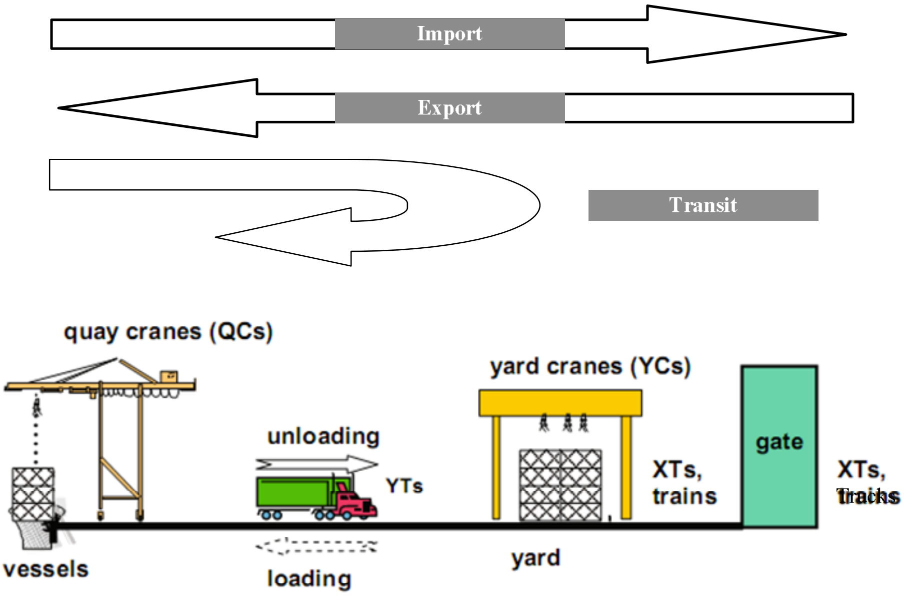

FIGURE. 1
Terminal Services and Equipments (Petering and Murty, 2009)

In automated container terminals, AGVs are similar to conventional trucks, but they operate driverless on a pre-defined guide path. ALVs are vehicles which move over a container, lift it up and transport it to the designated storage location. Contrary to ALVs, AGVs need to interact with a crane. In recent years, Lift AGVs are the systems which can leave and take containers to the buffer areas without lifting them. In non-automated terminals, straddle carriers or conventional yard trucks (YTs) are used for moving containers inside the terminal. On the landside, many European container terminals have railway links which are not so common in most Asian countries (Kulak et. al., 2011).

In the literature, AGV dispatching rules were tested firstly by Egbelu and Tanchoco (1984). Additionally, Durrant-Whyte (1996) and Evers and Koppers (1996) are the first academic studies about AGV applications at container terminals. The design of AGV systems in container terminals is still a common problem. For comprehensive reviews of AGV systems in container terminal literature, we would like to refer to the surveys by Vis (2006) and Roodbergen and Vis (2009).

Qiu et. al. (2002), Kim and Bae (2004), Bish et. al. (2005), Grunow et. al. (2006), Vis and Bakker (2008), Nguyen and Kim (2009) and Angeloudis and Bell (2010) are significant studies about AGV dispatching rules in automated container terminals

In this study, AGV dispatching rules are tested for a Π berth type container terminal layout using simulation by the help of the performance criterion of the total container handling in quay cranes. Hence, a object-oriented simulation model has been developed by using Arena 10.0. Some information about artificially filled type container terminals is given in the second part of the study. AGV dispatching rules are mentioned in the part 3 and some information about the designed container terminal is given in the part 4. In part 5, the simulation model which has been developed for testing is mentioned and the results of the simulation experiments are discussed with their statistically analysis. Finally, in the last part, the results of the study are presented.

ARTIFICIALLY FILLED TYPE CONTAINER TERMINALS

It is obvious in the scientific literature that AGV applications in automated container terminals are for the terminals in huge seaports. All of these huge seaports are built in deep coasts named as natural ports. Usually, container terminals in natural ports have just one major berth extending in parallel to the coast. However, in these terminals, yards are built perpendicularly or in parallel to the major berth.

Contrary to the natural ports, there may be several berths in the artificially filled ports where there are shallow seas. The most common ones above these types are; Π, L, π or Ψ berth typed. Berth and yard layout types of the artificially filled container terminals are described below:

Π berth type: The entire terminal is placed in the port which is artificially filled as peninsula. Yard area is placed in the middle of three berths which surround the peninsula. The terminals in Haydarpasa and Izmir ports are the examples for this type.

L berth type: While the yard area and one berth of the terminal are placed in the port, the other berth is built by filling the sea. Sometimes, this filled berth can be used as partial yard area. The container terminal which is placed in Mersin port is an example of this type.

Ψ berth type: While the yard area of the terminal is placed in the port, berths are placed in the long peninsulas which are filled perpendicularly to the sea. Sometimes, the berth which is artificially filled can be also used as partial yard area. Kumport container terminal in Ambarlı port is an example of this type.

π berth type: While the yard area of the terminal is placed in the port, berths are placed in the long peninsulas which are filled horizontally to the sea. Sometimes, the berth which is artificially filled can be also used as partial yard area. Shangai ports in Yellow Sea are examples of this type.

That container terminals in these kinds of ports have several berths may result in several yard areas in the terminal or horizontally or perpendicularly location of common yard area to the berths. As mentioned in Vis and Anholt (2010), Polat et al. (2010) and Kulak et al. (2011), the layout types of berths have a significant effect on terminal performance. This effect may lead AGV applications and dispatching rules in automated filled typed container terminals to differentiate according to the studies in the literature.

AGV DISPATCHING RULES

In the frame of this study, AGV dispatching rules are analyzed using two different ways. These are: transporter request rules and intersection rules. Transporter request rules are used when a transporter is requested from the berth, yards, and gate. On the other hand, intersection rules used in order not to come across traffic jam or have an accident during AGVs' travel on the designed paths are shown in Fig. 2.

a) Transporter Request Rules:

Smallest Distance: It is for selecting the available transporter nearest the requesting point.
Largest Distance: It is for selecting the available transporter farthest the requesting point.
Random: It is for selecting transporters randomly from the available transporter units.
Cyclical: It is for selecting the first available transporter unit beginning with the successor of the last unit selected.

b) Intersection Rules:

FCFS – First Come First Served: The vehicle that arrived first at the end of its incoming link is given control of the intersection first.
LCFS – Last Come First Served: The vehicle that arrived last at the end of its incoming link is given control of the intersection first.
Closest: Giving the intersection to the vehicle closest to its travel destination.
HVF – High Value First: Giving the intersection to the vehicle whose controlling entity has the highest value of Attribute ID. The highest value means that the transporter is loaded with export container.

LVF – Low Value First: Giving the intersection to the vehicle whose controlling entity has the lowest value of Attribute ID. The lowest value means that the transporter is loaded with import container.

DESIGNED CONTAINER TERMINAL

In the frame of the study, a large scaled Π berth typed and an artificially filled container terminal which can be built in a shallow coast area have been designed. Layout of this terminal which is designed as an automated container terminal is shown in Fig. 2.

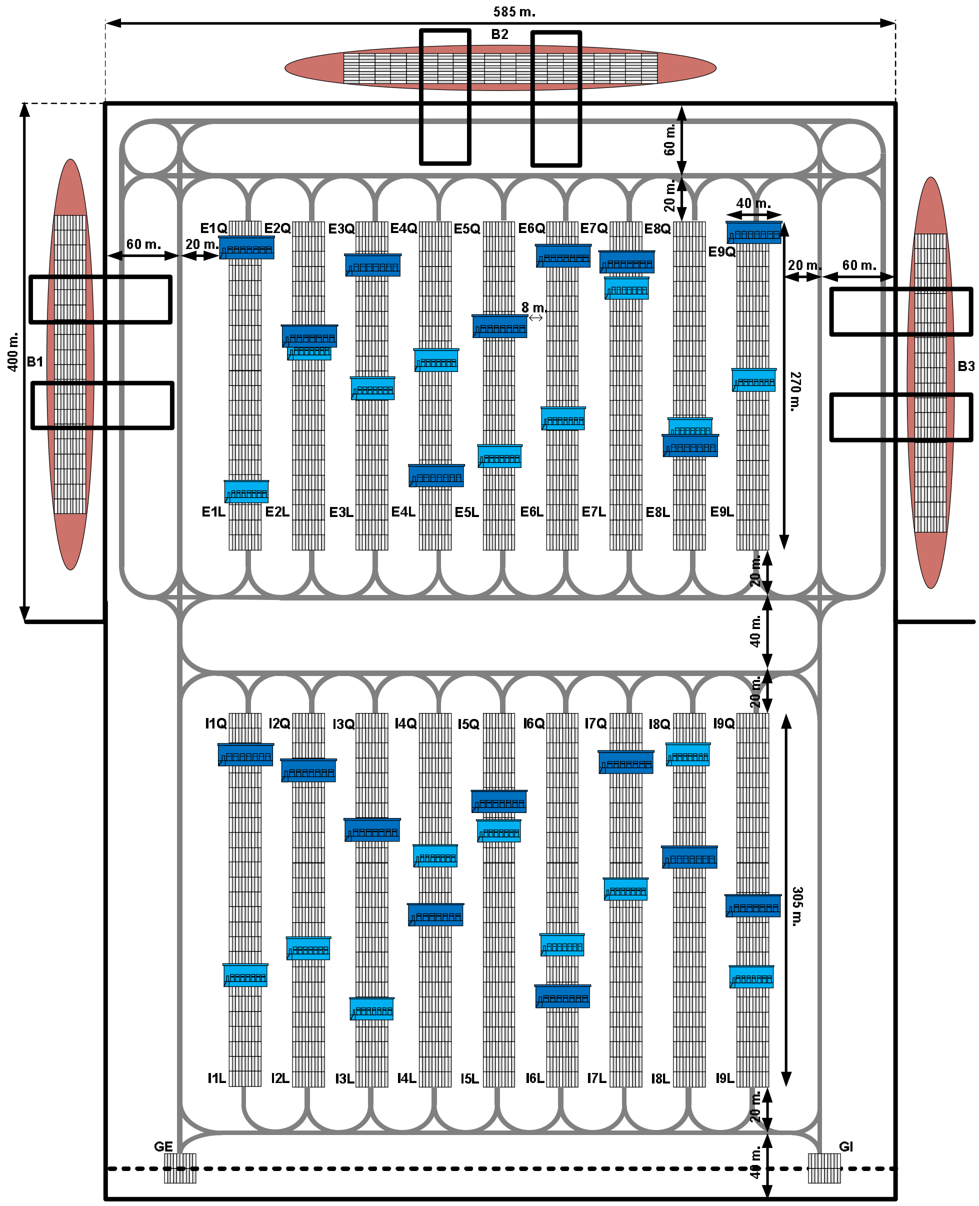

FIGURE. 2
Designed Terminal layout

In each berth of this terminal, there are two dual automated quay cranes. Also, in the yard area there are 18 blocks (9 blocks near to the gate for import containers, 9 blocks near to berths for export containers). In each block, twin automated stacking cranes, which have telescopic design, are assigned. For export containers, each block length is 270 m. (44 TEU), width is 40 m. (10 TEU) and height is 13 m. (5 TEU). Additionally, for import containers, each block length is 305 m. (50 TEU), width is 40m. (10 TEU) and height is 13 m. (5 TEU). In this condition, simultaneous stack capacity of the terminal is 42.300 TEU.

The simple presentation of AGV paths in the terminal are also shown in Fig. 2. AGV load/unload zones in blocks are located at the endpoints of each block. For export containers, container loading zone is located at the berth side and container unloading zone is located at the landside of block. For import containers, container unloading zone is located at the berth side and container loading zone is located at the landside.

In this container terminal, there are buffer areas which have the capacity of 20 containers at each block and 10 containers at each berth because of lift AGVs. Owing to these buffer areas, yard cranes and AGVs can run loading/unloading operations independently. Hence, it is possible to decrease waiting times of terminal equipments considerably. Optimum number of AGVs used in terminal has been obtained separately for each simulation scenario because of the differentiating number of AGVs according to the tested rules.

SIMULATION TESTS

Simulation Model

In the simulation model which was developed by using Arena 10.0, vessels are the entities. In the first part of the model, features of the vessels (loading/unloading amounts, vessel types – large, medium and small) are assigned and these vessels are allocated to berths. In the second part, there are the operations executed at berths. Loading/unloading processes of the containers in these vessels, and assignment of the containers unloaded from the vessel to the yards and AGV assignments are carried out. In the last part, yard area operations are mimicked.

For the simulation tests, collected data are; inter arrival times of vessels, load to be charged onto a vessel, load to be discharged from a vessel, handling time of quay cranes, handling time of yard cranes, travel time of AGVs, average storage time in yard blocks (Import & Export), Import/Export ratio, equipment availability of quay cranes, equipment availability of yard cranes, equipment availability of AGVs. These data were analyzed using Arena Input Analyzer 10.0 and SPSS 16 following the concept of trace-driven simulation. Distributions with their parameters were determined with respect to minimum squared errors based on the Chi Square Test of the Arena Input Analyzer.

In the model, we assume that YTs and AGVs can carry only one container and operating conditions of the terminal are not affected by weather conditions and do not differ between the working shifts. We also assume that vessel arrivals at berths are unscheduled and thus considered as random events and the collected data may differ. So, the simulation tests are implemented under 3.000.000 TEU demand with 5 replications and one-year simulation time, and total container handling at QCs per year is used as performance criterion.

Numerical Results

In the first experiment set, the simulation model is used for analyzing transporter request rules in designed terminal. For this purpose, 4 different transporter request rules for AGVs and only cyclical transporter request rule for YTs are tested. In the scenarios where AGVs are used, closest is used as intersection rule. These scenarios are also tested with different transporter numbers in order to obtain the optimum transporter number. The effect of transporter request rules using different transporter numbers on total container handling at QCs per year is presented in Fig. 3.

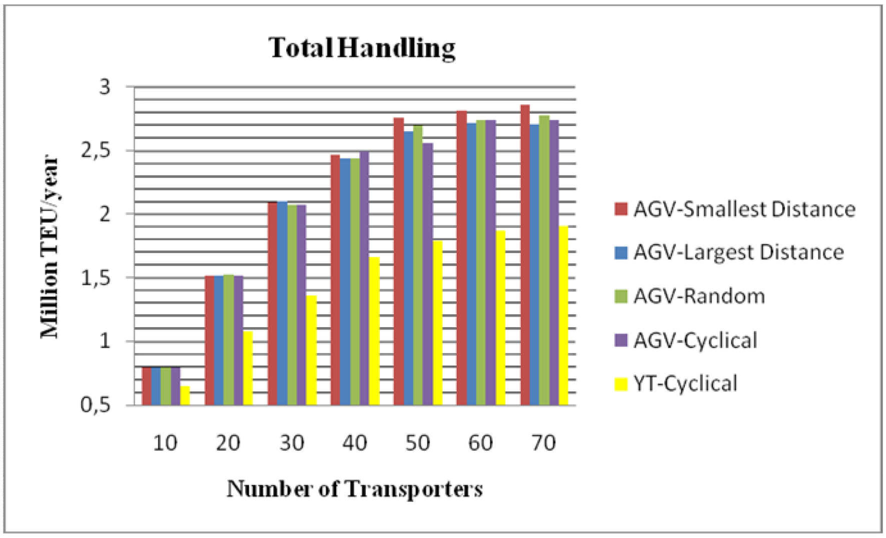

FIGURE. 3
The Effect of Request Rules Under Different Transporter Types and Numbers

As mentioned in Fig. 3, there is a significant difference between using lift AGVs and YTs. The main reasons for this are the low speed of YTs, the equipment failure and accident resulting from the human-controlled system.

