ICOVACS 2012

International Conference on Value Chain Sustainability

December 13-15, 2012

Izmir, Turkey

"Value Chain Sustainability through Innovation and Design"

PROCEEDINGS

Izmir University of Economics Publications

EDITORS

Tunçdan Baltacıoğlu

Melike Demirbağ Kaplan

Öznur Yurt

Izmir University of Economics Publications No: 051 Publising Date: March 2013

ISBN 978-975-8789-50-4

Printed in Izmir Turkey. 2013.

Graphics and Website Design by Melike Demirbag Kaplan

ICOVACS, ICOVACS 2012 Logo and Identity Design by Melike Demirbag Kaplan

Preface

On behalf of Izmir University of Economics and as the chair of ICOVACS 2012 (International Conference on Value Chain Sustainability), I would like to state that we were honored to host all the participants in Izmir, one of the most important logistics and design centers and port city of Turkey, during ICOVACS 2012, which was held on December 13-15, 2012.

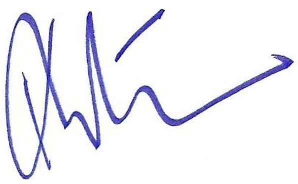
ICOVACS 2012 was organized by Izmir University of Economics, Turkey, and was supported by Tilburg University from The Netherlands, The University of Louisville from USA, and ETMK, from Turkey. In this respect, this year, ICOVACS was held in her hometown, after three years abroad, i.e. in Louisville, Kentucky (2009), Valencia, Spain (2010) and Leuven, Belgium (2011).

The conference brought together more than 50 academicians, researchers and practitioners from different countries. A total of 31 papers, co-authored by more than 60 researchers, were accepted and presented during the Conference, and published in the Proceedings. These papers cover a wide range of topics including Innovation and Value Chains, Logistics Innovation, Supply Chain Innovation, Design & Brand Innovation, Innovation and Technology, and Innovation Trends. We are grateful to our authors and reviewers for all their efforts during this remarkable scientific event.

We would like to thank our partners in organization who have supported us in realizing this event. We also would like to thank Netherlands Business Support Office for their contribution to the event, in addition to our acknowledgment of the support of the sponsors of the conference for their contributions.

I would like to thank the members of the organizing committee, Melike Demirbag Kaplan, Oznur Yurt, A. Can Ozcan, Muhittin Hakan Demir, Ahmet Camci, Cansu Yildirim, İsmail Karabas, Tunca Tabaklar, Burcu Guneri Cangarli, Dicle Yurdakul Sahin, Murad Canbulut and Ayse Sen, who have put great enthusiasm, effort and time into realization of the conference. Finally, we would like to thank everyone who has contributed for making this congress a memorable and successful event.

Sincerely,



Prof. Dr. Tunçdan Baltacıoğlu

Izmir University of Economics, Rector

Conference Chair

Organization

Organizing Institution

Izmir University of Economics, Turkey

Supporting Institutions

Tilburg University, The Netherlands

University of Louisville, Logistics and Distribution Institute, The U.S.

ETMK (Industrial Designers Society of Turkey)

National Organizing Committee

Tuncdan Baltacioglu

Melike Demirbag Kaplan

Oznur Yurt

A. Can Ozcan

Burcu Guneri Cangarli

Muhittin Hakan Demir

Ahmet Camci

Dicle Yurdakul Sahin

Cansu Yildirim

Ayse Sen

İsmail Karabas

Tunca Tabaklar

Murad Canbulut

International Organizing Committee

Jalal Ashayeri

Sunderesh S. Heragu

Contents

System Dynamics Approach in LPG Logistics: An Application for Turkey

Birkan Ozkan[1], A. Guldem Cerit [2]

Abstract

Liquefied Petroleum Gas, LPG is an oil derivative energy source and it requires specific methods for transportation and distribution. These methods have been technologically developed from its first use in history. In general these traditional methods have not changed much. The purpose of this study is to examine the behavior of Turkish auto gas logistics under different scenarios of Turkish auto gas market development. A system dynamics model has been developed for the auto gas transportation in a definite activity region of a Turkish LPG company and some relations between the transportation data have been examined. Three different scenarios have been developed in this paper for the LPG market and the number of gas stations. Results reveal that in all supply and demand scenarios Turkish auto gas logistics market seem to continue growing.

Keywords: *System dynamics, LPG logistics, Auto Gas, Turkey*

1.Introduction

Consumption of non-renewable energy sources takes the first place all over the world. The most popular type of non-renewable energy sources are "petroleum derivative products". While the popularity of petroleum products are so high, the auxiliary sectors for that energy source, like storage and logistics are developing rapidly.

Petroleum derivative fuels are categorized by their different physical and chemical properties. LPG and LPG like fuels come out with their low environmental effect and high energy content.

Discovery of the LPG product was nearly 90 years ago, however the commercial use of it has developed in the past 60 years. In the early years LPG product became popular due to the ease of use and elimination of its waste. After the development of the product as a vehicle fuel, its popularity even became higher.

While the consumption of LPG was increasing, logistics activities from production to supply for customer use have grown considerably and has reached a huge auxiliary sector. In the developing LPG sector, with the effects of the charges and the product popularity, the price of the product gets higher. Companies develop new methods for the auxiliary activities to increase their profitability. The distribution and logistics of LPG is also an important auxiliary activity which has to be planned more efficiently and must be developed by the companies (Polat, 2010).

The objective of this study is to examine the effects of changes in the LPG market on the LPG road truck logistics by using the system dynamics approach through different scenarios. The models developed are for a specific but important part of the sector.

System dynamics is a powerful methodology and computer simulation modeling technique for framing, understanding and discussing complex issues and problems. Originally developed in the 1950s to help corporate managers improve their understanding of industrial processes, system dynamics is currently being used throughout the public and private sector for policy analysis and design. System dynamics was created during the mid-1950s by Professor Jay W. Forrester of the Massachusetts Institute of Technology. Forrester's experiences as a manager led him to conclude that the biggest impediment to progress comes, not from the engineering side of industrial problems, but from the management side (Radzicki & Taylor, 2008).

[1] Aygaz A.S., Turkey +90 232 425 09 00 birkan.ozkan@aygaz.com.tr
[2] Professor and Dean, Dokuz Eylul University Maritime Faculty, Turkey, +90 232 453 4992 gcerit@deu.edu.tr

The term system refers to “reality” or some aspects of reality. A system may be defined as a “collection of interrelated elements, forming a meaningful whole.” So, it is common to talk about a financial system, a social system, a political system, a production system, a distribution system, an educational system, or a biological system. Each of these systems consists of many elements interacting in a meaningful way, so that the system can presumably serve its “purpose.”

A common scientific tool used in investigating problems and solutions is modeling. A model can be defined as “a representation of selected aspects of a real system with respect to some specific problem(s).” Thus, we do not build “models of systems,” but build models of selected aspects of systems to study specific problems. The crucial motivation, purpose that triggers modeling is a problem. The problem can be practical or theoretical. In any case, without a problem-purpose, “modeling a system” is meaningless. The structure of a system can be defined as “the totality of the relationships that exist between system variables.”

A typical system dynamics study goes through some standard steps. Although there will be variations depending on the nature of the problem and style of the modeler, main steps can be nevertheless summarized as follows (Barlas, 2002):

1. Problem identification and definition (purpose)
2. Dynamic hypothesis and model conceptualization
3. Formal model construction
4. Model credibility (validity) testing
5. Analysis of the model
6. Design improvement

In system dynamics modeling, dynamic behavior is thought to arise due to the Principle of Accumulation. More precisely, this principle states that all dynamic behavior in the world occurs when flows accumulate in stocks. In system dynamics modelling there are four different components (Forrester, 1961).

1. All impacts can be identified as flows and stocks.
2. Stocks and flows are elements of a feedback loop.
3. In the system, there is cyclic loop of causal connection.
4. Stocks, flows and the feed back loops can not be solved analyticaly, so the equations can only be solved by computer based simulation programmes.

System dynamics models developed for autogas distribution in this study have been based on a specific LPG terminal in the Aegean region of Turkey. There is a route planing crew in the terminal located in Aliağa/Izmir, who are following the stock levels of LPG filling stations in the Aegean region, and control the efficiency of the autogas distribution of the terminal (Basarir, 2011) . The purpose of the crew is to deliver the product in time and minimize the costs.

Two different system dynamics models have been developed in this study. In the models the tonnages of the LPG trucks and the tonnages of the filling stations are determined as stocks, and the effects of market evaluation on these stocks have been examined.

The study has revealed that whatever the changes in the LPG market dynamics are, because of the trend in investments on new filling stations, the logistics volume always tend to grow its capacity.

2.Methodology

This study is based on a descriptive research which makes use of a system dynamics model. Data on the autogas distribution of the company, that has the largest LPG carriage volume in Turkey have been collected and consolidated. These distribution data have been used for creating system dynamics models by making use of the software VENSIM PLE (VENSIM, 2011). Some factors that have effects on the distribution efficiency have been determined and some relations between those factors have been checked by using regression analysis. The models were executed with those relations (Kong, David and William, 2009).

3. Data Collection

The LPG distribution data of the company are saved in an ERP program (AYGAZ A.S, 2011). The details of all carriage routes such as truck details, operator details, carriage tonnage, carriage date and time details can be reported by that ERP program. In this study, the details of all carriage, distributed from the Aliağa LPG terminal between 01 Jan 2011 to 01 Dec 2011, are reported and the data are given in Table 1 and Table 2.