In order to analyze the effect of the transporter number and AGV dispatching rules on the total container handling amount, Analysis of Variance (ANOVA) test is implemented with SPSS 16.0. In Table 1, the results of ANOVA test according to 140 simulation data for the effect of transporter number and AGV dispatching rules are presented.

TABLE 1
ANOVA Results For the Effect of Transporter Number and AGV Dispatching Rules*

Source	SS	df	Mean Square	F	Sig.
Transporter Number	$6{,}781\text{x}10^{13}$	6	$1{,}130\text{x}10^{13}$	$4{,}044\ \text{x}10^{7}$	0,009
Transporter Request Rule	$5{,}921\text{x}10^{10}$	3	$1{,}974\text{x}10^{10}$	70622,824	0,000
Interaction*	$8{,}611\text{x}10^{10}$	18	$4{,}784\text{x}10^{9}$	17120,137	0,000
Error	$3{,}130\text{x}10^{7}$	112	279444,178		
Total	$7{,}166\text{x}10^{14}$	140			
Corrected Total	$6{,}795\text{x}10^{13}$	139			

*Dual interaction of intersection and transporter request rules

In Table 1, transporter numbers have a significant difference at %95 confidence level. In other words, the increasing in transporter numbers leads to a notable increasing in total handling amount. In Table 2, the results of Tukey HSD test which are carried out to obtain the differences above are in favor of which transporter request rule are presented. Simulation results which are related to 7 different transporter numbers are used in tests for transporter request rules.

TABLE 2
Tukey HSD Test for Transporter Request Rules

		Homogeneous subgroups (Alfa = 0,05)			
Transporter Request Rules	N	1	2	3	4
Largest Distance	35	2131039,7			
Cyclical	35		2143968,2		
Random	35			2148402,8	
Smallest Distance	35				2186285,9

According to Table 2, it is obvious that the transporter request rule which has the highest handling amount is the smallest distance. So, assigning AGVs to containers with smallest distance rule will provide higher handling amount as it provides time-saving and decreasing in waiting times. In Table 3, the results of Tukey HSD test which is used for obtaining the most appropriate transporter number under smallest distance rule are presented.

TABLE 3
Tukey HSD Test for Transporter Numbers

		Homogeneous subgroups (Alfa = 0,05)					
Transporter Numbers	N	1	2	3	4	5	6
10	5	789789,7					
20	5		1518227,3				
30	5			2089242,3			
40	5				2463485		
50	5					2762870,5	
60	5					2814570,9	
70	5						2863610,5

As mentioned in Table 3, it is clear that there is no notable difference between the numbers of 50 and 60 transporters. So, for 51-54-57-60 numbered transporters, Tukey HSD test is again carried out to find out the optimum number of transporters between the ranges of 50-60. In table 4, Tukey HSD test results are shown.

TABLE 4
Tukey Hsd Test for Transporter Numbers

		Homogeneous subgroups (Alfa = 0,05)	
Transporter Numbers	N	1	2
51	5	2745641,6	
54	5		2789305,6
57	5		2800128,0
60	5		2814569,6

In Table 4, there is a significant difference between the numbers of 51 and 54, 57, 60 transporters. However, there is no significant difference between the numbers of 54, 57 and 60 transporters. In this paper, although there is no feasibility study related to lift AGVs, the optimum number for these transporters are determined as 54 because of high purchase and installation.

In the second experiment set, the simulation model is used for evaluating the scenarios with designed intersection rules in terminals. For this reason, 5 different intersection ruled scenarios for the transporter number 54 and 4 different transporter request ruled scenarios are tested. In Fig. 4, the effect of intersection rules on the performance criterion under different transporter request rules is shown.

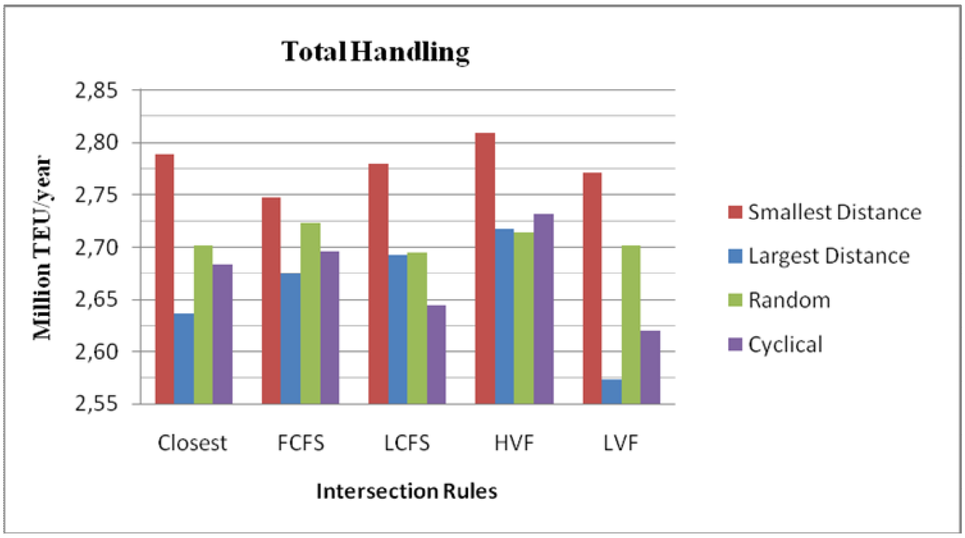

FIGURE. 4
The Effect of Intersection Rules Under Different Transporter Request Rules

As mentioned in Fig. 4, related effect is not stable. For this reason, by using SPSS 16.0, ANOVA test is carried out for simulation results which are to observe the effect of transporter request and intersection rules on the total container handling amount. In Table 5, the results of ANOVA tests which are executed according to 100 simulation results are presented for the effect of transporter request and intersection rules.

TABLE 5
ANOVA Test Results for Transporter Request and Intersection Rules

Source	SS	df	Mean Square	F	Sig.
Transporter Request Rules	$2{,}678 \times 10^{11}$	3	$8{,}927 \times 10^{10}$	90358,617	0,000
Intersection Rules	$3{,}206 \times 10^{10}$	4	$8{,}015 \times 10^{9}$	8112,358	0,002
Interaction*	$4{,}227 \times 10^{10}$	12	$3{,}522 \times 10^{9}$	3565,043	0,000
Error	$7{,}904 \times 10^{7}$	80	987960,97		
Total	$7{,}256 \times 10^{14}$	100			
Corrected Total	$3{,}422 \times 10^{11}$	99			

*Dual interaction of intersection and transporter request rules

According to the results obtained from Table 5, the transporter request rules have a %5 difference in handling amounts. Similarly, intersection and transporter request rules have a %5 difference in terms of interaction. This interaction shows that transporter request and intersection rules are interdependent. In Table 6, the results of Tukey HSD test, which is executed for determining that previously mentioned differences, are in favor of which dispatching rule is shown. In tests which are for transporter requests, for the number of 54 transporters, the simulation results repeated 5 times are used related to 5 different intersection rules.

TABLE 6
Tukey HSD Test for Transporter Request Rules

		Homogeneous subgroups (Alfa = 0,05)			
Transporter Request Rules	N	1	2	3	4
Largest Distance	25	2642109,68			
Cyclical	25		2657807,97		
Random	25			2696700,26	
Smallest Distance	25				2779308,80

According to Table 6, in the results which are obtained from the simulation carried out for 54 transporters, in terms of handling amounts, the best one is “smallest distance rule” among the dispatching rules applied in 4 different ways. Smallest distance rule, is different from the other transporter request rules in terms of being at

%95 confidence level. In Table 7, the results of Tukey HSD, which is executed with smallest distance rule, and the 5 times repeated simulation results are presented.

TABLE 7
Tukey HSD Test for Intersection Rules

		Homogeneous subgroups (Alfa = 0,05)			
Intersection Rules	N	1	2	3	4
FCFS	5	2747114			
LVF	5		2770685		
LCFS	5			2780275	
Closest	5			2789305	
HVF	5				2809165

In Table 7, it is shown that HVF is the best rule at %95 confidence level among the other intersection rules.

CONCLUSION

In this paper, a simulation model is developed to analyze transporter number, transporter request rules and intersection rules in a Π berth typed designed container terminal. Implemented tests show that the best scenario for the designed terminal configuration is the scenario with using 54 lift-AGVs, "smallest distance rule" as request rule, "HVF" as intersection rule. When the results are compared with Vis and Bakker (2006), smallest distance rule is familiar for transporter request rule in each study. However, in related study FCFS is proposed as intersection rule but, HVF is proposed in this study. The reason for this difference can be the different terminal berth types.

With the help of this study, we have identified that the transporter request and the intersection rules can behave differently according to terminal berth types. Consequently, the effect of these rules will be researched for the other artificial and natural berth types of container terminals. Furthermore, the effect of different transporter types on performance criterion could be another research topic in this type of container terminals.

REFERENCES

[1] Angeloudis, P. and Bell, M.G.H., 2010, "An uncertainty-aware AGV assignment algorithm for automated container terminals", Transportation Research Part E, 46 (3): 354-366

[2] Bish, E.K., Chen, F.Y., Leong, Y.T., Nelson, B.L., Ng, W.C. and Simchi-Levi, D., 2005, "Dispatching vehicles in a mega container terminal", OR Spectrum, 27:491–506

[3] Durrant-Whyte, H.F., 1996, "An autonomous guided vehicle for cargo handling applications", International Journal of Robotics Research, 16: 407–440

[4] Egbelu, P.J. and Tanchoco, J.M.A., 1984, "Characterization of automatic guided vehicle dispatching rules", International Journal of Production Research, 22: 359-374.

[5] Evers, J.J.M. and Koppers, S.A.J., 1996, "Automated guided vehicle traffic control at a container terminal", Transportation Research A, 30 (1): 21–34

[6] Grunow, M., Guenther, H-O., and Lehmann, M., 2006, "Strategies for dispatching AGVs at automated seaport container terminals", OR Spectrum, 28:587–610

[7] Kim, K.H., and Bae, J.W., 2004, "A look-ahead dispatching method for automated guided vehicles in automated port container terminals", Transport Science, 38(2):224–234

[8] Kulak, O., Polat, O., Gujjula, R. and Guenther, H-O., 2011, "Strategies for improving a long-established terminal's performance: A simulation study of a Turkish container terminal", Flexible Services and Manufacturing (under review)

[9] Nguyen, V. and Kim, K., 2009, "A dispatching method for automated lifting vehicles in automated port container terminals", Computers& Industrial Engineering, 56:1002–1020

[10] Petering, M.E.H. and Murty, K.G., 2009, "Effect of block length and yard crane deployment systems on overall performance at a seaport container transshipment terminal", Computers and Operations Research, 36: 1711–1725

[11] Polat, O., Kulak, O., Taner, M.E. and Guenther H-O., 2010, "Effect of Resource Allocation Rules in Different Layout Types of Seaport Container Terminals", 24th European Conference on Operational Research, Lisbon, Portugal, July 2010
[12] Qiu, L., Hsu, W-J., Huang, S.Y. and Wang H., 2002, “Scheduling and routing algorithms for AGVs: a survey”, International Journal of Production Research, 40: 745–760
[13] Roodbergen, K.J. and Vis, I.F.A., 2009, “A survey of literature on automated storage and retrieval systems”, European Journal of Operational Research, 194, 343-362
[14] Stahlbock, R. and Voß, S., 2008, “Operations research at container terminals: A literature update”, OR Spectrum, 30: 1-52
[15] Steenken, D., Voß, S. and Stahlbock, R., 2004, “Container Terminal Operation and Operations Research – A Classification and Literature Review”, OR Spectrum, 26: 3-49
[16] Vis, I.F.A., 2006, “A comparative analysis of storage and retrieval equipment at a container terminal”, International Journal of Production Economics, 103: 680-693
[17] Vis, I.F.A., 2006, “Survey of Research in the Design and Control of Automated Guided Vehicle Systems”, European Journal of Operational Research, 170(3), 677-709
[18] Vis, I.F.A. and Bakker, M., 2008, “Dispatching and layout rules at an automated container terminal”, Progress in material handling research: 2008, K Ellis et al. (eds), Material Handling Institute, Charlotte, North Carolina, 685-703
[19] Vis, I.F.A. and Van Anholt, R.G., 2010, “Performance analysis of berth configurations at container terminals”, OR Spectrum, 32(3), 453-476

CITY LOGISTICS SOLUTIONS IN A MEDIUM-SIZED TOWN

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Abstract *— In the paper authors presented selected results of the survey research conducted among citizens in three Polish medium-sized towns. Respondents provided their opinion about low-effective city logistics solutions, and their influence on the quality of life. The paper presents results of the second step of the research project 'Reference Model of City Logistics versus Quality of Life of Citizens' financed from funds for science in the years 2010-2013.*

Keywords *— city logistics, city logistics solutions, medium-sized city, the municipal plan of mobility*

INTRODUCTION

Transport is one of the most important factors, which have an influence on a high quality of life. It is a facilitator which connects people and allows to reach many different places. Transport is also a key ingredient for city logistics. Forecast shows, that activities of freight companies compared to 2005, will grow up by around 40% in 2030 and by over 80% in 2050. At the same time passenger transport could also increase by 34% in 2030 and 51% in 2050. Currently many large cities have a huge problem with congestion caused mainly by individual transport. The problem might be even bigger in 2050 when passenger cars will contribute more than 60 percentage to total passenger transport [1].

In 1990s European Commission mostly supported development of large cities like London, Berlin, Vienna. These metropolitan areas became interesting for many politicians. For a long time medium sized-towns were in the shadow of large metropolitan cities. Recently more and more countries increasingly have drawn attention to small and medium-sized towns. In 2006 American Newsweek, asserted that 'the last century was the age of the mega-town. The next will belong to their smaller humbler relations' [2].

Although the congestion problem in medium-sized cities is not so noticeable today the situation is changing significantly. Therefore, local authorities in medium-sized towns should take the initiative to implement city logistics solutions in order to avoid future problems with the freight and passenger traffic.

City Logistics in A Medium Sized Town

There are many definitions explaining what the medium-sized town is. One of the most popular says that it is a town with the population between 20 000 to 200 000 depending on the proper urban system and the size of the population in the country [3], [4], [5].

During the last decade many medium-sized towns in Europe have been developed in the social, cultural, educational and transport fields. The rapid growth in road transport (especially individual one) has affected spatial dispersion between home, work, leisure and shopping places [6]. As a result the motorisation index has risen in some cities over 40% during the last few years, causing problems with moving people and freight across the city [7]. Although congestion concerns mainly large cities this problem increasingly affects medium-sized cities, too.

In literature there are many different definitions of city logistics [8] – [17]. Some of them focus only on physical flows and some also include people's flows within the city.

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In authors' opinion city logistics ‘focuses on planning, coordinating and controlling processes taking place within the boundary of a given urban area and is related to physical movement of goods (i.e. raw materials, semi-products, goods and waste, etc.), people and information in a manner that will optimise costs, minimise congestion and improve quality of life’ [6].

The main aim of city logistics is to improve citizens’ quality of life. There are many solutions which have already been implemented in some large and medium sized cities. The advantage of a medium-sized town is that there are many low-effective solutions which could easily improve the citizens’ quality of life. Table 1 presents differences between city logistics in large cities and medium-sized towns.

TABLE 1

The most important differences in city logistics between large and medium-sized cities

Specification	**Medium-sized town**	**Large city**
Type of city logistics solutions	Mainly organisational solutions or purchase of assets	Mainly investment solutions
Cost of implementing solutions for urban logistics	Medium- and low- cost	High - cost
Response time for existing and expected problems in the area of city logistics	In Medium-sized towns problems in the area of city logistics are expected in several-year time, so those cities have time for prevention to avoid or decrease the future problems	In large cities problems in the area of city logistics have already been existing, so those cities should respond on this problems very quickly. There is no time for prevention but for cure (improvement)
Time of implementation in the area of city logistics	Short and medium time (few months to one-two years)	Long time (few years)
Stakeholders	Few stakeholders	Many stakeholders
Traffic/congestion	From time to time only during pick hours	Mostly while whole day, especially during pick hours
CO_2 emission	Medium	Very high
Motorisation index	Medium/high	Very high
Local authority	A town is manages by one local authority	A city is usually divided into many boroughs, manage by smaller administrative authorities

Source: own source

Although the logistics transportation does not require high capital expenditure involved in the case of medium-sized cities, the application of even the simplest solutions is preceded by many difficulties resulting from [2]:

1. Fragile strategic consensus – local authorities often expect tips or a guiding strategy from regional/provincial ones. These in turn count on local autonomy. Such inconsistent mutual expectations slow down work and reduce its effectiveness.
2. Intraregional conflicts – usually a conflict appears between the city and suburbs. These conflicts often result from the different administrative boundaries, separate budgets of individual regions and individual interest.
3. Lack of confidence and visionary power – for medium-sized cities it is more difficult to develop a visionary strategy than large urban agglomerations. This is due to limited funds and capacity, insufficient knowledge or lethargy of city managers, etc.
4. Gridlocked decision-making processes – lack of trust between local leaders, setting up relationships between decision-makers are not beneficial for making objective decisions.

One way to eliminate the difficulties connected with the implementation of city logistics solutions in medium-sized cities is the municipal plan of mobility. It is a tool, which integrates a policy of the movements’ management on the local level. This plan should be determined by regional and country plan of movement, regional strategy and spatial plan.

There are three objectives which the municipal plan of mobility includes:

1. 'Accessibility and mobility due to:
   1. Organizing the management of goods and passenger transport, parking and general accessibility at the level of a municipality,
   2. Meeting the needs of all transport modes in a balanced way,
   3. Implementing actions to enhance rational car use,
   4. Stimulating inter modality,
   5. Providing transportation to people with impaired mobility or modest income.
2. Improved road safety for achieving a reduction in the number and severity or road accidents,
3. Better quality of life space through measures aimed at improving the usability of public land while encouraging the development of local life activities and reducing traffic-induced nuisances' [18].

Before the municipal plan of mobility is developed, the city authorities should analysis indicators and residents' needs related to city logistics and quality of life (figure 1). This analysis should includes both statistics data and results of survey research conducted among citizens, enterprises and experts. The first version of the plan should be consulted with citizens and experts before its application. The municipal plan of mobility should include both city logistics solutions and the way of applying them (methods and tools).

The implementation of city logistics solutions should improved citizens' quality of life. The local authority should periodically evaluate implemented solutions. Every few years the municipal plan of mobility should be updated and the process of the implementation of city logistics solutions will start from the beginning like it is presented in the figure 1.

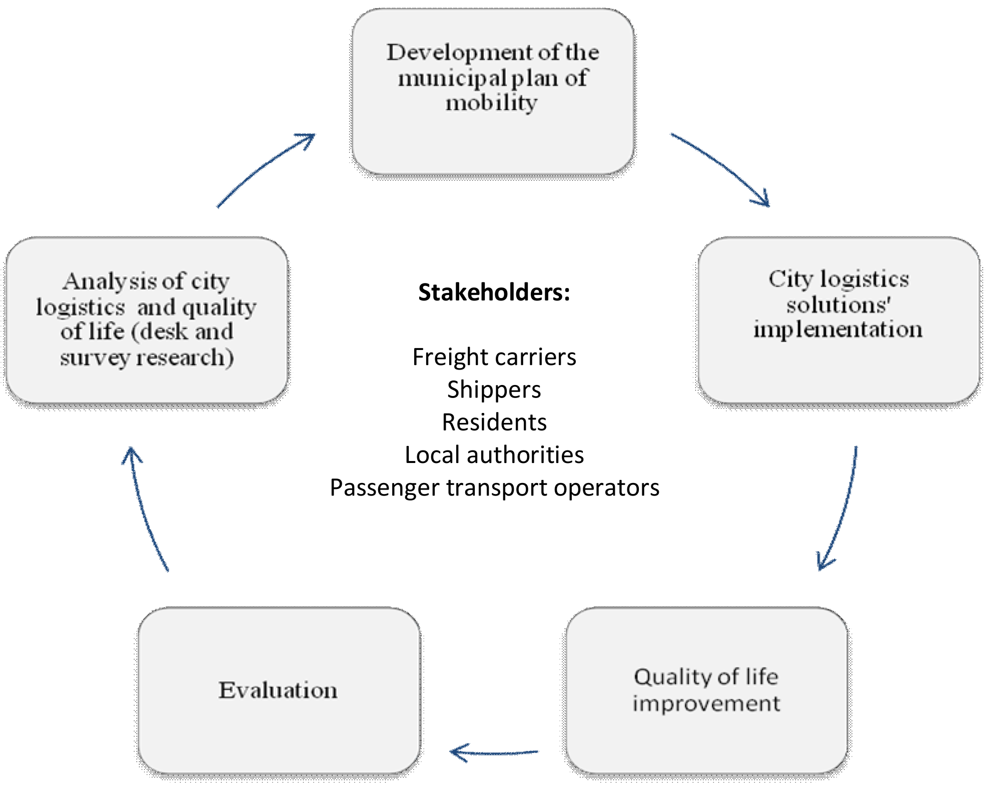

FIGURE.1
Process of introducing the municipal plan of mobility
Source: own resource

Examples of City Logistics Solutions

There are many different solutions which could be implemented in medium-sized cities. As it was mentioned before in medium-sized towns there are many low-cost solutions, which could improved movement within the city. Among them the most popular include:

1. **Traffic-light control system**. The implementation of traffic-light control system can be seen in the city of Kuala Lumpur, Malaysia. This system using sensors counts cars and allows a better assessment of changing traffic patterns. For example, if there is a traffic on a crossroad the fuzzy controller changes the signal light (extends green light on this crossroad) [19].
2. **Restrictions for heavy goods vehicles**. Temporary restrictions of entry of trucks during certain hours is one of the most used tools by planners. These restrictions may be imposed on all vehicles or only on those that exceed certain parameters like weight and dimensions [20]. Dublin is an example of the city, which provided restriction for heavy vehicles to load/unload within the city center area [21]. Boston prohibits freight vehicles from entering selected streets between 11 AM and 6 PM. Certain companies, like Brinks, Wells Fargo, the U.S. Postal Service and major local newspapers are allowed to enter restricted area after the noon. All rescue and utility services can access the area at anytime [22].
3. **Prohibition on the movement of trucks through the city center**. For example in most Manhattan streets exist prohibition against larger trucks. There is a special permit application, which can allow access by large trucks within the prohibited area [23].
4. **Real-time passenger information system.** This system provides real time and timetable information about bus services (via stop sings, websites or mobile devices) [24]. It is implemented in some Polish towns, like for example in Zielona Gora [25].
5. **Night delivery organisation**. Kessel is an example of the city, in which items are delivered at night. They are delivered to the city terminal, from where with a help of trucks to companies two times a day [26].
6. **Preference for public transport such as bus-lanes**. There are many cities in Europe where there are dedicated bus lanes. This solution in a simple way allows to eliminate buses delay [27].
7. **The introduction of entry fee to the city center**. An example of the city which introduced the fees to the center and has been collecting them since 2003 is London. The city has offered the residents several convenient ways of collecting charges as on- line in selected shops, petrol stations, SMS, etc. Free of any charges are vehicles using alternative energy sources and vehicles with a least 9 seats. As a result, the traffic in the central London dropped by 16-20% [28], [29].

There are many more city logistics solutions which could be implemented in a medium-sized city. The final decision which solution should be implemented will be determined by many factors. For example, a city located in the mountains will have different expectation of city logistics solutions than the a located by the seaside. Therefore, the opinion expressed by companies, citizens and experts about city logistics solutions should be required.

Organisation of Survey Research Conducted in The Medium Sized Town

The survey was the first part of the second step of the research conducted between January and March 2011 among 1600 residents of three medium sized cities in Poland (Gorzow Wlkp., Zielona Góra i Jelenia Góra). Cities selected to the study are located in the West part of Poland. The sample was a stratified quota sample selected with the following criteria:

1. gender (male, female);
2. age (up to 35, 35-60, 60 plus);

The survey research provide information about correlation between city logistics and quality of life and also assess these both aspects. In this paper authors present only a small part of survey research results.

Table 2 presents the opinions of the respondents concerning the solutions, which could have an impact on increasing the quality of life of the inhabitants in the field of urban logistics. The survey results have been divided into three cities: Gorzów Wielkopolski, Zielona Góra i Jelenia Góra. According to the survey research the highest percentage of the respondents in all three towns (over 70%) suggest that the flow of people and goods in the city could be significantly improved by applying such solutions as: traffic-light control systems, restrictions for heavy goods vehicles, prohibition on the movement of trucks through the city center and real-time passenger information system. In respondents' opinion the quality of life could also be improved by such concepts, like: preference for public transport such as bus-lanes, night delivery system, setting up places for bicycles to hire and the introduction of small buses for public transport, which could move with greater frequency than buses. The least important solution for respondents from Gorzów Wlkp. and Zielona Góra is prohibition on the movement of all vehicles through the city center.

TABLE 2
Respondents' opinion about the solutions that could improve the quality of life in the area of city logistics

City logistics solutions	Percentage of surveyed respondents, in whose opinion city logistics solutions could improve the quality of life		
	Gorzów Wlkp.	Zielona Góra	Jelenia Góra
1. Traffic-light control system	76,7%	79,7%	78,3%
2. Restrictions for heavy goods vehicles (e.g., restricted hours to enter the city centre)	75,5%	73,9%	73,5%
3. Prohibition on the movement of trucks through the city centre	74.7%	75,1%	81,5%
4. Real-time passenger information system	72,5%	77,2%	74,2%
5. Preference for public transport such as bus-lanes	65,0%	75,9%	78,5%
6. Night delivery organisation	71,5%	66,3%	61,4%
7. The introduction in the city some places for bicycles to hire	63,5%	68%	75,6%
8. The introduction of small buses for public transport, which could move with greater frequency than buses	60,8%	59,3%	75,2%
9. Restrictions on the movement of vehicles in the city center (during peak hours)	30,2%	25,3%	45,4%
10. The introduction of entry fee to the city center	15.5%	18,9%	44,4%
11. Prohibition on the movement of all vehicles through the city center	13,6%	15,5%	59,3%

Source: own resource

The survey results presented in this paper allowed to identify good undertakings which in the respondents' opinion could improve the quality of life. Studies show, that solutions, which could encourage the quality of life in medium-sized cities, particularly relate to the organisation of freight transport.

SUMMARY

In many cities of the world city logistics plays an increasingly important role. Recently, the number of cars has increased considerably and because of that problems with movement of people and material resources in urban areas intensified . In Western countries this problem already began to occur much earlier, therefore, many countries have introduced various solutions to reduce congestion in urban traffic.

In Poland the activities taken to reduce congestion are still insufficient and relate mainly to large cities. In medium-sized cities the problem is still underestimated, despite the fact that both surveys and statistics show a steady growth of motorization index. Therefore, it can be expected that for several years medium-sized cities may also be affected by congestion, which can significantly lower the quality of life. To counteract this situation the city authorities in cooperation with other participants of urban logistics should take the initiative of implementing city logistics solutions to meet current and future needs of the residents of the city.

REFERENCES

[1.] European Commission, Commission Staff Working Document Accompanying the White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, Brussels, 28.3.2011, SEC(2011) 391 final, pp. 12-14.

[2.] Klaus R. Kunzmann, Medium-sized Towns, Strategic Planning and Creative Governance in M. Cerreta, G. Concilio, V. Monno (Eds.), Making Strategies in Spatial Planning, knowledge and Values, p. 28.

[3.] European Foundation, (Ed.), 1994, Visions and actions for medium sized cities: Reports from the European Workshops of Alicante, Volos and Ovieto. European Foundation for the improvement of living and working conditions, Luxemburg.

[4.] Rivkin G. W., Rivkin L. D. (1982). Approaches for planning for secondary cities in developing countries,. Washington, DC: Rivkin Associates Inc

[5.] Rondinelli D. A. (1983). Secondary cities in developing countries: Policies for diffusing urbanizations, Beverly Hills, NJ: Sage.

[6.] Witkowski J., Kiba-Janiak M., Correlation Between City Logistics and Quality of life as an Assumption for a Referential Model, in: Prodeedings of the 7th International Conference on City Logistics (E. Taniguchi, R.G. Thompson, eds.), 7-9 June 2011, Mallorca, Spain, p. 641.

[7.] Kiba-Janiak M., Cheba K., 2010, City Logistics versus Quality of Life in The Area of Public Transport After an Example of a Medium-Sized City, International Logistics and Supply Chain Congress 2010, Logistics Association Publication No: 9, Istanbul, Turkey, 2010, pp. 279-286.

[8.] Taniguchi E., Thompson, R.G., Yamada T. and van Duin R. (2001), City Logistics – Network Modelling and Intelligent Transport Systems, Pergamon, Oxford, p.p. 1-15.

[9.] Würdemann G., (1992), ExWoSt-Informationen zum Forschungsfeld „Städtebau und Verkehr“ Bundesansalt für Landeskunde und Raumordnung, nr 3/1992, Bonn 1992, p. 5.

[10.] Stabenau H., (1993), Bedarfsgerechte Gestaltung einer Leistungsfähigkeiten City – Logistik in: Traffic Networks 93, Vortragband des Kongress am 22/23 Juni 1993 in Bremem, KPS Messe-und Ausstellungs GmbH, Bremen.

[11.] Soltysik M., (2001), Teoretyczno-metodologiczne problemy współczesnej logistyki, Gospodarka Materiałowa i Logistyka nr 11/2001, p. 17.

[12.] Szoltysek J., (2005), Logistyczne aspekty zarządzania przepływami osób i ładunków w miastach , AE w Katowicach, Katowice 2005, p. 93.

[13.] Ihde G. B., (1991), Transport, Verkehr, Logistik, Vahlens Handbücher der Writschafts – und Sozialwirtschaften, Vahlen, München 1991, p. 42.