Tablo 1 Truck distribution data of the terminal (01.01.2011-01.12-2011)

	Total Carriage Tonnages (kg)	Average truck Load (kg)	Number of truck Routes (Qty)
Truck	TCT*	ATL**	NTR***
T.1	2,166,551	14,541	149
T.2	3,075,413	13,730	224
T.3	1,146,111	13,977	82
T.4	2,981,765	14,132	211
T.5	3,133,326	13,110	239
T.6	3,130,473	14,101	222
T.7	2,635,918	10,023	263
T.8	3,348,479	14,310	234
T.9	2,520,282	9,266	272
T.10	3,231,163	14,621	221
T.11	1,863,518	10,353	180
T.12	3,438,411	14,694	234
T.13	2,900,568	14,289	203
T.14	3,721,048	13,937	267
T.15	2,547,851	9,543	267
T.16	2,673,358	13,570	197
T.17	3,290,210	13,883	237
T.18	2,847,880	10,244	278
T.19	2,459,488	10,248	240
T.20	3,585,301	14,457	248
T.21	3,364,297	13,298	253
T.22	3,633,931	19,750	184
T.23	2,497,551	10,112	247
T.24	3,454,184	14,156	244
T.25	1,245,423	14,826	84

*TCT :"Total carriage tonnage" total carriage tonnage of the truck in the period (kg)

**ATL: "Average Truck Load" The average carriage tonnage of the truck in a route (kg)

***NTR : "Number of Truck Routes" The number of routes that the truck realized in that time period. (Qty)

As seen in Table 1; throughout the time period, 25 LPG road trucks realized the carriages. The trucks were filled and the routes have been planned in the terminal. Average Truck Load (ATL) is determined from the LPG need of the stations on the route, and directly proportioned to the efficiency of the route plan. The average of ATL in that time period is 13.100 kg, hovewer in this study it is assumed to be 16.000 kg, which is thought to be the most efficient tonnage of the distribution.

Every truck route is planned to realize the carriage for more than one LPG station, according to the data taken from ERP programme, every truck stop at 3 LPG stations in a route. In this study it is again assumed that the number of LPG stations in one route are 5, which is considered to be the most efficient value for a route.

When the Number of Truck Routes (NTR) (Table 1) are examined, only 2 trucks could attain 270 routes in that period. So it is assumed that the maximum number of routes for a truck in one year is 270. The factors that affect the routes negatively, like the truck accidents, periodic maintenance and truck failures have been disregarded in this study.

As seen in Table 2, in that time period 121 autogas filling stations were loaded by those LPG trucks. The Average Filling Tonnage of Stations (AFTS) is directly proportioned to the sales tonnage of the stations. The data in Table 2 is again collected for the dates between 01 Jan 2011 to 01 Dec 2011.

Table 2 The filling station data of the terminal (01.01.2011-01.12-2011)

	Total Supply Tonnages (kg)	Average Supply tonnage of a St. (kg)	Supply Quantity of a St. (Qty)		Total Supply Tonnages (kg)	Average Supply tonnage of a St. (kg)	Supply Quantity of a St. (Qty)		Total Supply Tonnages (kg)	Average Supply tonnage of a St. (kg)	Supply Quantity of a St. (Qty)
Station	**TST***	**ASTS****	**SQS*****	**Station**	**TST***	**ASTS****	**SQS*****	**Station**	**TST***	**ASTS****	**SQS*****
B.1	2,201,723	5,504	427	**B.42**	522,688	3,351	160	**B.83**	930,509	2,570	411
B.2	312,059	3,760	90	**B.43**	392,914	3,302	125	**B.84**	1,271,941	4,212	321
B.3	819,329	3,532	235	**B.44**	307,907	2,184	148	**B.85**	813,041	3,646	225
B.4	763,929	5,617	139	**B.45**	1,152,707	2,632	468	**B.86**	433,941	2,553	172
B.5	491,364	5,014	105	**B.46**	760,547	4,422	181	**B.87**	411,051	2,855	149
B.6	424,666	2,372	190	**B.47**	187,480	2,534	75	**B.88**	310,662	2,567	125
B.7	471,913	4,370	110	**B.48**	262,655	2,153	129	**B.89**	296,077	5,383	58
B.8	460,291	3,624	129	**B.49**	2,770,166	4,432	678	**B.90**	152,495	2,990	60
B.9	1,390,022	4,006	386	**B.50**	288,533	2,857	103	**B.91**	516,398	3,715	153
B.10	938,259	5,618	200	**B.51**	223,202	2,689	90	**B.92**	261,284	2,233	124
B.11	1,207,357	6,007	208	**B.52**	1,756,858	4,540	423	**B.93**	134,708	1,981	78
B.12	333,194	2,192	167	**B.53**	1,264,893	5,337	253	**B.94**	54,994	1,719	33
B.13	262,315	2,547	108	**B.54**	456,970	3,410	157	**B.95**	192,682	2,639	81
B.14	166,464	2,685	72	**B.55**	2,076,007	5,126	431	**B.96**	154,092	2,233	75
B.15	508,455	2,705	199	**B.56**	873,092	3,951	235	**B.97**	108,551	2,360	47
B.16	1,329,872	4,836	286	**B.57**	280,711	4,010	72	**B.98**	2,522,306	6,337	420
B.17	773,162	2,160	401	**B.58**	327,780	2,465	143	**B.99**	255,991	3,122	84
B.18	426,519	3,741	125	**B.59**	509,691	2,115	255	**B.100**	421,366	2,341	186
B.19	759,944	5,205	150	**B.60**	2,583,687	4,689	592	**B.101**	226,117	2,485	93
B.20	974,436	2,648	386	**B.61**	423,279	2,505	170	**B.102**	74,030	2,056	36
B.21	142,258	2,411	64	**B.62**	246,714	2,145	119	**B.103**	418,089	2,389	187
B.22	273,537	1,940	156	**B.63**	224,776	3,038	76	**B.104**	461,399	2,549	189
B.23	209,952	2,142	113	**B.64**	223,766	2,172	106	**B.105**	304,683	2,208	161
B.24	234,178	3,208	73	**B.65**	268,654	2,511	116	**B.106**	1,340,499	2,573	581
B.25	1,319,491	4,312	311	**B.66**	301,115	2,923	116	**B.107**	465,609	5,232	92
B.26	273,733	2,320	128	**B.67**	774,745	3,490	241	**B.108**	213,035	1,677	137
B.27	905,915	5,177	193	**B.68**	487,981	3,128	160	**B.109**	41,672	1,736	24
B.28	1,139,806	2,651	462	**B.69**	216,298	2,458	94	**B.110**	452,845	2,116	224
B.29	197,098	3,790	57	**B.70**	377,243	2,638	151	**B.111**	776,548	2,615	312
B.30	796,759	2,226	399	**B.71**	901,280	5,092	179	**B.112**	233,659	2,434	102
B.31	1,956,182	4,714	429	**B.72**	337,920	2,397	143	**B.113**	394,132	3,009	136
B.32	702,136	3,312	216	**B.73**	595,320	3,133	203	**B.114**	339,233	2,277	156
B.33	351,248	3,314	108	**B.74**	561,427	2,495	233	**B.115**	125,529	1,550	99
B.34	394,392	2,465	166	**B.75**	1,201,780	3,577	359	**B.116**	105,617	2,296	57
B.35	948,450	3,513	292	**B.76**	1,649,635	4,053	421	**B.117**	60,393	5,490	13
B.36	191,662	2,861	74	**B.77**	963,735	3,664	323	**B.118**	171,106	2,632	71
B.37	729,706	4,099	196	**B.78**	346,213	1,813	209	**B.119**	40,634	2,902	16
B.38	473,814	2,164	233	**B.79**	671,939	3,377	216	**B.120**	45,893	1,912	32
B.39	521,144	2,978	199	**B.80**	97,810	2,717	38	**B.121**	58,166	2,908	28
B.40	13,338	1,667	8	**B.81**	133,670	2,522	53				
B.41	230,750	2,404	117	**B.82**	276,913	2,347	122				

*TST : The total supply tonnage of the station in the time period (kg)

**ASTS : The average tonnage of LPG for the station in a single supply (kg)

***SQS : The number of supply times realized for the station in the time period.

4.Model 1

The first model shows the evolution of “Number of Truck Routes” according to Autogas Market of Turkey in given time period. The “Total Carriage Tonnages” of trucks (TCT) is designed as the stock of the model. The stock quantity changes as the carriages tonnages of the trucks change. The change in carriage tonnage of LPG is designed as the flow of the model. In the model “Average Truck Load” (ATL) is designed as a constant coefficient. “Number of Truck Routes” (NTR) is designed as a variable coefficient. A regression analysis is realized for the values of TCT, ATL and NTR, as a result, Eq. (1) is derived. The regression statistics are given in Table 3. The key question in this model is, if there is a relation between ATL and NTR. The answer is negative, because the value of ATL is related to the efficiency of the routes created by the planning crew.

Table 3 Regression Results (NTR, TCT, ATL)

Regression Statistics		*Coefficients*	
Multiple R	0,991928659	Intercept	233,5073835
R Square	0,983922466	X Variable 1	7,15906E-05
Adjusted R Square	0,982460871	X Variable 2	-0,016505075
Standard Error	6,803363889		
Observations	25		

NTR = 7,15906E-05 TCT – 0,016505075 ATL + 233,5073835 (1)

By using the results of the regressions and assuming a 7% annual LPG market development for Turkey, the model seen in Figure 1 is created.

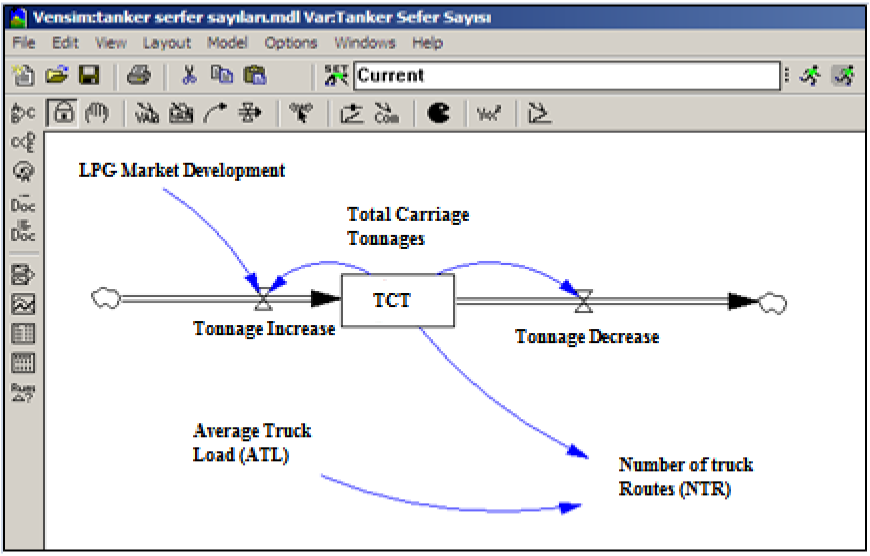


Figure 1 Model 1, Number of Truck Routes

Finally Model 1 is executed and the results are gained as shown in Figure 2. The development of the LPG market directly affects the total LPG carriage of a truck in given period. If TCT increases NTR also increases. Effect of the change in ATL to the NTR is seen clearly in Figure 2. Tonnage of the trucks and total number of routes are directly proportional to the efficiency of the routes.