[14.] Wittenbrink, (1992), (Zauberwort) City-Logistik: Neues schönes Zauberwort, DVZ – Deutsche Verkehrs-Zeitung nr 17/1992, p. 7.

[15.] Benjelloun A., Crainic T. G., (2009), Simulating the Impact of New Australian „Bi-Moda” Urban Freight Terminals, Trends, Chalenges and Perspectives in City Logistics, octombrie-decembrie, Buletin AGIR nr 4/2009 p. 45.

[16.] Klatte M., (1992), Handlungsbedarf fur eine City – Logistik, „Internationales Verkehrswesen” nr 3/1992 (44), p. 90.

[17.] Hesse M., (1992), City- Logistik et centera, „Verkehrszeichnen" nr 3/92, p.p. 21-22.
[18.] Debauche W., Laffineuce D., Borsu D., Ndiaye A. B., The Integration of Urban Goods Transport and Delivery in the Development of Municipal Mobility Plans in the Walloon Region: Towards a Comprehensive and Cross-Sectional Approach in Eiichi Taniguchi, Russe G. Thompson, Recent Advances in City Logistics, Proceedings of the 4th International Conference on City Logistics (Langkawi, Malaysia, 12-14 July, 2005).
[19.] Tan K. K., Khalid M. and Yusof R., Intelligent Traffic Lights Control by Fuzzy Logic, Malaysian Journal of Computer Science, Vol. 9 No. 2, December 1996, p. 30.
[20.] Allen J., Thorne G., Browne M., BESTUFS, Przewodnik po dobrych praktykach w towarowym transporcie miejskim, p. 19.
[21.] http://www.dublincity.ie/ROADSANDTRAFFIC/HGV/Pages/HGV%20Management%20Strategy.aspx 03-07-2011.
[22.] Best Practices Freight Mobility, Managing Freight Effectively from the City and Shipper perspective, Seattle Urban Mobility Plan, January 2008, p. 10A-3.
[23.] Kornhauser A. L., Morris A. G., Urban Goods Movement Model (UGMM) for Manhattan, http://www.nymtc.org/data_services/freight_model/files/ugmm.pdf, 03-07-2011, p. 2.
[24.] http://www.dft.gov.uk/itstoolkit/Tools/T20.php, 03-07-2011.
[25.] Witkowski K., Saniuk S., (2010) Logistics Management Aspects of the City Infrastructure in Trade and Freight: from Soil to Consumer (Tanyas M. And Bamyaci M.), Proceedings of the 8th International Logistics and Supply Chain Congress 2010, Logistics Association Publication No: 9, Istanbul pp. 294 – 302.
[26.] Kohler U., New Ideas for the City Logistics Project in Kassel, w (red.) Taniguchi E., Thompson R. G., Logistics System for Sustainable Cities, Elsevier, Oxford 2004, w Kijewska K., Iwan S., Przewóz ładunków przez obszary zurbanizowane – wybrane rozwiązania, Logistyka 5/2010, logistyka nauka, p. 3.
[27.] Eichler M. D., Bus Lanes with Intermittent Priority: Assessment and Design, A thesis submitted in partial satisfaction of the requirements for the degree of Master of City Planning In City and Regional Planning in the GRADUATE DIVISION of the UNIVERSITY OF CALIFORNIA, BERKELEY, 2005.
[28.] Baybaras M., Browne M., Developments in Urban Distribution in London in Taniguchi E., Thompson R. G., Logistics System for Sustainable Cities, Elsevier, Oxford 2004.
[29.] Kijewska K., Iwan S., Przewóz ładunków przez obszary zurbanizowane – wybrane rozwiązania, Logistyka 5/2010, logistyka nauka, p. 3.

DISTRIBUTION LOGISTICS PERFORMANCE MEASURES

Mehmet Tanyaş [1] , Birsen Konuk [2]

Absract – *Nowadays, customer demands are constantly increasing. Customer preference can be achieved through logistics. Logistics activities take place in four main categories; namely supply (inbound), distribution (outbound), production and reverse logistics. Distribution logistics will be analyzed because of the significant impacts it creates on market shares, sales, and profitability of firms. Comprehensive performance measurements capability is fundamental to achieving organizational success. Success of activities can be understood through measuring performance levels. Measuring performance is an experimental evaluation procedure of a business's activities. There are too many performance measures which are not consistent with each other. In this study all relevant measures have been observed and efforts have been made to constitute a common terminology. The measures obtained through literature research were grouped as per the SCOR model, which was developed by the Supply Chain Council. Distribution logistics performance measures obtained from literature have been grouped under 4 categories. These are; reliability, flexibility, responsiveness and cost.*

Keywords– Distribution Logistics, Distribution Logistics Performance, Performance Measurement, Scor

INTRODUCTION

Nowadays, customer demands are constantly increasing. Excellent product is no longer sufficient by itself to retain customer loyalty. Sofhisticated customers expect the whole package which includes distribution service [1]. As it is difficult to imitate a high-level logistics service, it is important to gain sustainable advantage in terms of competition in logistics. Since the customer is the ultimate judge of logistics performance, effective and timely responses to ever- changing customer tastes and preferences have become essential components for successful business performance [2].

In this study first measurement system and performance measurement will be discussed. Later distribution lojistics performance measures obtained from various studies and how these measures are grouped based on SCOR (Supply-Chain Operations Reference-model) will be emerged.

The Council of Logistics Management (CLM) recently changed name as Council of Supply Chain Management Professionals (CSCMP), defined logistics management as that part of SCM, that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer requirements (Url-1). Because SCM incompasses logistics, logistics performance measures were examined within the framework of SCM.

Logistics activities take place in four main categories; namely supply (inbound) logistics, distribution (outbound) logistics, production logistics and reverse logistics. Inbound logistics comprises raw material supply, storage, and production. Outbound logistics activities start with customer orders, end with distribution of product to customers. The purpose of production logistics is to feed each machine and workstation with the right product, in the right quantity and quality on the right time. Reverse logistics can be defined as all activity associated with a product after the point of sales. Reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value or proper disposal.

Being a process of face-to-face communication with customers, distribution logistics is particularly important. The services that are offered to the customers are provided with distribution logistics activities. Distribution logistics provides place, time, and quantity utilities. Possession utility of marketing can not be ensured without place, time, and quantity utilities. Distribution logistics will be analyzed because of the significant impacts it creates on market shares, sales, and profitability of firms [3].

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PERFORMANCE MEASUREMENT

The realization that competition in today's marketplace is "no longer company vs. company but supply chain vs.supply chain" has brought performance measurement to the forefront of managerial attention. The cliché "if you can't measure it, you can't manage it" represents an inescapable management reality. Comprehensive performance measurements capability is fundamental to achieving organizational success. Basic role of performance measurements systems include insight into the nature of value added processes, guiding the organization's progress toward achievement of goals, and providing critical feedback concerning the success of organizational strategies [4].

Success of activities can be understood through measuring performance levels. Measuring performance is an experimental evaluation procedure of a business's activities. Performance measurement is an analysis of both effectiveness and efficiency in accomplishing a given task. All evaluation is in relation to how well a goal is met. Effectiveness is defined as the extent to which goals are accomplished. Efficiency is the measure of how well the resources expended are utilized [5].

Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action. A performance measure can be defined as a metric used to quantify the efficiency or effectiveness of an action. A performance measurement system can be defined as the set of metrics used to quantify both the effficiency and effectiveness of actions.

A performance measurement system can be examined at three different levels as the individual performance measures, the performance measurement system as an entity, the relationship between the performance measurement system and the environment within which operates [6].

In modern business management, performance measurement assumes a far more significant role than quantifying and accounting. Performance measurement can provide important feedback to enable managers to monitor performance, reveal progress, enhance motivation and diagnose problems [7]. In supply chain management, measurement can facilitate inter-understanding and integration among the supply chain members. It also provides insight to reveal the effectiveness of strategies and to identify success and potential opportunities. It makes an indispensable contribution to decision making in supply chain management, particularly in re-designing business goals and strategies, and re-engineering process [8].

There should be four characteristics in an effective performance measurement system [9].

- Inclusiveness: Measurement of all pertinent aspects
- Universality: Allow for comparison under various operating condition
- Measurability: Data required is measurable
- Consistency: Measures consistent with organization goals

Performance measurement system must place emphasis on three separate type of performance measures as resource, output and flexibility measures. The goal of resource measures are to have high level of efficiency. Resource is an important part of the measurement system. Too few resources can negatively effect the output and the flexibility of the system, while the deployment of too many resources artifically increases the system's requirements.Total cost, distrubition cost, inventory cost are the examples of resource performance measures.

The goals of output measures are to have high level of customer service. Output measures includes customer responsiveness, quality and quantity of final product. Many output measures are easily represented numerically such as number of on time deliveries. However there are also output measures that are much more diffucult to express numerically such as customer satisfaction. Resources effect the output, and the output is important in determining the flexibility of the system. On time deliveries, customer response time, shipping errors, customer complains are example of output measures.

The goal of flexibility measures is ability to respond to a changing environment. Flexibility can measure a system ability to accommodate volume and schedule fluctuations from suppliers, manufactures, and customers. Flexibility is vital for an organization because it exists in an uncertain environment. Two type of flexibility can be identified. Range flexibility is defined to what extent the operation can be changed. Response flexibility is defined as the ease with which the operations can be changed. Four type of flexibility ca be defined as volume flexibility, delivery flexibility, mix flexibility and new product flexibility. Each of this type of flexibility can be measured in terms of range and response [9]. Performance measures should also be divided into three groups such as strategic, tactical and operational measures [10].

DISTRIBUTION LOGISTICS PERFORMANCE MEASURES

Distribution logistics performance measures have been developed by examining the studies related to the relationship between logistics performance and firm performance. The greater part of these studies consist of studies which examine the relationship between logistic capabilities and firm performance [11]-[12]-[13]-[14]-[15]-[16]. Studies researching the relationship between integration and company performance have also contributed to this study [17]-[18]-[19]. Measures have also been derived from studies related to strategy and company performance [20]-[21]-[22]-[23]-[24]. Theoritical studies related to logistics performance were also analysed to derive distribution logistics performance [9]-[10]-[25]-[26]-[27]. Studies related with the effect of distribution logistics and customer service to firm performance were examined to develop distribution performance measures [28]-[29]-[30]-[31]-[32]-[33]. Other studies related with flexibility and customer service also were analysed to emerge distribution logistics service performance measures [34]-[35]. After these analysis distribution logistics performance measures have been obtained. Table 1 shows these measures and name of researcher.

The measures obtained through literature research were grouped as per the SCOR model. The model combines process reference model approaches such as restructuring business processes, benchmarking, and process analysis. SCOR model contains standard definitions of management processes, the framework of process relations among the standart processes, standard metrics used to evaluate process performance, management practices, which lead to the best performance, standart alignment to features and functionality (url-2).

SCOR spans all customer interaction from order entry through paid invoice, all product transactions, from supplier's supplier to customer's customer, all market interactions, from the understanding of aggregate demand to the fulfillment of each order.

SCOR is based on five distinct management processes.

- Plan balance resources with requirements and establish plan for the whole supply chain.
- Source schedule deliveries; recieve, verify and transfer product and authorize supplier payment.
- Make Schedule production activities, issue product, produce and test, package, stage product, and release product to deliver.
- Deliver manage all order management steps from processing customer inquires and quotes to routing shipments and selecting carriers.
- Return manage defective product return steps .

There are 4 steps in SCOR model. Level 1 metrics are primary high level measures that may cross SCOR processes. At level 2 each process can be further described by type. Level 3 present detailed process element information for each level 2 process category. Implementation of supply chain management practices within the company occurs at level 4. Level 1 measures are grouped under 5 performance attributes as reliability, responsiveness, flexibility, cost, and assets. The measures obtained through literature research were grouped under these performance attributes.

TABLE 1

Studies Used to Obtain Distribution Logistics Performance Measures

Reliability	
Percent of on Time Delivery	Morash et al. (1996); Fawcett et al. (1997); Stank and Lackey (1997); Tracey (1998); Daugherty et al. (1998), Fawcett and Cooper (1998); Stank et al. (2003); Beamon (1999); Holmberg (2000); Gunasekaran et al. (2001); Chan and Qi (2003); Wisner (2003); Rafele (2004); Tracey et al. (2005); Forslund (2006); Kim (2006); Cho et al. (2008).
Delivery Reliability	Morash et al. (1996); Stank and Lackey (1997); Stank et al. (2003); Ellinger et al. (2000); Cho et al. (2008); (2008); Fawcett ve Cooper (1998).
Percent of Delivery without Errors	Fawcett and Cooper (1998); Beamon (1999); Gunasekaran et al. (2001); Chan and Qi (2003); Rafele (2004); Vonderambse and Lim (2005); Sezen (2008).
Percent of Delivery without Damage	Fawcett and Cooper (1998); Rafele (2004); Vonderambse and Lim (2005); Forlund (2006).
Responsiveness	
Delivery Time	Emerson (1996); Morash et al. (1996); Stank and Lackey (1997); Fawcett and Cooper (1998); Daugherty et al. (1998); Beamon (1999); Gunasekaran et al. (2001); Milgate (2001); Chan and Qi (2003); Rafele (2004); Neely (2005); Forslund (2006); Töyli et al.(2008); Cho et al. (2008); Sezen (2008).
Delivery Time to Target Market	Morash et al. (1996); Ellinger et al. (2000); Cho et al. (2008).
Delivery Consistency	Emerson (1996); Daugherty et al. (1998), Holmberg (2000).
Delivery Frequency	Tracey (1998).
Percent of Advanced Notification of Delivery Changes or Product Shortage	Stank et al. (2003); Ellinger (2000).
Response Time to Customer Inquiries	Fawcett et al.(1998), Vonderambse and Lim (2005).
Flexibility	
Percent of Urgent Orders Delivered	Gunasekaran et al. (2001); Chan ve Qi (2003); Forslund (2006).
Percent of Responsiveness to Order Size and Product Type Changes	Beamon (1999); Stank et al. (2003); Chan ve Qi (2003).
Percent of Responsiveness to Special Orders	Fawcett et al. (1997); Ellinger et al. (2000); Gunasekaran et al. (2001); Wisner (2003); Sezen (2008); Vonderambse and Lim (2005).
Cost	
Distribution Cost	Morash et al. (1996); Beamon (1999); Cho et al. (2008); Sezen (2008); Töyli et al. (2008).
Transportation Cost	Chan and Qi (2003).
Percent of Distribution Cost to Produt Cost	Ballou (1998).
Percent of Transportation Cost to Distribution Cost	Ballou (1998).