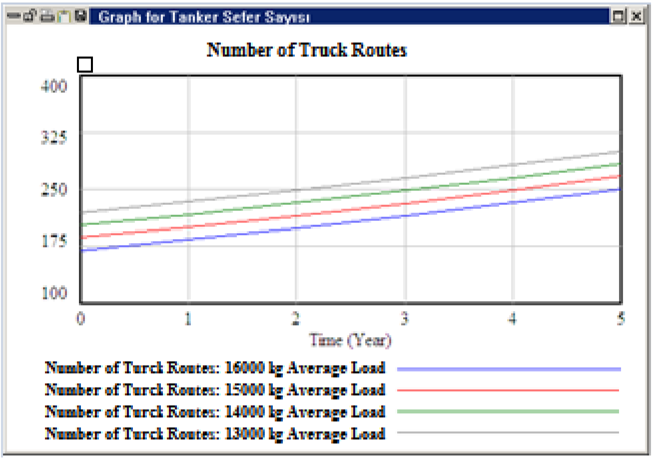


Figure 2 Relation Between ATL and NTR

5.Model 2

In the second model, the change in the number of supply for an Autogas station (Supply Quantity for a Station, SQS) has been analyzed, according to the evaluation of the Turkey Autogas Market. In this model the Total Supply Tonnage (TST) of a station is designed as a stock, also the evaluation of the market affect the flows of these stock directly. A regression analysis is realized for the values in Table 2, as a result, Eq. (2) and Eq. (3) are derived. The regression statistics are shown in Table 4 and Table 5.

Table 4 Regression Statistics (SQS, TST,ASTS)

Regression Statistics			*Coefficients*	
Multiple R	0,947155526		Intercept	173,3038821
R Square	0,89710359		X Variable 1	0,000272711
Adjusted R Square	0,895359583		X Variable 2	-0,047248041
Standard Error	42,68794097			
Observations	121			

$$SQS = 0{,}000272711\ TST + 0{,}047248041\ ASTS + 173{,}3038821 \quad (2)$$

Table 5 Resression statistics (ASTS, TST)

Regression Statistics			*Coefficients*	
Multiple R	0,622462922		Intercept	2432,096353
R Square	0,387460089		X Variable 1	0,001247227
Adjusted R Square	0,382312695			
Standard Error	869,93936			
Observations	121			

$$ASTS= 0{,}00124723\ TST +2432{,}09635 \quad (3)$$

In this Model, the market evaluation affects the total supply of the stations directly. It is assumed that the stations' supply tonnages are evaluated in the same ratio of the market evaluation. Every other specific condition for the stations that affect the supply tonnage is disregarded, hovewer the case that the change in the number of stations affect the market share of every other station has been considered in the model.

The frequency of the supplies has an important effect on planning the routes. If the frequency is low, the supply quantity (SQS) will also be low and the tonnage in every supply will be higher. Briefly when Average Supply Tonnages of a Station (ASTS) increases, the Supply Quantity of a Station (SQS) will decrease. But the physical storage capacities of the stations in given region is maximum 11000 kg. So the LPG tonnage in one supply can not exceed this value.

According to these assumptions, Model 2 is designed and can be seen in Figure 3. Finally Model 2 is executed and the results are obtained as shown in Figure 4.

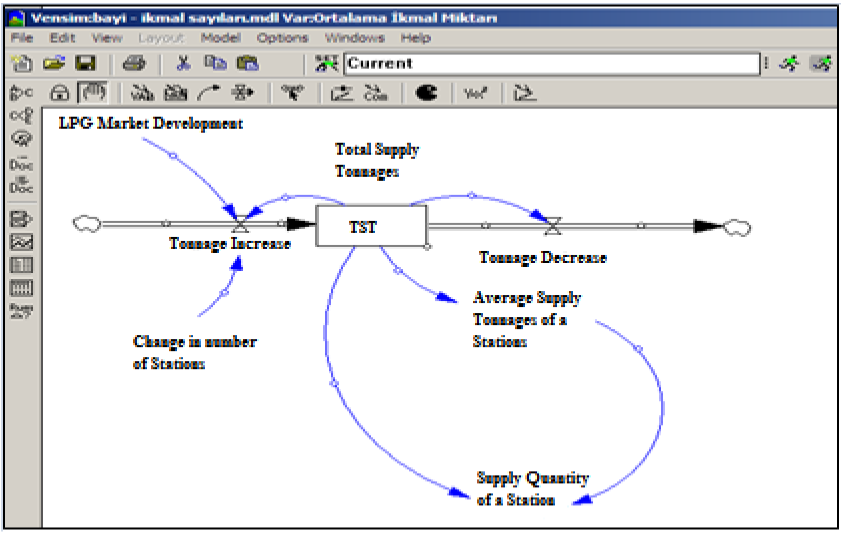


Figure 3 Model 2, The Supply Quantity of Stations

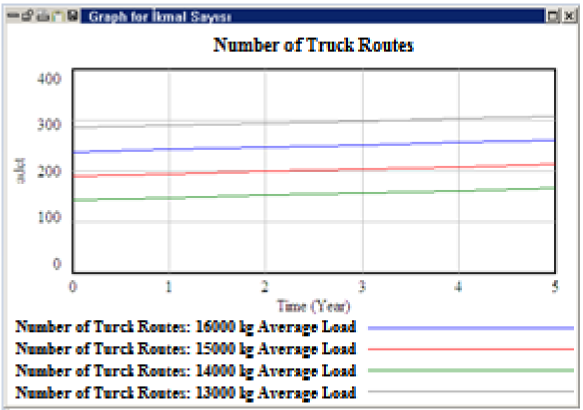


Figure 4 Relation Between ASTS, SQS

6.Developing The Scenarios

6.1.Scenario 1

96% of Autogas filling stations in Turkey, continue their activity and sited under fuel filling stations, however every fuel filling station can not be active on LPG filling sector because of some legal restrictions. Currently there are 8200 LPG filling stations and nearly 12000 Fuel filling stations in Turkey (EPDK, 2010c), (EPDK, 2010d).

In Scenario 1 it is assumed that the legal restrictions will be cancelled and the number of LPG filling stations will increase exponentially (18%). On the other hand it is also assumed that the Turkey LPG Market will grow rapidly like the passing years (8% annually) (EPDK, 2010a, EPDK, 2010b).

According to these assumptions the models described before are executed and some additional calculations have been made. The results of those calculations are given in detail in Table 6.

With the 18% increase in the number of LPG filling stations, at the end of the year 2016 it appears to be 277 stations. Total Quantity of Supply (QOS) made from Aliağa terminal is obtained by multiplying the number of Filling stations and Supply Quantity of a Station (SQS). Before the maximum quantity of supply for a truck in a route was assumed as 5. So the result is divided by 5 and Quantity of Route realized from Aliağa Terminal (QTR) would be obtained. When QTR is divided with the number of trucks (25), the Quantity of total Routes for a truck (QTRT) would be obtained. As assumed before there is a limit for QTRT (270).

Table 6 Scenario 1 Detailed Results of Calculations

		2011	2012	2013	2014	2015	2016
Total Market	TON	2.638.861	2.849.970	3.077.967	3.324.205	3.590.141	3.877.353
Terminal tonnage	TON	70.892	76.563	82.688	89.304	96.448	104.164
Number of Filling st.	Qty	8.189	9.663	11.402	13.455	15.877	18.734
Number of Filling St. By Terminal	Qty	121	143	168	199	235	277
Number of Truck Routes (NTR) Model 1	Qty	170	186	203	222	242	264
Supply Quantity for a St. (SQS) Model 2	Qty	229	212	197	183	171	159
Total Quantity of Supply (QOS)	Qty	27.709	30.269	33.191	36.382	40.115	44.014
Maximum Qty of Supply	Qty	5	5	5	5	5	5
Quantity of Terminal Routes (QTR)	Qty	5.542	6.054	6.638	7.276	8.023	8.803
Quantity of Total Routes for a Truck(QTRT)	Qty	222	242	266	260	267	267
Number of Trucks	Qty	25	25	25	28	30	33

As seen from the results, the terminal can handle the Autogas distribution with its logistics capacity of 25 trucks until the end of the year 2013, however the year 2013 is critical and if some negative conditions occur for the trucks the supply for the stations can not be handled. For the years 2014, 2015 and 2016 the logistics capacity of the terminal must increase to 28, 30 and 33 trucks.

The evaluation in Quantity of Routes planned from Aliağa terminal (QTR) can be seen in Figure 5.

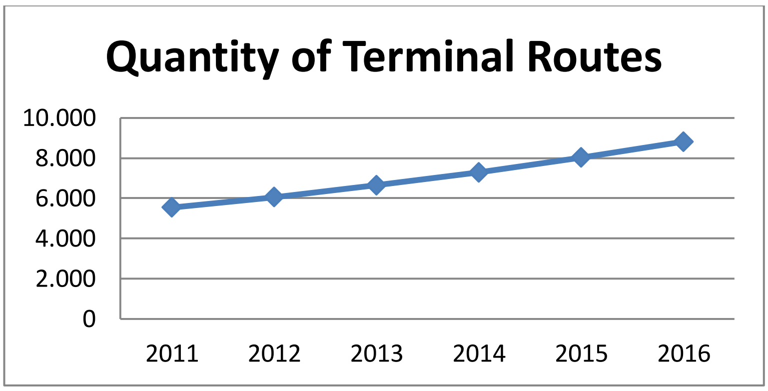


Figure 5 Scenario 1, Quantity of Terminal Routes (QTR)

6.2.Scenario 2

In Scenario 2 it is assumed that the evaluation of LPG Market and number of LPG filling Stations will be the same as the passing years.

It is assumed that the number of LPG filling stations will increase by 14 % and the LPG market will grow by 8 %, (EPDK, 2010a), (EPDK, 2010b). The models described before are executed and some additional calculations have been made. The results of those calculations are given in detail in Table 7.

With the 14 % increase in the number of LPG filling stations, at the end of the year 2016 the quantityt of stations appears to be 233 stations. The total Quantity of Supply (QOS) made from Aliağa terminal is divided by the maximum quantity of supply for a truck (5) and the Quantity of Route made from Aliağa Terminal (QTR) is obtained. By dividing QTR by the number of trucks (25), Quantity of total Routes for a truck (QTRT) is obtained.

At the end of the year 2013 the terminal can handle the supply capacity, however it will be critical under some negative conditions regarding the trucks. At the end of the year 2014 the minimum quantity of trucks must be 27, in 2015 it will be 30 and in 2016 it must be 32.

The evaluation in Quantity of Routes planned from Aliağa terminal (QTR) is also seen in Figure 6.

Table 7 Scenario 2 Detailed Results of Calculations

		2011	2012	2013	2014	2015	2016
Total Market	TON	2.638.861	2.849.970	3.077.967	3.324.205	3.590.141	3.877.353
Terminal tonnage	TON	70.892	76.563	82.688	89.304	96.448	104.164
Number of Filling st.	Qty	8.189	9.335	10.642	12.132	13.831	15.767
Number of Filling St. By Terminal	Qty	121	138	157	179	204	233
Number of Truck Routes (NTR) Model 1	Qty	170	186	203	222	242	264
Supply Quantity for a St. (SQS) Model 2	Qty	229	219	210	200	192	184
Total Quantity of Supply (QOS)	Qty	27.709	30.209	33.023	35.853	39.238	42.867
Maximum Qty of Supply	Qty	5	5	5	5	5	5
Quantity of Terminal Routes (QTR)	Qty	5.542	6.042	6.605	7.171	7.848	8.573
Quantity of Total Routes for a Truck(QTRT)	Qty	222	242	264	266	262	268
Number of Trucks	Qty	25	25	25	27	30	32

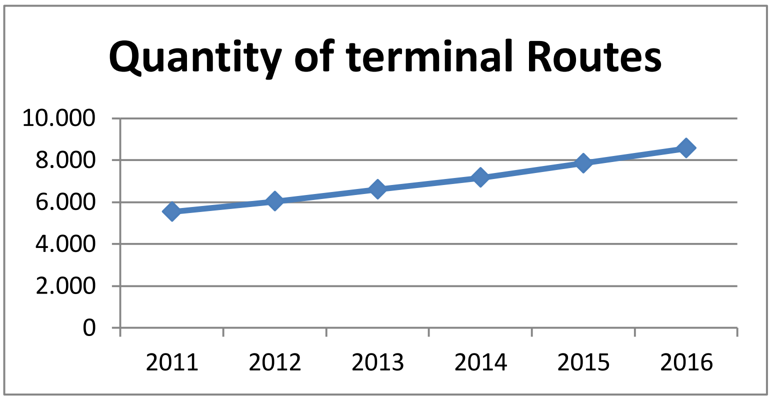


Figure 6 Scenario 2, Quantity of Terminal Routes (QTR)

6.3.Scenario 3

The vehicles running with LPG are getting older day by day. So the owners of the vehicles tend to change their vehicles with new ones. Choosing the vehicles running with diesel fuel is reasonable because of the economic advantage in both purchasing and running.

On the other hand the vehicles running by electricity will be more common and by new technologies all cars running also by petroleum products or electricity will be more efficient. So the decrease in consumption of LPG will be inevitable.

In this scenario it is assumed that the LPG Market will decrease by 3 % and the increase in the number of LPG filling stations will continue by 14 % as the past years (EPDK, 2010a), (EPDK, 2010b). Again the models have been executed and some additional calculations have been made. The results of those calculations are given in detail in Table 8.

As a result at the end of the year 2016 the number of filling stations appears to be 233. The total Quantity of Supply (QOS) realized from Aliağa terminal is divided by the maximum quantity of supply for a truck (5) and Quantity of Routes realized from Aliağa Terminal (QTR) is obtained. By dividing QTR by the number of trucks (25), the Quantity of total Routes for a truck (QTRT) is obtained. QTRT for this scenario is increasing but at the end of the year 2016, its value can not reach the maximum value of 270. So an increase in the truck quantity of the terminal has not been predicted. The key point in this scenario is, while the LPG market is decreasing, the total quantity of supply realized from the terminal will not decrease.

Table 8 Scenario 3 Detailed Results of Calculations

		2011	2012	2013	2014	2015	2016
Total Market	TON	2.500.000	2.425.000	2.352.250	2.281.683	2.213.232	2.146.835
Terminal tonnage	TON	70.892	68.765	66.702	64.701	62.760	60.877
Number of Filling sty.	Qty	8.189	9.335	10.642	12.132	13.831	15.767
Number of Filling St. By Terminal	Qty	121	138	157	179	204	233
Number of Truck Routes (NTR) Model 1	Qty	170	164	158	152	146	142
Supply Quantity for a St. (SQS) Model 2	Qty	229	200	176	156	140	126
Total Quantity of Supply (QOS)	Qty	27.709	27.588	27.676	27.966	28.611	29.355

Maximum Qty of Supply	Qty	5	5	5	5	5	5
Quantity of Terminal Routes (QTR)	Qty	5.542	5.518	5.535	5.593	5.722	5.871
Quantity of Total Routes for a Truck(QTRT)	Qty	222	221	221	224	229	235
Number of Trucks	Qty	25	25	25	25	25	25

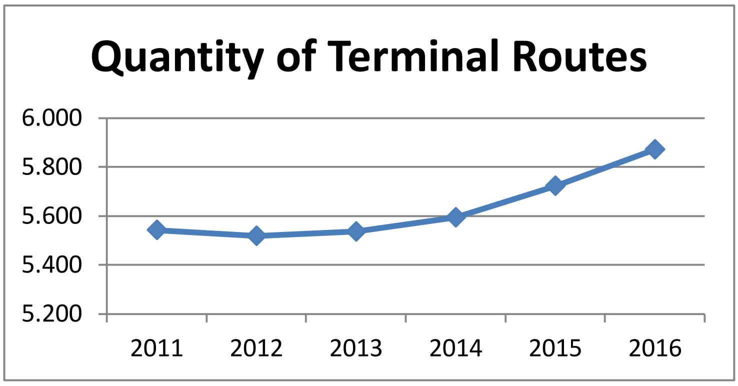


Figure 7 Scenario 3, Quantity of Terminal Routes (QTR)

7.Conclusion

In this study 3 different scenarios have been examined and the future of the LPG market has been predicted due to those scenarios.

According to the First Scenario, LPG market maintains its development similar to the past 5-6 years. Hovewer the number of the filling stations increase exponentially because of the cancellations of some legal restrictions. The result of this scenario shows that the distribution capacity also will grow exponentially.

According to the Second Scenario, both the LPG market and number of filling stations maintain their evaluation similar to the past 5-6 years. The result again shows that the distribution volume will grow by a smaller ratio, and some investments for new trucks will also be necessary for coming years.

According to the last Third the market demand tends to be decreasing, hovewer the number of filling stations increase by the same ratio similar to the past years. As a result the distribution capacity will drop for the first 1-2 years but after this period it wil start to grow again in a small ratio. For the first 5 years it is not necessary to invest on new trucks but, it this investment would be necessary in the long period of time.

For all scenarios, an opinion for the terminals distribution capacity and number of new trucks have been determined. In this respect the company can plan its fleet capacity for longer periods, and this can increase the efficiency of the terminal.

In conclusion, LPG market in Turkey has some risks but those risks do not affect the LPG distribution and LPG logistics sector. So this sector will maintain its increase in the short period and will need new investments.

8.References

AYGAZ A.S., (2011). *2010 Annual Report.*

Barlas, Y., (2002). *System Dynamics: Systemic Feedback Modeling for Policy Analysis.* In Knowledge for Sustainable Development - An Insight into the Encyclopedia of Life Support Systems, UNESCO-EOLSS Publishers, Paris, France; Oxford, UK, pp. 1131-1175.

Basarır, T. (2011). Logistics in LPG Distribution. *HR Magazine*, Presentation in 13. Logistics Management Conference. Istanbul.

Chi, K. C., Reiner, D. M. and Nuttall, W. J. (2009). *Dynamics of the UK Natural Gas Industry: System Dynamics Modelling and Long-Term Energy Policy Analysis.* EPRG Working Paper 0913, Cambridge Working Paper in Economics 0922, www.eprg.group.cam.ac.uk

Forrester, J. W. (1961). *Industrial Dynamics.* Massachusetts: The MIT Press.

Radzicki, M. J. and Taylor, Robert A. (2008). *Origin of System Dynamics: Jay W. Forrester and the History of System Dynamics. U.S. Department of Energy's.* (28 December 2011). http://www.systemdynamics.org/DL-IntroSysDyn/

Polat, E. (2010). *Turkey: Largest LP Gas Park in the World.* (02 January 2012), www.worldlpgas.com

Türkiye Cumhuriyeti Enerji Piyasası Düzenleme Kurumu. [EPDK]. (2010a). *2010 Annual Report.*

Türkiye Cumhuriyeti Enerji Piyasası Düzenleme Kurumu. [EPDK]. (2010b). *Liquefied Petroleum Gasses (LPG) 2010 Sector Report.*

Türkiye Cumhuriyeti Enerji Piyasası Düzenleme Kurumu [EPDK]. (2010c). www.epdk.gov.tr

Türkiye Cumhuriyeti Enerji Piyasası Düzenleme Kurumu [EPDK]. (2010d). *Petroleum Sector Report 2010.*

VENSIM, *Ventana Systems*, (b.t.). 28 November 2011, www.vensim.com.