The operational definition of measures are shown below:

Reliability Measures

- Percent of on Time Delivery: Orders delivered on promised date / number of total orders
- Delivery Reliability: Delivered quantity / promised quantity
- Percent of Delivery without Errors: Number of orders delivered without errors / numbers of total orders
- Percent of Delivery without Damage: Number of orders delivered without damage / total number of orders

Responsiveness Measures

- Delivery Time: Order delivery date- order receipt date
- Delivery Time to Target Market: Order delivery date to target market-order receipt date from target market
- Delivery Consistency: Numbers of orders delivered in the same time / number of total orders
- Delivery Frequency: Number of orders delivered in a certain period of time
- Percent of Advanced Notification of Delivery Changes or Product Shortage: Number of notification in advance of delivery changes or product shortage / total number of delivery change and product shortage
- Response Time to Customer Inquiries: Time spend for answers to customer inquiries

Flexibility Measures

- Percent of Urgent Orders Delivered: Number of urgent orders delivered / total number of urgent orders
- Percent of Responsiveness to Order Size and Product Type Changes: Fullfill order size and product type changes / number of requested order size and product type changes
- Percent of Responsiveness to Special Orders: Numbers of Special Orders delivered / total number of orders

Cost Measures

- Distribution Cost: Total cost of transportation, warehouse and stock keeping cost
- Transportation Cost: Total cost of investment for transportation and transportation management
- Percent of Distribution Cost to Produt Cost: Distribution cost / product cost
- Percent of Transportation Cost to Distribution Cost: Transportation cost / distribution cost

Performance measures are defined and categorized in various ways in the studies analyzed. For example there are 6 different definion for on time delivery measure. These definiton are; number of on time delivery [9], on time delivery [10]-[4]-[12]-[29]-[32]-[25]-[19]-[36], on time delivery capability [23], percent of on time delivery [13]-[9], percentage of orders delivered on time [12], punctuality- orders delivers on time / total orders [26]. There are 4 different definiton for delivery consistency namely; continually increasing on percentage of on time deliveries [13], meeting quoted or anticipated dates on a consistent basis [17], delivery consistency [4]. There are also many different definition for percent of delivery without errors, such as;

delivery reliability-error free [7], shipping errors [4]-[19]-[9], Correctness- mistake orders dispatched / orders dispatched [26], undamaged delivery [32], achivement of defect free deliveries [10].

There are also many different categorizaton for performance measures. Such as; cost, time, assets, customer service measures [37]. Cost, activty time, responsiveness and flexibility are other grouping made by different researcher [9].

Different definion for same measures, and categorized them in a various way cause confusions. In our study measures are defined and categorized in a common terminolgy, using SCOR model.

CONCLUSION

Distribution is important part of marketing mix, and it creates firms important opportunity to obtain differantiation advantage. Distribution is a critical process of the supply chain, and links the entire organization with it inbounds and outbound suppliers and market in which it operates. Success of activities of distribution logistics can be understood through measuring performance level. An important step in measurement involves selecting the most appropriate measures. Right measures must be employed to the right situation .

Literature research showed that, many studies take into consideration distribution logistics performance together with supply logistics performance and others measures.

This study emerged distribution logistics performance measures and will offer important contribution to the science, because only the impact of distribution logistics performance on firm performance can be measured. Second it is seen that performance measures are defined and categorized in various ways in accordance with the specific views of researchers as well the scope of their respective studies. In this study all relevant measures have been observed and efforts have been made to constitute a common terminology. In our study measures obtain through literature research were grouped as per the SCOR model, which was developed by the Council of Supply Chain. Future research can be made by taking into account measures and groups in this study, thus common terminology can be used.

REFERENCES

[1] Bookbinder, J. H. and Lynch, M.E., 1997, "Customer Service in Physical Distribution: a utility-function approach", International Journal of Physical Distribution & Logistics Management, 27, 540-558

[2] Jeong, J.S. and Hong, P., 2007 "Customer Orientation and Performance Outcomes in Supply Chain Management", Journal of Enterprice Information Management, 20, 578-594

[3] Langley, C.J., Coyle J.J., Gibson, B.J., Novack, R.A., Bardi, E.J., "Managing Supply Chains, A Logistics Approach", 2009, International Edition, South Western.

[4] Fawcett, S.E. and Cooper, M.B., 1998, "Logistics Performance Measurement and Customer Success", Industrial Marketing Management, 27, 341-357

[5] Mentzer, J. T. and Konrad, B. P., 1991, "An Efficiency / Effectiveness Approach to Logistics Performance Analysis", Journal of Business Logistics, 12, 33-62

[6] Neely, A., Gregory, M. and Platts, K., 2005, "Performance Measurement System Design: A literature Review and Research Agenda", International Journal of Operation & Production Management, 25, 1228-1263

[7] Chan, F.T.S. and Qi, H. J., 2003, "An Innovative Performance Measurement Method for Supply Chain Management", Supply Chain Management: An International Journal, 8, 209-223
[8] Waggoner, D. B., Neely, A. D. and Kennerly, M. P., 1999, "The Forces that Shape, Organisational Performance Measurement Systems", The International Journal of Production Economics, 60-61, 53-60
[9] Beamon, B.M., 1999, "Measuring Supply Chain Performance", International Journal of Operation &Production Management, 19, 275-292
[10] Gunasekaran, A., Patel, C. and Tırtıroğlu, E., 2001, "Performance Measures and Metrics in a Supply Chain Enviroment", International Journal of Operation & Production Management, 21, 71-87
[11] Morash, E.A., Droge, C. L. M. and Vickery, S. K., 1996, "Strategic Logistics for Competitive Advantage and Firm Success", Journal of Business Logistics, 17, 1-22
[12] Fawcett, S. E. Stanley, L. L. and Smith, S.R., 1997,"Developing A Logistical Capability to Improve The Performance of International Operations", Journal of Business Logistics, 18, 101-127
[13] Stank, T. P. and Lackey, C. W. L., 1997, " Enhancing Performance Through Logistical Capabilities in Mexian Maquiladora Firms", Journal of Business Logistics, 18, 91-123
[14] Lynch, D. F., Keller, S. B. and Ozment, J., 2000, "The Effects of Logistics Capabilities and Strategy on Firm Performance", Journal of Business Logistics, 21, 47-67
[15] Tracey, M., Lim and J. S. Vonderembse, M. A., 2005, "The Impact of Supply Chain Management Capabilities on Business Performance", Supply Chain Management: An International Journal, 10, 179-191
[16] Cho, J. J. K., Ozment, J. and Sink, H., 2008, "Logistics Capability, Logistics Outsourcing and Firm Performance in an E-Commerce Market", The International Journal of Physical Distribution & Logistics Management, 38,336-359
[17] Ellinger, A. E., Daugherty, P. J. and Keller, S. B., 2000, "The Relationship Between Marketing / Logistics Interdepartmental Integration and Performance in U.S. Manufacturing Firms, An Empirical Study", Journal of Business Logistics 21, 1-22
[18] Germain, R., and K. N. S. Iyer., 2006, " The Interaction of Internal and Downstream Integration and its Association with Performance", Journal of Business Logistics, 27, 29-34
[19]Sezen, B., 2008, "Relative Effects of Design, Integration and Information Sharing on Supply Chain Performance", Supply Chain Management: An International Journal, 13, 233-240
[20] Tan, K. C., Kannan, V. R., Handfield, R. B. and G. S.,1999, "Supply Chain Management: an Empirical Study Of its Impact on Performance", International Journal of Operation & Production Management, 19,1034-1052
[21] Wisner, J.D., 2003, "A Structural Equation Model of Supply Chain Management Strategies and Firm Performance", Journal of Business Logistics, 24 ,1-26
[22]Vickery, S. K., Jayaram, J., Droge C. and Calantone, R., 2003,"The Effect of an Integrative Supply Chain Strategy on Customer Service and Financial Performance: An Analysis of Direct versus Indirect Relationship", Journal of 0peration Management, 21,523-5
[23] Kim, S. W., 2006, "Effect of Supply Chain Management Practices, Integration and Competion Capability on Performance", Supply Chain Management: An International Journal, 11, 241-248
[24] Fawcett, S. E., Calantone, R. ve Smith, R. S., 1996, "An Investigation of the Impact of Flexibility on Global Reach and Firm Performance", Journal of Business Logistics 17, 167- 197
[25] Holmberg, S., 2000, "A Systems Perspective on Supply Chain Measurements", International Journal of Physical Distribution & Logistics Management, 30, 847-868
[26] Rafele, C., 2004, "Logistics Service Measurement: A Reference Framework", Journal of Manufacturing Technology Management, 15, 280-290
[27] Ballou, R. H., 1998. Business Logistics Management, Prentice Hall.
[28] Daugherty, P. J., Stank, P. T. and Ellinger, E. A., 1998, "Leveraging Logistics / Distribution Capabilities: The Effect of Logistics Service on Market Share", Journal of Business Logistics, 19, 35-51
[29] Tracey, M . 1998," The Importance of Logistics Efficiency to Customer Service and Firm Performance", International Journal of Logistics Management, 9, 65-81
[30] Milgate, M., 2001, "Supply Chain Complexity and Delivery Performance: An International Explaratory Study", Supply Chain Management: An International Journal, 6, 106-118
[31] Stank, T.P., Goldsby, T. J., Vickery, S. K. and Savitskie, K., 2003, "Logistics Service Performance: Estimating Its Influence on Market Share", Journal of Business Logistics, 24, 27- 55
[32] Forslund, H., 2006, "Performance Gaps in the Dyadic Order Fulfillment Process", International Journal of Physical Distribution & Logistics Management, 36,580-595

[33] Töyli, J., Hakkinen, L., Ojala, L. and Naulo, T., 2008, "Logistics and Financial Performance", International Journal of Physical Distribution & Logistics Managemet, 38, 57-80
[34] Vonderembse, Z. Q. M. A. and Lim, J. S., 2005," Logistics flexibility and its Impact on Customer Satisfaction", The International Journal of Logistics Management, 16,71-95
[35] Emerson, C. J. and Grimm, C. M., 1996, "Logistics and Marketing Components of Customer Service: an Empirical Test of The Mentzer, Gomes and Krapfel Model", International Journal of Physical Distribution & Logistics Management, 26, 29-42
[36] Khan, A.K., Bakkapa, B., Bhimaraya A.M. and Sahay, B. S., 2009, "Impact of Agile Supply Chain Delivery Practices on Firm Performance, Cluster Analysis And Validation", Supply Chain Management: An International Journal, 14, 41-48
[37] Griffis, S.E., 2001, "Aligning Logistics Measures to Measurement Needs", *PhD Thesis,* The Ohio State University, Ohio

Url-1 http://cscmp.org/Default.asp

Url-2 http://supply-chain.org/

CONSOLIDATION AND COOPERATION OF AIR CARGO CARRIERS IN A GLOBAL ERA: A REVIEW OF CURRENT STATUS AND FUTURE PROSPECTS

Ferhan Kuyucak[1], Yusuf Sengur[2]

Abstract *– Cooperation and consolidation efforts of airline industry have long been scrutinized in terms of economic and managerial outcomes to industry. Recently these efforts have also becoming an issue for air cargo carriers. To overcome regulatory barriers and reach cost efficiency, wider network coverage, and better customer services air cargo carriers have faced to an important decision whether being in a cooperation and consolidation attempts or not. In this study, such attempts of air cargo carriers are discussed through industrial examples.*

Keywords – Airline alliances, Cargo carriers, Consolidation, Cooperation, Mergers and acquisitions

INTRODUCTION

Air cargo service is an important enabler for economic development. Its speed and large coverage area create a link between producers, suppliers, and consumers all around the world. It also provides an important strategic advantage through time sensitive deliveries. Air cargo business is an integral part of airline industry, because other than full cargo airlines, airlines can also carry cargo by their passenger aircraft and also their dedicated aircraft. Cargo air carriers are also subject to similar dynamics of airline industry. Other than this, air cargo industry is also closely linked to global supply-chains and logistics.

Cooperation through mergers and acquisitions, joint ventures and alliances and increasing level of consolidation in the air transportation industry has been a global trend at present. Consolidation is resulting in a more concentrated air transportation system, composed of a smaller number of larger firms and transforming both national and international airline markets. While airline consolidations increase, airline alliances continue to expand as globally as well. In addition to combination air carriers' cooperation, cooperation among full cargo carriers or between full cargo and combination carriers has also coming to agenda.

Air cargo carriers like the airline passenger carriers seek to expand their network coverage area for cost efficiency and better customer service to increase choice for them. In the era of globalization of industrial markets and supply chains, current regulatory barriers are among the main issues for air cargo carriers. Consolidation and cooperation seem a better preference for air carriers to reach cost efficiency and wider network coverage, and to overcome regulatory barriers.

While there is a substantial upward trend in consolidation globally; cooperative and consolidative patterns for cargo airlines are not clear yet. This paper aims to document the cooperation and consolidation trends from an air cargo carrier perspective, and explore how industry consolidation trends effects air cargo carriers. For this purpose, first, it tries to clarify external and internal environment for passenger and cargo markets and the drivers of airline consolidations. Later it addresses the extent, nature and impact of the recent surge in cooperation strategies followed by the cargo airlines with an overview of cargo airline consolidations which occurred in recent years. It ends with some future prospects in the light of current status.

Overview of the Air Cargo Industry

Air cargo is vital to the transport of goods globally. It is somehow impossible to think today's global economy could sustain without the direct support of air transportation. No other means of transportation could meet the needs of global economy well. Especially for perishable goods, special cargos, and high value-to-

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weight products such as microelectronics, pharmaceuticals, aerospace components, medical devices, and when there is an urgency air cargo sounds the best solution for them.[1] Air cargo contributes significantly to businesses to streamline their supply chain by reducing both inventory costs and period of time to reach the products to the markets. Air cargo also supports the industrial transformation occurring during the last decades such as e-commerce, shorter product life spans, outsourcing, and practice of just-in-time logistics.[2]-[3]

International air freight accounts approximately 30-35% of all international trade by value. This represents 1-2% of all transported goods by weight.[2]-[1] The air cargo volume heavily depends on international trade. In effect, its growth rate is quite parallel to international trade growth rate. Even it is growing faster than international trade.[4] Cargo traffic increased 18.9% in 2010 after 2 years consecutive decreases in 2008 and 2009 according to the ICAO's annual trends report.[5] Boeing stated that over the reflecting the economic growth, worldwide cargo traffic is expected to raise average 5.9% while passenger traffic will average 5.3% growth for the next 20 years.[6]

The air cargo can be transported by three types of air carriers. All-cargo carriers have aircraft specifically designed for transporting cargo by air and these aircraft are called air freighters. Mixed passenger cargo carriers are also carrying air cargo in the lower deck of their passenger aircraft or they may own air freighters too. The third type of air cargo carriers is providing door-to-door parcel services such as UPS, Fedex, and DHL etc. While some large airlines such as Lufthansa, Singapore Airlines, Korean Air, Cathay Pacific, and China Airlines have mixed passenger-cargo fleet, some others like American Airlines and United Airlines do not have air freighters and they provide cargo services with their passenger aircraft. All-cargo airlines such as CargoLux, Nippon Cargo Airlines, Atlas Air, and ABX are some of the major all-cargo airlines.[1]

Consolidation and Cooperation in the Air Cargo Industry

Three common types of consolidation have been occurring in airline industry such as mergers, acquisitions and joint venture of airlines. Merger&Acquisition is a marriage between airlines. Air France and KLM, United Airlines and Continental Airlines; British Airways and Iberia are the examples of big airlines' marriages in recent years. The acquisition of KLM Airlines by Air France was the first large scale international airline merger. It was an example of successful merger that allows these two airlines combine their operations and create a huge consolidated airline.

Joint venture occurs in airline industry as two airlines combine for example their cargo operations and manage them separately from their passenger operations.