World LP Gas Association [WLPGA]. (2007). *Turkish LPG Industry Report.* (January 2007). www.worldlpgas.com

Role of Industrial Design in Value Chain - Case of a Specific LED TV model from Consumer Electronics Market

Can Uçkan Yüksel[3]

Abstract

With the great pace of innovations in display technologies and software developments, TV market became highly competitive and almost mature. Consumer electronics (CE) market has many emerging sub-categories where nowadays the boundaries blurred very fast. Industrial design has become a prerequisite for CE market. Leading A-Brand CE companies have created and sustained their brand image with innovative design applications of their products. These technology and innovation led companies justify the customer's interest and loyalty with the quality and after sales services.

Backlight Module System (BMS) is a brand new methodology for LED TV manufacturers regarding the display supply management and production. BMS is directly related to value creation through the supply chain. Because smarter, user centred interface designs and more innovative and elegant industrial design applications become feasible for TV manufacturers practicing BMS.

With this paper, it is aimed to reveal the BMS method and discover the possibilities it has brought to industrial and interaction design of LED TV business with the insight of CE product manufacturer. Distinctions from older supply chain management and manufacturing techniques, the novelties and benefits for industrial design of CE products are also explained.

Keywords: Cost Efficiency through Integrating Design, Logistics and Branding, Innovative Value Chain Management

1. Aim & Scope of the paper

Aim of the paper is to identify the Backlight Module System (BMS) method and examine the steps closely to highlight the advantages and disadvantages of the process.

2. Introduction

At the beginning, identifying most used concepts and terminology in the consumer electronics and manufacturing methodologies would be helpful to ease the understanding. In common understanding, an original equipment manufacturer, (OEM), does manufacturing complex products or components to be purchased by another companies and retailed under that buyer company's brand name. Having started with OEM /ODM concepts, which are not new for PC industry, a market research shows that in 2006, 82.6% of PC notebooks' components are made by Taiwanese ODMs). These are also rising trends among the top TV brands. "Original Equipment Manufacturing" is what Vestel Electronics Co. has been practising from 1985. Vestel Electronics has started designing digital video broadcasting receivers (DVB boxes) for British customers where digital broadcasting has started its first implementations very early. Customers such as electronic products whole sellers and some catalogue retailing brands (Alba, Bush, Argos, etc.) were the first

[3] Manisa Vestel Electronics Co., Turkey, +90 236 2330131 - 2221, can.uckan@vestel.com.tr

customers. Electronic shops, big shopping markets (chain store brands) came after a while, after Vestel has become a big OEM player.

According to Wikipedia, when a company designs and manufactures a product with the specifications given by a contractor brand firm to sale, it is called original design manufacturer (ODM). After certifying a certain level of quality both in manufacturing and developing design capabilities; “Original Design Manufacturing” has become second big business for Vestel. Vestel started to offer key solutions (fully designed products- new ID, MD specifically done for the electronic hardware required and new software options, ready to be manufactured with proper order) for electronics brands like, J Lewis, etc. With the cumulatively increasing amount of sales for B and A brands, Vestel has been expanding rapidly and have invested in new electronics markets such as computers, monitors and lighting equipments.

With the know- how accumulated through the years of manufacturing, ID and mechanical design departments working with collaboration to achieve innovative solutions to be able to create as much as new industrial design alternatives as possible for OEM and ODM customers. Today, the number of foreign customers has reached more than a hundred with set-top box, CRT TV, TFT LCD, LED TV demands. The customers are welcome to pick up the “on-the-shelf” designs done by in-house design department (ID). Vestel started to sell industrial design with and (mostly) more than electronic &software design.

In TV business subcontracting has become very important because of the pressure to introduce new products to market on time increasing pace of technology and connectivity of the electronic products and households. After TFT was introduced to markets, it has started to be replaced with LED TV's. Because of its energy saving, environmental protection according to new legislations and all other physical properties better than TFT's, it has won the market share of 36.9% in 2010, and was projected to be the half of market share in 2011.) (ref1)

Consumer electronics world and home entertainment (TV) business have been leaning on LED and smart TV concepts lately, both A Brands like Samsung, LGE, Sony, and OEM companies like Vestel, Funai, TPV, etc. To be able to integrate innovation to the TV sets, all LCD TV makers, indiscriminating OEM and A brands try to apply new TV set manufacturing methods.

3. What is Backlight Module System (BMS)?

3.1 How a TV Set is made?

Steps of conventional TV set making should be clarified firstly, to understand backlight module system methodology. Traditionally, TFT LCD and LED TV manufacturing has several& similar steps. OEM set makers purchase LCD displays (usually LCD "module" term is used in the electronic market for the display) from outsource companies specialized on display production as finished components ready for assembly. “A brands” like Samsung and LGE produce their own displays so that they can create their own designs according to their enhancements of their own display technologies concurrently.

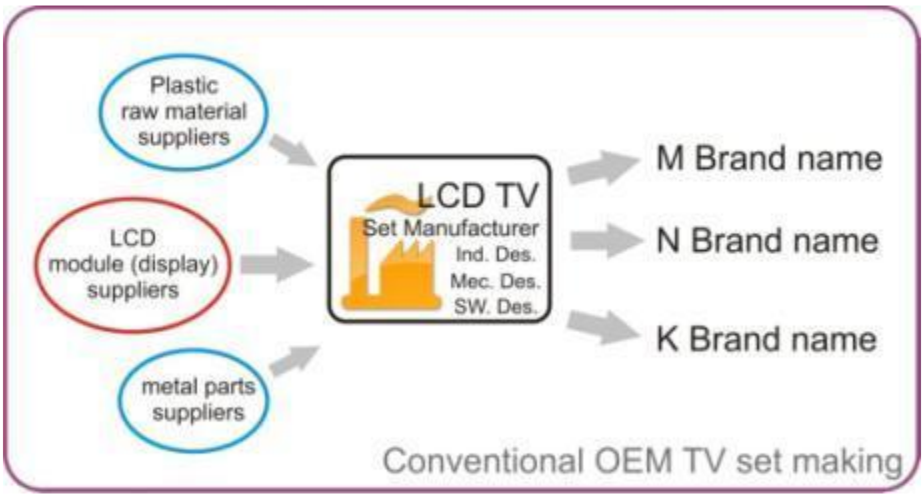


Figure 1. Conventional OEM TV set making

OEM Set manufacturers could have in-house industrial design department to create their own models or most of them have this service from outsource design firms. Vestel has its own ID department for many years and the responsibilities of the team inside the R&D department grow continuously. After having a solid ID for new TV set, mechanical design takes over the projects 3D data from ID and prepares it ready to send to mould maker outsource companies. None of the TV set makers -even A brand companies- do the moulds of your TVs on their own, instead TV set makers have mould producers make the moulds for them. Chinese, Korean and some other far-east producers lead this business also. Vestel prepares and sends the 3D data of the new models to its mould maker contractors in far-east. Concurrently, software and hardware design continues. As the trial shots starts to come to Vestel, new versions of software are also tested. Having passed all the tests, software versions are approved. While, according to the trial shots, mould improvements and corrections are done and approved to be shipped to factory where the mass production will take place. After the moulds' arrival, pilot and mass production begins respectively.

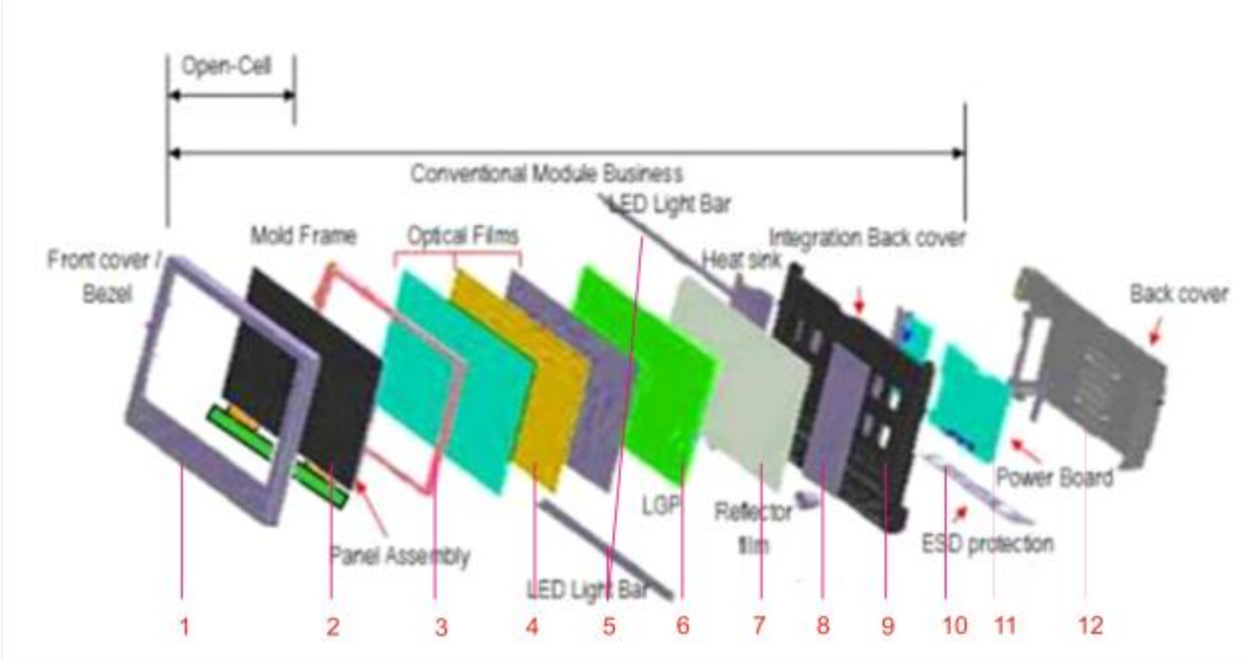


Figure 2. Generic exploded view of a LED TV

Table 1. Parts of a LED TV and their functions.