Alliance is one of the forms of cooperation between two or more business entities. An alliance could be viewed as a lesser form of a merger. However, businesses remain separate and do not abandon their decision making autonomy in the alliances.[7] Fu et al.(2010) argue that strategic alliances are the second best choice to achieve broader network connections after liberalization. On the other hand, when foreign ownership and control restrictions are relaxed airlines might consider merger and acquisition is a possible alternative to have a better network structures and market position.[8]

The main difference between alliances and mergers is about ownership and control. Alliances have nothing to do with legal ownership and control. Alliances have loose links and based on revenue sharing. During alliances every company remains independent, whereas, as a result of a merger a new company established.[9]

Trethewey and Oum (1992) classified airline alliances into three categories: [10]

- Type I (simple route-by-route alliance),
- Type II (broad commercial alliance), and
- Type III (equity alliance).

Type I alliances are also called tactical alliances. Tactic alliances are narrow types of other alliances. They are restricted with activities on a few routes. They generally include code sharing and cross-selling activities between two airlines. Block space, shared frequent flier programs (FFPs), joint use of airport facilities and ground handling activities can also be subject of Type I alliances. [9].

Second and third types of airline alliances are seen as strategic alliances, because these types of alliances are much more about strategic level of corporate commitment. [10] Strategic alliances differs from the other types of cooperation by having exclusive memberships and a joint marketing entities for network-wide cooperation.[11]

Fan et al, 2001 highlighted five forces influencing the structure of airline alliance and consolidation:[11]

- Increase globalization in trade and air transportation,
- Increase, intra-regional interaction,
- Economics incentives for airline consolidation,
- Pace of liberalization in air transport industry,
- Anti-trust concerns.

There are many internal and external forces that may influence airlines to be enthusiastic towards any types of alliances and consolidation. These are the most striking ones.

Alliances provide some benefits to airlines such as expanding their network, realizing economies of scale and scope, improving product quality and customer service.[7] Alliances also help cost structure by providing more efficient and effective customer service. Another significant benefit is to reduce waiting time at transit points for both passenger and cargo.[4] Oum and Park (1997) identified six main reasons for alliances for airlines:[12]

- Expansion of seamless network service
- Traffic feed between partners
- Cost efficiency
- Improved service quality
- Increased itinerary choices for passengers
- Advantage of CRS display

Different types of alliances include different type of joint activities and shared benefits of its members. Any type of alliances can produce such joint activities:[12]

Coordination in ground handling

- Joint use if ground facilities
- Shared membership for frequent flier program
- Codesharing or joint operation
- Block space sales (passenger/cargo)
- Coordination of flight schedules
- Exchange of flight attendants
- Joint development of systems or systems software
- Joint advertising and promotion joint maintenance
- Joint purchase of fuels and other supplies

Obviously all reasons and benefits of alliances are not applicable to air cargo business. However, air cargo business shares most of the reasons and benefits of alliances in airline passenger business, because more than half of the cargo carried by airlines is transported as belly cargo in passenger aircraft. Thus, air cargo transportation and passenger transportation are significantly overlapped to each other.[13]-[4] Air cargo airlines have also seen alliances as a prominent option to provide more integrated cargo services and overcome regulatory barriers that restrict to accession of domestic markets and limit foreign ownership. Minimized waiting time by adjusting time schedule and joint activities at the connecting airport are the benefits from the alliance for partners. Hence, it is found that cargo alliance is likely to increase the outputs of alliance partners. Alliance reduces the marginal cost because of complementary production of passenger and cargo services.[4]

For air cargo industry, the need for consolidation and cooperation is growing because of the factors that meet increasing customers expectations, need for scale to reach lower cost structure and better margins, having financing problems of small airlines. In addition, changing ownership restrictions has led the way considering consolidation is a viable option for air carriers.

According to Global Air Cargo Survey 2010, air cargo executives also expect more industry consolidation which has already came in the scene. 80% of CEO’s agreed that “only a small number of strong, global freighter operators will remain.” Only 20% of the executives are actively looking for some merger and acquisition opportunities. Whereas, 48% of them are planning to seek out alliances and partnership opportunities.[14]

TABLE 1
Consolidation and Cooperation in Air Cargo Industry

Type	Activity	Example
Consolidation	Merger & Acquisition	Lufthansa Cargo-Austrian Airlines
	Joint venture	Air China Cargo Co., Ltd. (Air China Ltd.-Cathay Pacific Airways Ltd.) U.S Cargo Sales Joint Venture, LLC (Air France Cargo-Delta Air Logistics-Korean Air Cargo), Aerologic (Lufthansa Cargo-DHL Express)
Cooperation	Tactic alliances	Qantas-Air France
	Strategic alliances	SkyTeam, WOW

Industry Examples

Several examples of air cargo carriers' consolidation and cooperation efforts are given below:

Lufthansa Cargo and Austrian Airlines merged their global cargo activities and harmonized product portfolio and processes in 2010. China Eastern Airlines and Shanghai Airlines also merged their cargo subsidiaries in 2010 and the new cargo airlines became the largest cargo carrier in China with 20 freighters.

Air China and Cathay Pacific announced their joint venture Air China Cargo Co., Ltd. (ACC) has started operation on May 2011. China is one of the world's fastest-growing air cargo markets and this joint venture will enable the joint venture to strengthen the market position in China.

Creating seamless network for passengers is most likely the main reason of joining an airline alliance. Similarly, a cargo alliance leads to seamless coordination and delivery globally for its members. Large airline alliances are mainly for passenger airline business. Among them, OneWorld alliance has also started an initiative to deepen relationship for cargo other than passenger business in 2002. A typical air cargo alliance is thought to have members such as all-cargo airlines and cargo subsidiaries or units of passenger airlines. Well-known cargo alliances are SkyTeam Cargo and WOW Cargo.

SkyTeam Cargo is the largest group among the air cargo alliances. SkyTeam Cargo alliance was founded by SkyTeam members AeroMexico, Air France, Delta, and Korean Air in 2000. Russian Aeroflot joined the global airline alliance on May 2011 and the number of team members reached to eight. The other three members are Alitalia Cargo, Czech Airlines Cargo, and China Southern Cargo. SkyTeam Cargo alliance provides its members and its customers seamless cargo coordination, movement of cargo throughout the alliance's global network, shared warehouse handling, and simplified processes.

WOW Cargo Alliance was established by Lufthansa Cargo, Singapore Airlines Cargo, and SAS Cargo Group in 2000. Then JAL Cargo joined the alliance in 2002. WOW Cargo Alliance aimed to offer customers and its partners an expanded network and harmonizing their services to transport products seamlessly throughout the network. Lufthansa Cargo left the alliance in 2009 and JAL left in 2010.

FUTURE PROSPECTS AND CONCLUSION

Consolidation and cooperation attempts among air cargo carriers have brought the industry thinking new possibilities. Seeking to create seamless network and better customer services seems to accelerate consolidation and cooperation among airlines. Such attempts may also be expected with logistic and freight companies as well. Air cargo carrier alliances are not extensive like air passenger industry. However, it also provides numerous benefits to its members as well as customers like efficiency and seamless services.

Consolidation and cooperation serve to industry having cost efficient and better customer services through expanded and seamless network. What air carriers and other logistic parties would do is trying to seek for some opportunities all around the world to make them satisfied with a successful partnership. Since, goods will continue to travel more and more globally in the future. In addition, air cargo industry will continue its growth and air services will continue to allow time-sensitive deliveries through seamless network coverage.

First attempts towards cooperation and consolidation are expected to give strength to both cargo airlines and other logistic parties to seek more integrated services in the future. Intensive consolidation in air cargo industry may have deep effects to industry. As a result of consolidation, financially strong air carriers, expanded networks, and high profit margins are expected. Vertical consolidation may also help industry having simplified processes and more customer focused services that air cargo carriers are enthusiastic about such service level. As a result, it can be said that cooperation is much more widespread than consolidation between cargo airlines. On the other hand, these cooperation efforts may be seen a trial and error period which might trigger industry consolidation in the future.

REFERENCES

[1] Kasarda, J. D., Appold, S. J. and Mori, M., 2006, “The Impact of the Air Cargo Industry on the Global Economy”, The International Air Cargo Association Air Cargo Forum Calgary, Canada, September 13, 2006.

[2] Zhang, A. and Zhang, Y., 2002a, “Issues on Liberalization of Air Cargo Services in International Avaition” Journal of Air Transport Management, 8, pp.275-287.

[3] Zhang, A. and Zhang, Y., 2002b, “A Model of Air Cargo Liberalization: Passenger vs. All-cargo Carriers”, Transportation Research Part E 38, pp.175-191.

[4] Zhang, A., Hui, Y.V., Leung, L., 2004, “Air Cargo Alliances and Competition in Passenger Markets” Transportation Research Part E 40, pp.83-100.

[5] ICAO (International Civil Aviation Organization), 2010, www.icao.int

[6] Boeing Current Market Outlook, 2010, www.boeing.com

[7] Zhang A. and Zhang Y., 2006, “Rivalry between strategic alliances” International Journal of Industrial Organization, 24. pp.287-301.

[8] Fu, X., Oum T.H., and Zhang A., 2010, “Air Transport Liberalization and its impacts on airline competition and air passenger traffic” Transportation Journal, Fall 2010, pp. 24-4.

[9] Iatrou, K. and Oretti, M., 2007, “Airline Choices for the Future: From Alliances to Mergers”, Ashgate Publishing Limited, Hampshire.

[10] Trethwey M.W. and Oum, T.H., 1992, “Airline Economics: Foundation and Strategy and Policy” The Centre for Transportation Studies, University of British Columbia.

[11] Fan, T., Wigeant-Langlois, L., Gessler, C., Bosler, B., and Wilmking, J., 2001, “Evolution of global airline strategic alliance and consolidation in the twenty-first century” Journal of Air Transport Management, 7, pp.349-360.

[12] Oum, T. H. and Park, J-H., 1997, “Airline Alliances: current status, policy issues, and future directions.” Journal of Air Transport Management, Vol.3 No.3, pp. 133-144.

[13] Glisson, L. M., Cunningham W.A., Harris, J.R., and Di Lorenzo-Aiss J., 1996, “Airline Industry Strategic Alliances: Marketing and Policy Implications”, International Journal of Physical Distribution & Logistics Managament, Vol.26 No.3, pp. 26-34.

[14] Hermann, N., Watterson, A., and Hornick, S., 2010, “View from the Top: Global Air Cargo CEO Survey”, Research Report 2010, Oliver Wyman.

A MARKET RESEARCH ON THE CHARTER TYPE CHOICE OF TURKISH GENERAL CARGO AND DRYBULK SHIPOWNERS

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Abstract - *The purpose of this study is to determine the most preferred charter types by Turkish general cargo and dry bulk shipowers and uncover the criteria taken into consideration while shipowners decide on certain charter party types. In the study, the methodology utilized which constitutes literature review, in-depth interview, and survey. The data gained through the survey was processed, through which the means were found out and exposed to factor analysis. The study reveals that Turkish shipowners mostly prefer voyage charter, which is respectively followed by consecutive voyage charter, contract of affreightment and short term time charter. Another point revealed through the study is that shipowners consider certain variables relatively important over the others in deciding on the charter types. The variables could be listed as follows respectively in terms of their ranking and the level of importance they have been given: the risk in the vessel charter type chosen, sustainability of the profit gained, the need to organize cash flow and keeping the owner control over the charter party.*

Keywords - Charter Types, Market Research, Turkish Dry Bulk shipping,

INTRODUCTION

In 2009, international seaborn trade reached to 7.843 billion tons. 1.19 billion tons of these trade consisted of containerized cargoes and 6.65 billion tons of cargo consisted of oils, main bulks and other dry cargoes[1]. Although some small amounts of oil, dry bulk and general cargoes are carried on cargo owners own vessels, majority of the world's bulk and general cargoes are carried by chartered vessels. On the other hand, although biggest international charter market is in tanker and dry bulk tonnage, there is also a significant market for liner and specialist vessels. Liner companies from time to time need to charter in additional ships to meet the requirements of upswing in trade or to service the trade while their own vessels are undergoing major repairs[2]. Either in liner or in tramp market, the chartering of the vessels is inevitable. In chartering, there exist different methods. This situation forces the shipowners and cargo owners to decide on the most appropriate charter types.

The purpose of this study is to determine the most often preferred charter types by Turkish general cargo and dry bulk shipowers and uncover the criteria taken into consideration while shipowners decide on certain charter party types.

In the literature, there exists very few studies focusing on chartering. The studies which have been reached are: Voyage chartering of dry Bulk Carriers [3], time chartering of the vessels [4], the responsibilities of charterers in time charter [5], charterer's liabilities under the ship time charter [6], merchant vessel chartering and operation in international trade[7], analysis of freight rate volatility in dry bulk shipping markets[8], [9], [10], [11], dry bulk shipping spot and time charter freight rates [12], [13]. However these studies are not directly related with determination of charter party preferences either by shipowners or charterers. But, study reference [13] looks for answer for two questions. The first one is "what explains why some shippers and carriers rely on spot contracts, and others do not?" and the second one is what explains the

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contract duration and vertical integration decisions of shippers and carriers that do not contract spot? In another study, the type of contract observed in a trade should therefore depend on the following: the characteristics of the cargo flows, the nature of the markets for the transported commodity, the geographic dispersion of supply sources, and the characteristics of the ships employed in that trade. This is the only study that we have reached so far.

In this study, section 1 introduces the overall vessel charter types, comparing and contrasting them. Section 2 discloses the overall number and tonnage of the general cargo and dry bulk carriers owned by Turkish shipowners and their ranking in the total trade shipping fleet. Section 3 involves an overall literature review with particular respect to vessel chartering through which the variables concerning charter type choices have been revealed, deep interview, and survey.

CHARTER CONTRACTS

Charter contracts are negotiated between the "shipper" of a commodity, the individual or firm desiring to transport it by ship between two ports, and the "carrier," usually the owner of a ship. There are three basic forms of shipping contract: the voyage charter, the time charter, and the contract of affreightment [14]. Besides, there are other charter types which can be accepted as secondary charter types. These are consecutive voyage charter which is a special type of voyage charter, trip charter which is a special type of time charter and bare boat charter.

The voyage charter is the most basic type of shipping contract [14]. A voyage charter provides transport for a specific cargo from port(s) of loading to discharging for a fixed price per ton [2]. Under a voyage charter the shipowner is usually responsible for all costs incurred on the voyage. Since voyage contracts are usually negotiated shortly (between a few days to two weeks) before the loading of the cargo, they are "spot" contracts, although carriers and shippers sometimes negotiate forward-voyage contracts a month or more in ad- vance of the agreed on loading date [14]. Consecutive voyage charters are a special type of voyage charter where the vessel is contracted for several voyages which follow consecutively upon each other [15].

Another common form of shipping contract is the time charter, under which the charterer takes operational control of the ships carrying his cargo, while leaving ownership and management of the vessel in the hands of shipowner [2]. Under time charter, the charterer obtains the services of a ship for a specified period of time. Whereas the voyage charter specifies all important characteristics of a particular ship's trip, the time charter allows the charterer to choose its operating pattern to suit his particular needs. He pays the variable expenses arising from his use, including fuel and port charges. The ship- owner provides a crew to serve the vessel, except under the relatively rare "bare boat" charter, where the shipper does. Time charter prices are usually quoted on a per diem basis. Parties usually negotiate time charters immediately prior to the transfer of control of the ship, although some are forward contracts. They range in duration from a month to several years: most expire in less than three years, but some extend for fifteen years[14].