	Part	Description & Functions
1	Front cabinet	Plastic part that end-users perceive as outer box includes all components in. ID creates the overall shape/application differences.
2	Panel assembly	Panel Assembly part is called as LC (Liquid Crystal) Cell. It contains Bare LC cell, COF (Chip on Board) and Driver Board. There are three main technology type of LC cell which are TN (Twisted Nematic), VA (Vertical Alignment) and IPS (In Plane Switching).
3	Mold frame	Plastic frame holding the layers of optical films in order and gathers them with panel assembly. It closes with the integration back cover
4	Optical films	Optical films main purpose is to create uniform luminance distribution on the BLU (Backlight Unit) with the help of Light sources according to target specs.
4.1	Reflector Sheet:	Located at the back side of the optical pool, reflecting the light which has the opposite direction of the active display side and which reflected back from the top optical films. Its reflection ratio is around 98%. Different than mirrors, reflector

		sheets diffuse (spectral- lambertian) the light to create a uniform light distribution.
4.2	Light Guide Plate	Used in edge type BLU's. Directs the from its source light perpendicular to display.
4.3	Diffuser Plate	Supports the other films with its strong structure, has high light diffusing capability, protects more fragile sheets from heat.
4.4	Diffuser Sheet	Prevents the moire effects caused by BEF.Protects the BEF
4.5	Prism Sheet BEF (Brightness Enhancement Film)	Normalizes most of the light forthe audience. Refflects back the light coming in wide angles and provides it to come in right angle.
4.6	Polarizer Film DBEF (Dual Brightness Enhancement FilmDual Film)	Controls the angle, reflection and polarization of the light.
5	Led Light Bars	The light source of the display/two types:at the edges or placed directly behind the films.
8	Heat Sink	
9	Integration Back Cover	BC that holds the module components together with the mold frame.
10	ESD Protection	Electrostatatic Discharge protection shields to prevent eletrocution.
11	Power Board & Main Board & RF-IR Cards	Electronic boards with necessary integrated circuits to take propriate electrivity in and make the display process the data and make the TV "work".
12	Back Cover	Plastic covering whole product and assembled to the front cover's bosses.

3.2 Backlight Module System (BMS)

It is a manufacturing and business method, kind of integration of final LCD module assembly with the whole TV set assembly route. In the BMS model, set makers purchase LCD "cells" (the LCD panel without backlight unit or driver IC with PCB) or "open cells". Open cell can be defined as LCD module which are panels with driver IC and power PCB but without the backlight unit (Hsieh, 2011).

To be more specific, instead of purchasing module from the manufacturer, TV set makers buy *only* panel assembly from the producer and gathers other components from different suppliers. Set makers starts from display unit making; plastic frame of display unit is designed, moulded and other components are laid over in the right order. It seems quite easy to explain generally but the process requires exceptionally fine skilled workers, clean and restricted area and serious know-how of display and TV set making.

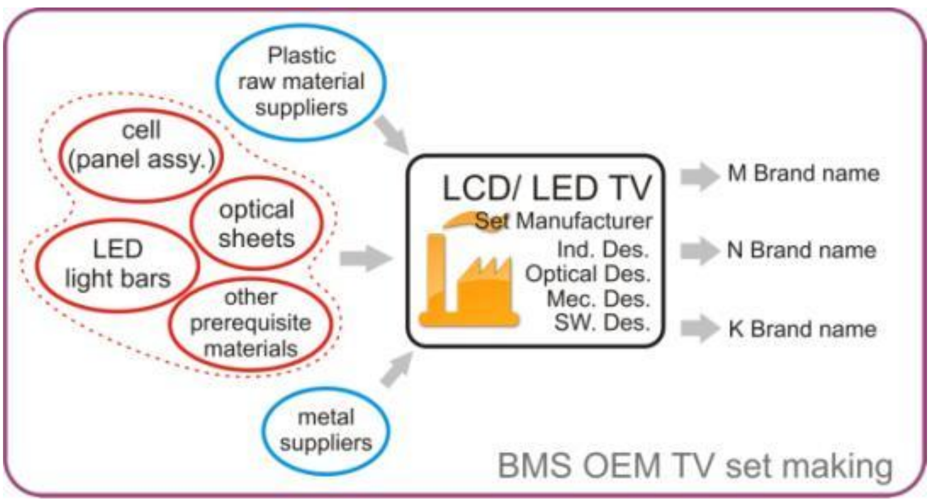


Figure 3. BMS OEM TV set making process scheme.

In the recent LCD TV value chain reports, it is forecasted that cell and open cell shipments would increase from %25 in 2011 to nearly %50 in 2012. Nearly all LCD TV panel producers are shipping cells or open cells and they report to increase their production according to the demand in this trend.

Firstly, many China TV set makers such as Hisense, Konka, TCL, Skyworth and Changhong began implementing this model in 2009. But as an A brand with huge production capacity Samsung has greater impact on industrial design, mechanical and software design and total industrial engineering of TV set making business. After Samsung has led the way explicitly, Funai, Foxconn, Briview, Raken, Wistron, Vestel, TPV and Chinese TV brands have set up module assembly lines to start to take advantage of BMS integration. Vestel's project of BMS is the first integration project in Turkey and Europe that backlight unit of the display and TV is designed, (partially) produced and assembled in the same factory. With this TV production model, optical and mechanical parts of the backlight unit (except from the liquid crystal) is designed and produced for the first time in Turkey.

3.3 Why BMS?

Traditionally, Samsung Digital Media and Communications (DMC) was purchasing LCD TV panels (in the form of LCD modules) from panel suppliers, completing the mechanical and electrical design work for the LCD TV set, and then integrating the panel with the TV chassis to finish the set product like other set makers. This model was explained above as "the conventional process", in which there are clear divisions between panel makers and set makers. Since Samsung electronics has been a display module producer, Samsung DMC was purchasing half of the need from in-house, half from the outsource suppliers such as AUO, Chimei, Innolux and CPT. This policy helps to balance and leverage the company’s supply pool so that it can manage market changes. Vestel like many OEM companies, pursues the similar strategy, except owning and benefiting a module production company such as Samsung did until recent years. Instead, Vestel made use of as many as different display producer sources to handle the economic crisis, any size shortages from a producer, etc. So that in Vestel, industrial design and mechanical design of the LCD TVs have been under some serious extraneous constraints of displays, outsourced modules, etc.

But, in order to become more flexible, Samsung DMC shifted its purchasing from complete LCD modules to fully open cells or halfway open cells. Having been in the LCD module making market, Samsung electronics was quite simplifying the supply chain. Because they have already gained a deep know how on operating as cell and TV manufacturer.

As Yang & Hsieh put forward, in the “BMS business model” a set maker involves the supply chain integration. In the “Open Cell business model” a panel maker purely ships open cells to set makers, not the complete LCD module.

Thus, Samsung can lead the TV market easily, they can concentrate on industrial design applications with new innovative materials and different mechanical solutions. Because they produce their own display modules, these brands can even create new display structures according to their industrial design specifications. So that innovative ideas, brand new concepts could be supported and realized with new displays.

4. What are the effects of BMS from Industrial Design and Supply management perspectives?

4.1 Industrial Design in CE - Latest Trends

CRT (Cathode Ray Tube) TVs have started a virtual entertainment era but are dead for a long time. TFT LCD TVs have dominated the market for a while. They are actually more efficient with less energy consumption in bigger sizes. But their dominance did not last long enough to survive today; after LED LCD TV's were pushed to market very fast. In fact, fluorescent lights (CFL) displays and LED LCDs both employ the liquid crystal diode (LCD) technology front panel containing the “twisting crystals” which define LCD technology as understood from their name. But LED TV uses LED lights for backlighting instead of CFL lights as in CCFL LCD's. Also, LED light bars can be placed in two ways structuring the assembly, which names and shapes the display type. The first type -"direct led" or "full-array"- meaning that the LED lights are placed behind the entire LCD panel. In other type - called “edge lit”- LEDs are located around the edges of the panel and this placement allows for extremely thin construction.

Figure 4. TFT LCD

Figure5. LED LCD

The characteristics of the panel and the overall thickness directly affects the industrial design, where the designers get limited more and more with the reducing dimensions of TV sizes. In CRT TV's, the overall shape was really huge to play with. In TFT, the volume to create difference between new models was cut off partially. In LED technology "thickness" of the TV started to be questioned again. Because, while the thickness of 40" LED TV set becoming 39mm, bezel thicknesses are reduced to 19-22mm. The places to make difference and create a style are constraint drastically so that combinations of new materials and mould techniques, even new textures to realize new design ideas became the matter of R&D departments of TV set makers.

Nowadays, the TV and home entertainment market is saturated and therefore it is very competitive. An overview of TV market would show two A brands; Samsung is aggressive and leading the market, LGE is just following it closely but creating its own style, own way of doing things. After these two, some Japanese and Korean brands and some big OEM producers could be listed such as Sony, Sharp, Toshiba, Sanyo, Vestel, ChiMei etc. The third group consists of many Chinese brands, cat-copying Samsung and LGE.

Samsung is known as the "innovation creator" of the market which creates new perceptions about TV business. For ex. the TV became slimmer and slimmer, the perception of size of the TV changed in last decade. In CRT, 32" TV were huge to handle, creating doubts to have it at home even if you can afford it. Nowadays, 32" are considered small for living rooms; 40" is the starter for family TV. A type of a mould has been started to be used, so that polycarbonate material could be moulded as front cabinets of TV with high gloss surface. High gloss effect of the new TVs became the trend and “black” dominated the shelves once again. After two or three year, Samsung has utilized double injection moulds to create a new effect of transparency around the bezel. LGE has used the same effect as a quick response and the market has been turned to that direction with the concurrent black addiction.

Figure 7. Conventional LED TV

Figure 8.BMS LED TV

Again, Samsung presents the most innovative display type productions so that they can produce 40” with very slim bezel with drastically slim thickness. Nowadays, the high gloss surfaces are combined with black matte finishes. Chrome plating over plastic parts of details is one of the most preferred applications, but colour palette has been widened to cooler gray tones. Use of transparency and brushed metal surfaces as the design elements started to be applied even at the table top stands. Colour choices of TV sets alternate to–so called gun metal- gray tones, and ice white with the main

While the general look gets slimmer, technology of the TV is enhanced, also. TVs get smarter, so that they can connect with the electronic devices in the house and you can control them over your TV remote. Now, some smart TVs recognize the voice of the audiences in order to control the TV; it is enough to direct the remote and pick the channel you like to watch with the remote.

The prizes of the smart LED TVs are not affordable for everyone, however, the ads reinforce the customers the vice versa. Despite the higher price of LED TV's, TFT LCD sales scaled down in recent years. And as the LED technology spreads in far-east, the price difference decrease drastically. In small sizes the gap between two display types dropped down to $5-7, however, in bigger sizes like 40" the gap stays around $75. According to the sales reports, the prices didn't restrain the customers; %58 of LCD sales of Europe is LED TV. Compared the pace of change from CRT to TFT, the change from TFT LCD to LED TVs (considering all its benefits of new design, aesthetics and functional benefits) seems to take a while because of the price issue.

4.2 Advantages of BMS

Gains of BMS method of TV set making should be examined from different perspectives to be understood clearly. Because manufacturing a TV is very complex system to organize and to continue business globally requires more than just know-how of production.

For TV set makers, this new method of LCD cell business brings flexibility in module (display) and TV design. The bigger purchasing pool the company have, the more purchasing power it has over the components such as open cell, LED chips, backlight unit and other module component supply chain to have the best prices with good allocations.

Display modules are the most important cost item in the TV set (almost %60 of the total cost). Supplying the display from outsources decrease the competitive capacity of the TV set makers. Modules procured from outsources have limited technical and mechanical specifications and these specs limit industrial, mechanical and software design and production. This kind of supply chain constitutes a kind of dependency to the outsource suppliers. BMS application could help to reduce the stress of this dependency over the research & development departments. With the integration of module making into TV set making process, TV manufacturer brands can add value to their supply chain. Display modules could be designed according to new industrial designs. These designs are unique for the brand and cannot be copied unless BMS method and all same design–led solutions are utilised. With the BMS method, R&D gains importance and new innovative industrial designs could be feasible where they cannot be applicable with outsourced display modules. BMS brings flexibility to the manufacturer.

Also, BOM of BMS LED TVs is less than conventional TV, - less freight costs decrease the end-product cost while the product could be still sold higher prices because of its slim design and extra specifications. So, the product becomes more profitable.

4.3 Disadvantages of BMS

The advantages are very convincing. But many companies still use conventional modules to assemble TV and manufacture TV sets with conventional methods. Also, not %100 of production lines of the A brands and OEM companies (mentioned above) are converted to BMS style. This methodology certainly has some disadvantages and needs some prerequisites to benefit.

Firstly, the supply chain becomes very hard to organize. In case of a traditional model of TV manufacturing, three or four module producers the TV set makers would be dealing with. In BMS TV set making, the operation becomes more complex because number of components used in a TV set increases and there are some alternative suppliers/ vender to choose. The set maker company need to make connections and negotiate with more suppliers of cell suppliers and the other components of display module. The detachment of multiple parts in BMS manufacturing is coercive on the logistics of the components. Sustaining the harmony between suppliers of many meta-products (parts necessary for display assembly) is more difficult than handling only one finished meta-product - display module. Organizing the timetables of mould arrivals and component deliveries has the vital importance in a mass production company.

Secondly, BMS production needs very high tech equipments and high skilled specially educated workers. The circumstances of the production lines need to be differentiated from normal production lines, especially from the location should be kept separated from plastic manufacturing and paint shops nearby because display assembly requires a strictly clean zone.

BMS method also requires mechanical engineering of the plastic parts to hold the filters and cell together. The metal parts used in the TV set should be reorganized according to every different cell modules and changing interior structure of the main-board, power-board and display module triple. The design of the display module mechanics is quite different from whole TV set because of its constraints and precisions.

So, it is a fact that BMS method increases the responsibilities and work load on the central purchasing, logistics, production planning and design groups in the company.

5. Conclusion

In home entertainment business there are several ways to be afloat, OEM&ODM manufacturing, B& A Brand strategies. There are companies that choose to be trustworthy and agile strategic partners of well-known brands. Some choose to lead the market and its trends with all costs as an A Brand. Regardless the market strategy of the company, new business methods evolve from the emerging trends. And most of the time, applying these new methods of business becomes compulsory rather than necessity for the big manufacturers.

Vestel is one of the companies that have chosen to be the strategic partner for worldwide brands and whole seller for many electronic shops. BMS methodology is one of the new ways doing business in LED TV market which created quite a success from many perspectives. However it has some difficulties that many companies cannot take the risk to put into action.

Positive and negative sides of BMS have been analyzed briefly in the sections above. So, it is revealed that utilizing BMS became a differentiation point for the companies who are trying to apply its very unique designs and innovative ideas in LED TV market. In order to lead novelties and to be followed, industrial design is to be supported with unique mechanical and electronic design while the operational system of the factory accommodate itself with this "design& innovation led" perspective. Complexity of BMS really becomes a burden for the factories that just copycat the A brands, and even could bring an economical pressure. But for the factories that has enough background on manufacturing and logistics operations overseas, BMS method is a real facilitator of development and economical growth with its flexibility and cost saving effects.

6. References

http://www.lcdmodules.org/lcdblog/2011/12/27/led-lcd-tvs-in-2011-will-reach-50-market-penetration/ accessed on 12.04.2012

D.Y. Sha, P.K. Chen, Yung-Hsin Chen, 2008. The Strategic Fit of Supply Chain Integration in the TFT-LCD Industry. *Supply Chain Management: An International Journal*, vol. 13; Iss: 5; 339 – 342.

Vestel, 2011. Vestel - Samsung Cell In Tv Out Arkaışık Modül Sistemi. Tubitak Sanayi Ar-ge Projeleri Destekleme Programi Proje Değerlendirme ve Izleme Sistemi – Ön Bilgi Formu.

Yang, D., Hsieh, D., 2010. Samsung LCD TV Focused on Supply Chain Integration Opportunities. accessed on 17.05.2012

Wu,H. et al., 2011. A study of supply chain replenishment system of theory of constraints for thin film transistor liquid crystal display (TFT-LCD) plants. *African Journal of Business Management*, vol. 5; 21, 8617-8633.

What is the role of design-led innovation and prototyping in developing innovative business models?

Cara Wrigley[4]

Abstract

'Business model' and 'business model innovation' have gained substantial attention in management literature and practice. However, many firms lack the capability to develop a novel business model to capture the value from new technologies. Existing literature on business model innovation indicates the central role of the notion of "value" and the importance of experimentation in business model innovation. This conceptual paper investigates how design-led innovation may facilitate firms to develop novel business models for new technologies and to prototype them. First, we introduce the concept of business model and design-led innovation and highlight the opportunities for bridging both streams of research. Afterwards, we propose design-led business model innovation as a future research area and highlight the role prototyping and boundary objects play within it. Potential research questions and future research avenues are also presented and discussed.

Keywords: *design-led innovation, business model experimentation, business model prototyping*

1. Introduction

Changes in today's global economic environment require firms to revisit traditional assumptions of the industrial era about how businesses create and capture value (Teece 2010). Thus, business models and business model innovation have been focal elements of discussions in management practice and literature (Amit et al. 2010; Johnson et al. 2008). A technology is of little value if it is not commercialised via a differentiated business model. However, developing a novel business model to capture the value from technologies is not a trivial task, neither for start-ups nor for established firms (Chesbrough 2010). Existing practice-oriented case studies on business modelling highlight the central role of the 'value proposition' in order to link a technology to economic returns. In addition, the capability of business model experimentation is vital in order to identify radical new value propositions and business models, and to collect the data supporting it. However, the literature presents little understanding about how to facilitate business model experimentation (Chesbrough 2010). In design-led innovation, the iterative process of proposing 'radical new meanings', the act of creating visual representations, and prototyping are central. However, existing work on design and design-led innovation is not sufficiently linked to the concept of business model and business model experimentation (Verganti 2011). There is a significant gap between both streams of literature and practice. The role of design-led innovation in developing novel business models is unexplored and misunderstood.

To bridge this gap, the following conceptual paper aims to understand how design-led innovation can facilitate the development of radical business model innovation. Further, it investigates the role of prototyping and tools in design-led business model innovation. The paper is structured as follows: in the following section, a brief introduction and review of existing literature pertaining to the concepts of business

[4] cara.wrigley@qut.edu.au

model innovation and design-led innovation are explored. Subsequently the research proposition is then discussed and the paper concludes with a hypothesised research agenda.

2. Business Model Innovation and Design Led-Innovation – Existing Literature and Conceptual Foundation

'Business model' and 'business model innovation' have gained substantial attention in strategic management, innovation and entrepreneurship (Amit et al. 2010). Further, 'design-led innovation' may facilitate the process of modelling novel business models for (new) technologies (Verganti 2011). However, both areas have not sufficiently been linked and studied as a conglomerate. In the following section, both concepts are briefly introduced.

2.1 Business model innovation and new technologies

Nowadays, the term *'business model'* is ubiquitous and seems to be central to today's management practice (Margretta 2002; Johnson et al. 2008). All businesses either explicitly or implicitly employ a particular business model that describes the value creation, delivery, and capture of the mechanisms it employs (Teece 2010).