A special type of time charter is trip charter. When a charterer wishes to employ a vessel for a voyage but does not wish to take the risk of having to pay demmurage, for example, he may charter the vessel on time charter terms but specify the voyage and the expected duration of the voyage. The charterer would pay hire in the usual way as in a time charter, instead of freight, and the contract would be treated as any time charter [16].

The last major type of shipping contract is the contract of affreightment (COA). In the contract of afftreightment, the shipowner agrees to carry a series of cargo parcels for a fixed price per ton [2]. These contracts are usually relatively long-term contracts. They specify the cargo, minimum and maximum volumes carried over specified time periods, the ports of origin and destination, and the frequency of service. They also frequently set out various performance requirements that the shipper and carrier must satisfy, as well as pricing mechanisms. The most common pricing mechanism is variable cost (usually defined as fuel plus crew) plus a fixed payment.5 In some instances prices are indexed by the spot charter rates for similar ships or cargoes that prevail at various points throughout the duration of the COA. All of these terms indicate that COAs are much more than simple rate tariffs between a shipper and carrier. Under a COA the shipper guarantees cargo volumes and the carrier guarantees service frequency in return. Thus, the contract specifies input and output as well as price.

Bareoat chartering, or chartering by demise exists as an alternative to period time-chartering, whereby an owner of a vessel charters away the ship to another party who takes all the responsibility for operating the vessel and assumes more the role of owner than of charterer [17]. Under this arrangement the investor, not necessarily a professional shipowner, purchases the vessel and hands it over to the charterer for a specified period, usually ten to twenty years. The charterer manages the vessel and pays all operating and voyage costs [2]. This taxonomy of charter types reveals that contractual arrangements in shipping markets are extremely varied.

TURKISH NATIONAL FLEET

In January 2010, there were 102,194 commercial ships in service, with a combined tonnage of 1,276,137 thousand dwt in the world [1]. Together, the top 35 shipowning countries (in terms of DWT) control 95.5 per cent of the world tonnage. About one third of this tonnage is controlled by owners from developing countries and about two thirds by owners from developed countries.

According to reference [1], Turkey owns 1222 ships over 1000 GT. 558 of these ships operate under national flag, while 664 of them operate under foreign flags. Turkish shipowners have a capacity of 16 768 968 DWT on and over 1000 GT. 7 139 310 DWT of this capacity is under national registration, while 9 629 658 DWT of the capacity is with foreign flags. Size of the Turkey's ship capacity is at 18th place in global rank. Ships on and over 500 GT, which make up the Turkish Maritime Trade Fleet are given in the Table 1. Ships given in the table generate 100% of the total fleet on DWT basis.

TABLE 1

Turkish Maritime Fleet as of June the 8^{th} 2010

SHIP TYPES	NUMBER				DWT			
	NATIONAL REGISTRY	SECOND REGISTRY	TOTAL	%	NATIONAL REGISTRY	SECOND REGISTRY	TOTAL	%
General Cargo	**100**	**325**	**425**	**27,02**	**130.723**	**1.307.649**	**1.438.372**	**17,94**
Bulk Cargo	**6**	**90**	**96**	**6,1**	**173.638**	**3.398.039**	**3.571.677**	**44,55**
Container Ships	7	42	49	3,12	128.276	493.189	621.465	7,75
General Cargo & Container	0	20	20	1,27	0	140.250	140.250	1,75
Container/ RO-RO	0	2	2	0,13	0	13.820	13.820	0,17
Oil Tankers	61	69	130	8,26	66.430	1.114.960	1.181.390	14,74
Product Tankers	0	1	1	0,06	0	3.260	3.260	0,04
Chemical Tankers	8	77	85	5,4	34.296	604.242	638.538	7,96
LPG Carriers	0	6	6	0,38	0	25.868	25.868	0,32
RO-RO Ships	1	26	27	1,72	0	191.379	191.379	2,39
RO-RO Ferry-Pax Ships	4	18	22	1,4	2.396	28.269	30.665	0,38
Ferry-boats	13	27	40	2,54	1.904	10.365	12.270	0,15
OTHER	457	213	670	42,6	63.161	85.040	148.201	1,86
TOTAL	**657**	**916**	**1.573**	**100,0**	**600.824**	**7.416.330**	**8.017.154**	**100,0**

Source: DTO (Chamber of Shipping) Statistics, 2010

When the Turkish fleet is analyzed, it is seen that 62,49% of the fleet consists of general cargo and bulk cargo ships. It shows that the fleet mainly consists of such ships. This study particularly focuses on determining the tendency of charter of general cargo and bulk cargo shipowners.

AIM OF THE STUDY

The aim of the study is to determine the most often preferred charter types by Turkish general cargo and dry bulk shipowers and uncover the criteria taken into consideration while shipowners decide on certain charter party types.

RESTRICTIONS OF THE STUDY

The study is applied for Turkish ship owning companies which have general cargo and dry bulk cargo ships of on and over 1500 dwt.

METHODOLOGY OF THE STUDY

A multiple method with three stages were used for the study. In the 1st stage, second hand data sources were searched in detail, and it was attempted to determine the factors which have effect on determining the charter types; through the literature review.

In the second stage, factors affecting the charter type were determined by conducting interviews with senior managers and ship brokers who are actively involved in charter contracts and who work at ship management companies.

In the third stage, the survey was conducted through the questionnaire which was prepared by using the factors that have influence in determining the type of charter contract.

Determination of factors effecting the charter party types

First of all, Turkish National Thesis Bank of the High Education Board was searched in order to reach the post graduate thesis and doctoral thesis written on the chartering. In addition, articles that focus on different aspects of the factors that affect the ship charter contract types of carriers were determined. Within scope of the study, 90 variables were determined, which affected the determination of charter type of shipowners. However, number of said variables were reduced to 25 after consulting to specialist academicians on chartering.

Interview

With regard to the preparation of the questionnaire form, it is decided to include the opinions of shipbrokers and ship managers, in addition to the variables identified through the literature review. In order to obtain new variables, interviews were held with the experts from the shipping industry.

Five Turkish ship owning company which have offices in Izmir were interviewed in order to determine the variables in the questionnaire. Interviews took 30 minutes on average. In general, satisfactory and purpose-oriented answers were received to the questions, which were prepared before interviews. 37 variabless were identified following the interviews.

Generation of the Questionaire

A questionnaire form with 4 parts were prepared to identify the factors affecting the selection of charter type, and to determine the tendencies of Turkish shipowners with regard to the chartering. First part consists of 5 questions which will reveal the profiles of participants. Second part consists of 5 questions that include general information on enterprises, which will reveal the company profiles of participant enterprises. Third part consists of two questions in order to identify the chartering types preferred by the shipowners. Last part of the questionnaire form consists of 28 questions, which were prepared to identify the factors affecting the selection of charter type of Turkish shipowners. Therefore total 40 questions were asked. Above mentioned 28 questions were prepared in accordance with 5 point likert scale and they include expressions which are intended to reveal the approaches of participants.

Concerning the generation of the questionnaire form, variables which were identified through literature review as well as the variables determined through interviews with Turkish shipowners that have offices in Izmir were taken as basis. Total 62 variables were found - 25 of them were found through the literature review, while 37 of them were found through the interviews. These variables were analyzed according to the instructions and recommendations of the Instructors of Dokuz Eylül University in Izmir, for purposes of determining the variables in the form, which could affect the selection of charter type. Some of the variables were united, which were similar in terms of meaning and content, some of them were found inappropriate and were improved by adding certain expressions. Consequently, 28 variables were determined, which could affect the selection of charter types by Turkish shipowners.

Questionnaire form was sent to 8 specialist academicians. Expressions, meaning clarity and format were reviewed and necessary adjustments were made by the academicians. In its final shape, the questionnaire form consisted of 4 pages (including the cover), 4 parts and 40 questions and was ready to be distributed to the ship owning companies forming the sample group.

Population and Sample

The population of the study is shipowners which operate their vessel under Turkish or foreign flag and which have ship types that could be used for carrying dry bulk cargo, general dry cargo with a capacity of 1.500 dwt tonnes and over, which conduct operations actively and which have office in Turkey. 192 enterprises with these qualifications were found in DTO (Turkish Chamber of Shipping) records. The population of the study is said 192 enterprises.

Process of Applying the Survey

Firstly, telephone calls were made with these 192 ship owning companies. During these telephone conversations, concept of the survey was explained, and it was told that the obtained data would only be used for this scientific study and that trade names of them would be kept confidential. Following these telephone conversations, questionnaire forms were sent to them via e-mail. Field study was started on June 22, 2010 and ended on July 12, 2010. During this period, 93 forms were sent back. Reached sample number consists of approximately 48% of the population.

Techniques Used for Analyzing the Survey Data

Regarding the analysis of the data, Statistics Package Program SPSS 16.0 was used, which is used for Social Sciences. The data obtained via this package program was subjected to several analysis methods. Concerning the returned forms, the survey was analyzed in terms of reliability and Cronbach Alfa was checked. Alpha coefficient was determined as 0,858. In addition, it was determined that the scale used in the survey was highly reliable. Answers given to 40 questions were assessed through various analysis techniques. Answers given in the first, second and third parts were subjected to frequency analysis and their frequency dispersion was explained and interpreted. While the variables that affect the selection of the type of ship charter contract which are included in the forth part were subjected to factor analysis. Consequently, 9 factors were obtained among 28 variables, which affect the selection of the type of charter.

FINDINGS OF THE SURVEY

Findings obtained through the survey method were explained in four parts. In the first part, profile information of the participants was given, while in the second part; profile information of the ship owning companies was explained, in the third part; ship charter types most commonly used by shipowners, as well as ship carter types used by these companies previously were explained. In the last and fourth part; factors affecting the selection of ship charter type were described.

Profile of the Participants

Findings related to the profile variables of participants are given in Table 2. According to the findings, 30,1% of the participants are at the age of 31-35. Furthermore, 65,5% of the participants are university graduate, while 14% of them are post graduate.

TABLE 2
Profile of the Participants

AGE				EDUCATION		
Age	**(n) Frequency**	**(%) Percentage**		**Education**	**(n) Frequency**	**(%) Percentage**
25 - 30 ages	17	18,3		Secondary school	1	1,1
31 – 35 ages	28	30,1		High school	18	19,4
36 - 40 ages	25	26,9		University	61	65,5
41 - 45 ages	14	15,1		Post graduate	13	14
46 and over	9	9,6		**Total**	93	100
Total	93	100				
EXPERIENCE				**FUNCTION**		
Experience	**(n) Frequency**	**(%) Percentage**		**Function in the organization**	**(n) Frequency**	**(%) Percentage**
1 - 5 years	14	15,1		Chartering manager	19	20,5
6 - 10 years	21	22,6		Shipowner's home broker	27	29
11 - 15 years	27	29		Senior manager	9	9,7
16 - 20 years	19	20,4		Manager	27	29
21 years and over	12	12,9		Member of the Board of Directors	11	11,8

Analyzing the experience periods of the participants in maritime sector, largest group (29%) was the group with an experience of 11-15 years. Observing the dispersion according to the functions of the participants, home brokers and enterprise managers share the 1st rank with a percentage of 29%.

Profile of the Companies

In the second part of the study, number of ships of the participating enterprises, sizes of the ships, types of the ships, regions where the ships are operated, as well as data regarding the flags of the ships were subjected to frequency analysis. Findings are given in Table 3.

TABLE 3
Findings Related to the Company Profiles

NUMBER OF SHIPS		
Number of ships in the fleet	**(n) Frequency**	**(%) Percentage**
1	37	39,8
2	28	30,2
3	9	9,7
4	5	5,3
5	5	5,3
6	2	2,1
7	2	2,1
9	1	1,1
11	1	1,1
16	1	1,1
20	1	1,1
30	1	1,1
Total	**93**	**100**

SIZE OF THE SHIPS		
DWT	**(n) Frequency**	**(%) Percentage**
1.500 - 10.000	70	61
10.001 - 25.000	12	10,4
25.001 - 35.000	9	7,8
35.001 - 50.000	8	6,9
50.001 - 85.000	11	9,5
85.001 - 120.000	3	2,6
120.001 dwt and higher	2	1,8
Total	**115**	**100**

TYPE OF THE SHIP		
Ship types	**(n) Frequency**	**(%) Percentage**
Dry bulk cargo	37	32,7
General cargo ship	70	62
Other	6	5,3
Total	**113**	**100**

SAILING REGION		
Region	**(n) Frequency**	**(%) Percentage**
Black Sea	57	33,4
Mediterranean Sea	65	38
North and northeast Europe	17	9,9
West Africa	9	5,2
Whole world	23	13,5
Total	171	100

FLAG		
Flag	**(n) Frequency**	**(%) Percentage**
Turkish	80	86
Foreign	6	6,5
Turkish and foreign *	7	7,5
Total	**93**	**100**

* Shipowners operating Turkish and foreign ships.

First question was regarding the number of ships operating within the enterprise. 37 participants stated that they had only 1 ship. This number constitutes 39,8% of total answers and generate the group with the biggest percentage. In the second place, there are the enterprises with two ships, which has a percentage of 30,2%. While enterprises with three ships have a percentage of 9,7%. Total percentage of these three groups is determined as 79, 7% - which is a significant amount for the whole sample group. Analyzing these dispersions, it was observed that the participants were mainly enterprises with small fleets.

61% of the participants answered the question on the size of their ships as 1.500- 10.000 dwt. In the second place, 10,4% of the participants answered as 10.001- 25.000 dwt, while in the third place; 9,5% of the participants answered as 50.001- 85.000 dwt. However, only 1,8% of the enterprises had ships with a size of 120.000 dwt and higher. These figures show that Turkish shipowners usually have ships with small tonnage.

When the participants were asked about the region where they operated their ships, 38% of them answered as Mediterranean Sea, while 33,4% of them answered as Black Sea in the second place, and 13,5% of them answered as all seas of the world in the third place. These figures reveal that participating Turkish shipowners conducted their trade operations mainly between the ports adjacent to the Mediterranean Sea and Black Sea. This results from the small-tonnage fleets of the participating enterprises.

When analyzing the types of ships, it was revealed that 62% of the participants operated general cargo ships, while 32,7% of them operated dry bulk cargo ships. This results from the small-tonnage ships owned by the participants. In addition, these figures also show that enterprise employees who participate in the study are mainly interested in general cargo ship operations and charter types.

According to the survey, 86% of the participating enterprises operated their ships under Turkish flags, while 7,5% of them owned ships with foreign and Turkish flags. Furthermore; remaining 6,5% operated ships only with foreign flags. If we gather the obtained analysis, it can be observed that enterprises which have small fleets with small tonnage have a tendency towards operating ships under Turkish flags.

Type of Preferred Charter Contract

In this part, it is intended to reveal the charter contract types which are used by the enterprises and the charter type which is more commonly preferred by Turkish shipowners. For this purpose, answers to these two questions were analyzed with frequency analysis method and shown in Table 4 and Table 5 below

TABLE 4

Types of Chartering Contracts Used by the Shipowners

	Types of Charter Contract Used by the Shipowners *	(n) Frequency	(%) percentage	Cumulative percentage
SHIP CHARTER CONTRACTS	Voyage Charter	85	31	31
	Consecutive Voyage Charter	53	19,2	50,2
	Contract of Affreightment	36	13	63,2
	Long Term Time Charter	21	7,6	70,8
	Short Term Time Charter	45	16,4	87,2
	Trip Charter	35	12,8	100
	Bareboat Charter	0	0	100
	Other if any	0	0	100
	Total marking	275	100	
	*** In this table, types of ship charter used by the shipowners (even if they used just for once) that participated in field study.**			

In table 4, you can see the types of charter contracts used by the participant enterprises. According to the table, voyage charter type is the most commonly used charter type with a percentage of 31%. In the second place, there is consecutive voyage charter type with a percentage of 19,5%. While short term time charter type is in the third place with a percentage of 16,4%. According to the table, participants have never used bareboat charter type. Consequently, Turkish shipowners utilize voyage charters and derivatives at the rate of 63,2%. Therefore it can be said that Turkish ship owning companies mainly make voyage charter contracts. On the other hand, quantity of the shipowners who use time charter derivatives cannot be underestimated, with a ratio of 36,8%. As bareboat charter type has not been marked by the participants in the form, it can be concluded that shipowners don't prefer this type of contract.

TABLE 5

Type of Chartering Contract the Shipowners Mostly Preferred

	Type of charter which is most commonly used by shipowners*	(n) Frequency	(%) Percentage	Cumulative percentage
CHARTERING CONTRACT THE SHIPOWNES MOSTLY FREFERRED	Voyage charter contract	58	62,4	62,4
	Consecutive voyage charter contract	12	12,9	75,3
	Contract of affreightment	11	11,7	87
	Long term time charter contract	2	2,2	89,2
	Short term time charter contract	8	8,6	97,8
	Trip charter contract	2	2,2	100
	Bareboat charter contract	0	100	100
	Other if any	0	100	100
	Total	93	100	100
	*** In this table, most common charter type used by the participant ship owner is given.**			

According to the Table 5, 62,4% of the enterprises preferred voyage charter type. Consecutive voyage charter type is in the second place with a ratio of 12,9%. Contract of affreightment is in third place with a percentage of 11,7%, while short term time charter contract is in fourth place with a percentage of 8,6%. Finally, long term time charter contracts and trip charter contracts are less commonly used contracts, with a ratio of 2,2%. Again, no participant marked bareboat charter contract.

Evaluating the data in Table 5 and Table 6 together, it is clear that the answers given to the question on charter contract type were consistent with the answers given to the question on most commonly used charter type. Analyzing the frequency dispersions of the answers given to both of the questions, voyage charter contract is in the first place, while consecutive voyage contract is in the second place. This finding reveals that participating Turkish shipowners used voyage charter and voyage charter contract derivatives more commonly and frequently. Even though time charter derivatives were used by Turkish shipowners previously, repetition rate of these derivatives is quite lower than voyage charter types. On the other hand; findings also reveal that shipowners who participate in the survey have never used bareboat charter contract and had no tendency towards this type.

Factors that have Effect on the Selection of the Charter Party Type

In this part of the study, it was identified which factors affected the selection of charter type to what extent. Mean and standard deviation values of the answers given to 28 questions are given in Table 6. According to the values given in the table, most important factor that affect the selection of charter type is the risk included in the selected charter type. This factor is followed by the reliability of the charterer, condition of the operated ships, sustainability of the commercial revenue on a balanced basis, profitability of the trade operations, age of the ships and the experience of the ship owner in ship chartering respectively. On the other hand, variables which have the least effect on the selection of charter type are concern of imitating the competitor companies, having prejudgements due to previous unsuccessful contracts, corporate structure of the ship owner, and the use of statistical market modelings.

TABLE 6

Mean and Standard Deviation of the Variables That Have Effect on the Selection of Charter Type

	Variables	**N**	**Mean***	**Standard Deviation**
1	Profitability of the trade	93	4,24	0,56
2	Fluctuations in freight and hire rates	93	3,84	0,75
3	Sustainability of the trade revenue	93	4,26	0,81
4	Risk in the selected charter type	93	4,48	0,56
5	Need of arranging the cash flow by the ship owner	93	4,05	0,97
6	Estimation of the economic crisis by the ship owner	93	3,07	1,02
7	Uncertainty in economic crisis periods	93	3,96	0,77
8	Knowledge of the ship owner about ship charter types	93	3,69	1,02
9	Strategy of the ship owner in ship chartering	93	4,04	0,73
10	Experience of the ship owner in charter contracts	93	4,18	0,66
11	Market intuition of the ship owner	93	3,68	1,08
12	Use of scientific market assessments	93	3,30	1,06
13	Use of statistical market modellings	93	2,84	0,92
14	Daily market conditions	93	3,93	0,73
15	Fleet size of the ship owner	93	3,94	0,71
16	Concern of imitating competitor companies	93	2,11	0,84
17	Corporate structure of the organization of ship owner	93	2,92	1,07
18	Demands on the charterer with regard to the charter type	93	4,10	0,60
19	Demand of utilizing the raising market conditions	93	4,03	0,71
20	Reliability of the charterer	93	4,35	0,58
21	Controllability of the charter contract by the ship owner	93	3,91	0,76
22	Operational proficiency of the charterer	93	3,73	0,86
23	Cargo potential in the worked region	93	3,75	0,90
24	Age of the operated ships	93	4,23	0,68
25	Availability of cargo handling equipment in the ships	93	3,48	1,17
26	Having prejudgments due to previous unsuccessful contracts	93	2,67	1,11
27	Financial power of the ship owner	93	3,21	1,07
28	Condition of the operated ships	93	4,26	0,53

*Average, 5-point Likert scale- 1 : Completely Disagree, 5 : Completely Agree

Implementation of the Factor Analysis

Within scope of the study, factor analysis was applied on the answers (in likert scale) of the expressions in the questionnaire form which is prepared in order to measure the factors that affect the selection of charter type and the effect levels of these factors. Following the factor analysis, 28 variables were gathered under 9 factor groups (see Table 7). Then alpha coefficients of these factors were checked and their reliability was tested individually. Obtained factors account for 71,32% of the total deviation in the data. Certain differences were observed in some of the variables which are designated to the factors in terms of content. When denominating the factors, reasonable effort was made to give a name which could generalize the variables that load on the factor. When it was not practicable, denomination was made by considering the biggest variable that load on the factor.

TABLE 7

Factor Analysis of the Variables that Affect the Selection of Charter Type

FACTORS AFFECTING THE SELECTION OF CHARTER TYPE		Alpha coefficient 0,858	
Variant No	**Factor dimensions and the variables that generate them**	**Cronbach' a**	**Factor Loading**
	RISK IN THE MARKET	**0,767**	
4	Risk in the selected charter type		0,775
3	Sustainability of the trade revenue		0,68
5	Need of arranging the cash flow by the ship owner		0,674
7	Uncertainty in economic crisis periods		0,569
2	Fluctuations in freight and hire rates		0,549
	QUALIFICATIONS OF THE CHARTERER	**0,755**	
22	Operational proficiency of the charterer		0,878
23	Cargo potential in the worked region		0,76
21	Controllability of the charter contract by the ship owner		0,577
	PROFICIENCY OF SCIENTIFIC MARKET ESTIMATION	**0,667**	
12	Use of scientific market assessments		0,874
13	Use of statistical market modellings		0,754
6	Estimation of the economic crisis by the ship owner		0,343
	KNOWLEDGE AND EXPERIENCE OF THE SHIP OWNER	**0,775**	
8	Knowledge of the ship owner about ship charter types		0,826
10	Experience of the ship owner in charter contracts		0,813
9	Strategy of the ship owner in ship chartering		0,681
11	Market intuition of the ship owner		0,446
	PREJUDGEMENT	**None**	
26	Having prejudgments due to previous unsuccessful contracts		0,654
	CORPORATE STRUCTURE AND ASSET-RELATED SITUATION	**0,553**	
17	Corporate structure of the organization of ship owner		0,809
16	Concern of imitating competitor companies		0,786
18	Demands on the charterer with regard to the charter type		0,384
15	Fleet size of the ship owner		0,238
	RELIABILITY OF THE CHARTERER	**0,629**	
20	Reliability of the charterer		0,822
19	Demand of utilizing the raising market conditions		0,66

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	TECHNICAL SUFFICIENCY OF THE SHIPS	**0,570**	
25	Availability of cargo handling equipment in the ships		0,69
24	Age of the operated ships		0,647
28	Condition of the operated ships		0,557
1	Profitability of the trade		0,527
	DAILY MARKET CHANGES	**0,329**	
14	Daily market conditions		0,71
27	Financial power of the ship owner		0,485

Following the factor analysis, 9 main factors that affect the selection of charter type are determined as follows: market risk, qualifications of the charterer, sufficiency of scientific market estimation, knowledge and experience of the ship owner, prejudgement, corporate structure and asset-related situation, reliability of the charterer, technical sufficiency of the ships and daily market changes.

CONCLUSIONS AND RECOMMENDATIONS

This study is aimed at determining the general tendency of Turkish shipowners with regard to chartering. Within this scope, charter types used by the Turkish shipowners, most common charter contract type used by the same, as well as the factors that affect the determination of charter contract type were studied. Following the literature search, no field study was found which focused on the charter types used by the Turkish shipowners, most common charter contract type used by the same, as well as the factors that affect the determination of type of ship assignment contract. Therefore this study is the first study in this field.

When profiles of the participants were analyzed, it was observed that the participants are generally young, well- educated and chartering department employees with broad experience. On the other hand, when profiles of the participant enterprises were analyzed, it was observed that they operate ships for carrying general cargo and dry bulk cargo, conduct their operations mainly in Black Sea and Mediterranean Sea, have ships with small tonnage and Turkish flag.

Within scope of the analysis of ship assignment contract types used by the enterprises, it was revealed that participant enterprises use voyage charter contract most commonly. This is followed by consecutive charter contract and short term time charter contract respectively. Therefore it can be concluded that participant enterprises have a tendency towards using voyage charter party and its derivatives. In addition, it is clear that short term time charter contract is the most commonly preferred type among time charter parties. On the other hand, bareboat charter has not been marked by any of the enterprises. This finding reveals that Turkish shipowners did not prefer bareboat contracts.

28 variables, which had effect on the selection of charter type were determined through interviews and literature reviews. Among these variables, most important factor was the risk in the type of ship charter contract. This is followed by the following factors respectively: reliability of the charterer, condition of the ship, sustainability of the trade revenue on balanced basis, profitability of the trade operation, age of the ship and experience of the ship owner in ship chartering. On the other hand, variables which have the least effect on the selection of charter type are: concern of imitating the competitor companies, having prejudgements due to previous unsuccessful contracts, corporate structure of the ship owner, and the use of statistical market modelings.

After subjecting the variables in the field study to factor analysis, nine factors were identified, which affect the selection of ship assignment contract type. They are: market risk, qualifications of the charterer, sufficiency of scientific market estimation, knowledge and experience of the ship owner, prejudgement, corporate structure and asset-related situation, reliability of the charterer, technical sufficiency of the ships and daily market changes.

This study was conducted through the general cargo and dry bulk shipowners. A similar study could be realized out through the tanker owners. This study was carried out at a time of the worldwide economic crises.

Another survey that could be conducted as a post crises period could reveal certain changes in the shipowners' preferences. Furthermore, the 71,4 % of the owners involved in this study manage vessels of 1,500 – 25,000 dwt. Another research involving the owners of handy size and/or larger ships could draw a clearer picture of the preferences in such particular markets.

REFERENCES

[1] UNCTAD, 2010. "Review of Maritime Transport"
[2] Stopford, M., 1997. "Maritime Economics", Routledge ,London
[3] Çetin, İ. B., 1997. "Dökme Kuru Yük Gemilerinin Sefer Esasına Göre Kiralanması (Türkiye Uygulaması)". Yayınlanmamış Yüksek Lisans Tezi. İzmir: Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü. ("Voyage Chartering of Dry Bulk Carriers: An Aplication in Turkey", Unpublished Master Thesis, Dokuz Eylul University, Institutes of Social Sciences, Izmir).
[4] Özer, T., 2010. "Gemilerin Zaman Esasına Göre Kiralanması: Türk Donatanların Gemi Kiralama Konusundaki Eğilimi", Yayınlanmamış Yüksek Lisans Tezi. İzmir: Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü.("Time Chartering of the Vessels: The Attitudes of Turkish Shipowners Towards Chartering" Unpublished Master Thesis, Dokuz Eylul University, Institutes of Social Sciences, Izmir).
[5] Muran, H., 2008. "Zaman Çarteri Sözleşmesinde Çartererin Yükümlülükleri". Yayınlanmış Yüksek Lisans Tezi. İstanbul: Marmara Üniversitesi Sosyal Bilimler Enstitüsü. ("The Responsibilities of Charterers in Time Charters" Published Master Thesis, Marmara University, Institutes of Social Sciences, Istanbul).
[6] Nunes, T., 2004. "Charterer's Liabilities Under The Ship Time Charter", Houston Journal of International Law. Vol. 26(3):568.
[7] Williams E. C. and Luther Trey Denton, L. D., 1996, "Merchant Vessel Chartering and Operation in International Trade: Ehtical and Safety Issues", International Journal of Commerce & Management ,Vol.6 No. 1, 1996.
[8] Jing, L., Marlow, P.B., Hui, W.,2008. "An Analysis of Freight Rate Volatility in Dry Bulk Shipping Markets", Maritime Policy & Management. Vol. 35(3):248.
[9] Thuong, L.T. and Ho, C. 1987, "Coping With International Freight Rate Volatility", Journal of Purchasing and Meterials Management. Vol. Oct:30.
[10] Scarsi, R., 2007. "The Bulk Shipping Business: Market Cycles and Shipowners' Biases", Maritime Policy & Management. Vol. 34(6):588-589.
[11] Angelidis, T. and Skiadopoulos, G., 2007. "Measuring The Market Risk of Freight Rates: A Value at Risk Approach", International Journal of Theoretical and Applied Finance. Vol. 11(11):447-448.
[12] Kavussanos M.G. and Alizadeh, A.H., 2001. "Seasonality Patterns in Dry Bulk Shipping Spot and Time Charter Freight Rates", Transportation Research. Vol. Part E: 444-464.
[13] Goulielmos, A.M. and Psifia, M., 2007. "A Study of Trip and Time Charter Freight Rate Indices: 1968-2003", Maritime Policy & Management, Vol. 34 No. 1 Feb.
[14] Pirrong, S.C., 199. "Contracting Practices in Bulk Shipping Markets: A Transactions Cost Explanation", Journal of Law and Economics, Vol. 36, No. 2 (Oct., 1993), pp. 937-976
[15] Gorton, L., Ihre, R and Sandevarn, A.,1999."Shipbroking and Chartering Practice"Fifth Edition, LLP Limited, London.
[16] Lopez, N. J., 1992."Bes' Chartering and Shipping Terms", Eleventh Edition, Barker & Howard Ltd. London.
[17] Packard, W. V., 2001. "Sea-Trading", Volume 3, Trading, Fairplay Publications Ltd. Essex. U.K.