In existing literature, the concept of the 'business model' has been defined and referred to in manifold ways; as a statement, a description, a representation, an architecture, a conceptual tool or model, a structural template, a method and so forth (Amit et al. 2010). Thus, there is no consistent definition of what a business model is. However, literature describes key components of a business model highlighting the notion of value (value stream, value proposition), monetary and financial aspects, and aspects related to a firm's exchange relationships (e.g. delivery channels) and competencies and activities (Chesbrough 2006; Teece 2010; Margretta 2002; Zott & Amit 2010).

All in all, it is widely agreed that the notion of *value* is central to any business model (Teece 2010). A good business model needs to answer Peter Drucker's age old question: What does the (customer) value? (Margretta 2002). As known from innovation research, answering this question is not a trivial task when developing a new business model. Further, scholars emphasize that 'designing' business models is a crucial task for both entrepreneurs and managers and discuss tools and methods such as an activity system framework to conceptualize a new business model (Zott &Amit 2010).

From a technology and innovation perspective, the business model takes a central element in creating and capturing value from investments in research and development (R&D); however, this is often neglected in reality (Chesbrough 2010). The economic return a business can expect from taking a new technology to the market is dependent on the business model. That is, the business model is the heuristic logic that connects technical potential with the realization of economic return (Chesbrough 2006). To profit from innovation, firms not only need to excel in technology development and product innovation but also in business modeling and business model innovation (Teece 2010). Chesbrough (2010) argues that a mediocre technology pursued with a great business model may be more valuable than a great technology exploited via a mediocre business model (Chesbrough 2010). Thus, firms – both young start-ups and established firms – need to develop the capability for business model innovation as existing managerial practices and business planning to embody and break down significant barriers for business model innovation.

To succeed in business model innovation and to successfully link a new technology with economic success, business model 'experimentation' matters. This is highlighted in case examples of business model innovation in various industries – ranging from music industries to pharmaceuticals (Chesbrough 2010; Sosna et al. 2010). Experimentation helps to conceive a new business model and to generate the data needed to justify it. Case studies highlight how business model innovation is not a matter of superior foresight ex ante rather, it requires significant trial and error, and quite a bit of adaptation ex post (Chesbrough 2010).

2.2 Design and design-led innovation

The term *'design'* is used by many disciplines, to describe various activities. Over the years a plethora of authorities (Yazdani 1999; Cross, Christiaans & Dorst, 1996; Cross 2006) have documented its description in an attempt to constantly re-define it. Design can be used to describe a holistic and multi-disciplinary problem-solving approach that takes user needs, desires, and capabilities as its starting point and focus. However, design is not a linear process (Brown 2008). It is seen in the innovation field as the human-centered, prototype-driven approach, using designer's processes and frameworks to solve problems (Brown

2008). Indeed, the value of design is a different way of thinking, doing things and tackling problems from outside the box (Bucolo & Matthews 2011).

However, the term *design led innovation* is described as the tools and approaches which enable design to be embedded as a cultural transformation within a business. According to Verganti (2008) design led innovation is a strategy that aims to radically change the emotional and symbolic characteristics of products and services through a deeper understanding of broader changes in society, culture and technology. Rather than being driven by user needs or technological developments, design led innovation is pushed by a firm's vision about possible new product meanings and languages that could diffuse in society (Verganti 2008). It is this difference that affords design led innovation a unique opportunity for radical innovation in business value propositions by using the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity (Brown 2008).

Firms using design led innovation are competing through products and services that have a radical new meaning: those that convey a completely new reason for customers to buy them (Dell'Era, Marchesi & Verganti, 2010). Dell'Era, Marchesi and Verganti (2010) identify design led innovation as innovation where novelty of message and design language are significant and prevalent compared to novelty of functionality and technology. This is based on the idea that each product holds a particular meaning to consumers and that the style is just possible rhetoric that can be exploited to communicate it.

In order to create and foster radical innovation designers continuously toggle back and forth between analysis and synthesis and operate both in the *concrete* and *abstract* world. Instead of directly moving from *observations* to *solutions*, they make use of *'frameworks'* and *'imperatives'*: *Observations* help to collect data about the real world. Further, design-led innovation relies on frameworks to *reframe* observations and develop a new problem statement. *Imperatives* translate the problem statement into a value proposition, but not the features or capabilities of the solution. These imperatives and ideas are then turned into *solutions* and *artefacts* (Beckman und Barry 2008).

Throughout the process of design-led innovation various tools help to create 'tangible' representations of *observations, frameworks, imperatives (or ideas)* and *the final solution.* They represent important boundary objects, make the intangible tangible and help to move back and forth between the abstract and real world (O'Mahony und Bechky 2008). Examples of such tools are a day in the life, customer journey maps, contextual interviews, narratives and storyboards to name only a few (Stickdorn & Schneider, 2010). These tools play a crucial role in the prototyping stages in order to create and refine value propositions for the end user and prototype different types of solutions.

2.3 Gaps and opportunities

Existing work on business model innovation and design-led innovation highlights the (i) lacking understanding of the enablers for business model experimentation both in start-ups and incumbent firms, (ii) the missing link between design-led innovation and business model innovation.

There are many hurdles for companies trying to design novel business models and to experiment with business models varying drastically from corporate culture to perceived measures of success. Established mental models, common "beliefs" about how business create and capture value, and the limited understanding of interplay between technologies and business models hinder organisations to develop and test new business models (Chesbrough 2010). Designers and design-led innovation is about challenging existing beliefs, problems, and solutions, and thus, it is obvious that design-led innovation may support the conception and testing of novel business models. However, design-led innovation is still very much focused on designing new products and services. This highlights the need for designers to function in parallel with corporate decision makers, using their ability to re-frame the problem and experiment with multiple possible solutions. The integration of design into the main stream of business is an obvious gap in the literature; designers need to speak the same language and to become familiar with concepts of strategic management and business modelling. The idea that prototyping and experimentation matters, is understood in product development, (Thomke et al. 1998) yet linking the business model to this process has not yet been established. To sum up, there is need to link design-led innovation and design-led prototyping with business model innovation.

3. Novel Business Models and Design-Led Business Model Innovation – A Proposition and Research Agenda

In order to create novel business models, experimentation imperative. However, businesses struggle turning intangible ideas to tangible outcomes and the enablers for business model experimentation are scarcely understood. This is where design-led innovation and the idea of translating between the concrete and abstract worlds - via observations, frameworks, imperatives, and solutions - comes into play. Design-led innovation can help organizations to observe and collect the data from the real world, to reframe it, and translate it into imperatives and ideas in the abstract, a long with developing and testing new solutions in the real world. To do so, design-led innovation needs to rely on visual representations of observations, reframed problem statements, ideas, and business model prototypes. A variety of boundary objects comes into play. However, no singular boundary object is going to solve their problems or produce a radical solution. A tailored variety must be employed depending on the businesses situation, approach and need, as well as their iterative employment. More importantly throughout this process the technology (or core intellectual property) needs to be challenged and adapted to suit the best business model innovative outcome. The process of how to successfully implement this collectively is a vast gap in the literature.

To initiate a new research agenda, our overarching proposition is as follows: Design-led innovation may facilitate the development of novel business models by:

(1) conceiving radical business model 'propositions' and translating (new) technologies into meaning and value (without restricting the proposition to a new product or service)

A new technology is of little significance, if there is no business model to create and capture value. In existing practices innovation teams regularly move directly from technological functions and solutions to observations. However, we propose that design-led innovation will help to reframe the problems and propose radical business model 'propositions' that 'mean' value for the customers. Design-led innovation may facilitate to move back and forth between the abstract and real world and the world of technologies and other dimensions of a business models such as markets, pricing, delivery channels, resources, business relationships and so on. Indeed, there are interdependencies between the technological system design and business model; thus, different business model options may require different technological systems. Future research may address questions such as: What factors influence the conception of radical business model 'propositions'? How do design teams tackle the interrelationships between technologies and other 'design elements' of a business model when conceiving different types of radical business model propositions?

(2) creating boundary objects related to observations, problem statements, ideas and solutions in order to make both the novel business model and the process of business modelling more tangible and to iterate between the real and the abstract world

Business modelling is a lot about intangibles. Thus, the conception and experimentation with novel business models challenging. There are tools and frameworks to analyse and conceive new business models (Zott und Amit 2010); some of them already create visual representations of a business model (Chesbrough 2010; Osterwalder & Pigneur 2010). Design-led innovation makes use of tools to create representations of observations, ideas and solutions; thus, creating important boundary objects. Future research may address questions such as: What is the relative role of tools for creating visual representations of radical business model ideas (abstract world) and prototypes of radical business model solutions (real world) throughout the process of conceiving and testing business model ideas? How do such boundary objects help to overcome established beliefs about existing business models in a sector or market?

(3) collaboratively designing with key stakeholder groups to create and test radical business model ideas and *'real'* business model solutions (or artefacts) in a design-led business model innovation process with various prototyping stages

This research is of particular interest to both technology start-ups and established firms. Business model innovation is not a matter of superior foresight ex ante rather it requires a trail-and-error approach to the creation of business models. If design moves from a product-centric view towards a business model view, design-led innovation can facilitate the prototyping of business model solutions and collect observations to further adapt the business model after the 'experiment'. Such experiments may require the interaction and involvement with different stakeholders – including customers and complementary partners. Future research may investigate questions such as: What does the maturity of the business model prototype and the set-up of 'experiments' influence the success of business model prototyping? What are contingencies for involving different stakeholders throughout the process of business model prototyping and testing?

Future research may rely on both qualitative and quantitative research design to investigate our proposition. Action research and exploratory research may help to get a deeper understanding on how design-led innovation facilitates business model innovation. Further, natural experiments and longitudinal analyses of business model innovation case studies may enhance understanding design-led business model innovation and experimentation.

4. References

Amit, R.; Zott, C.; Massa, L. (2010): The business model: Theoretical roots, recent developments, and future research. Barcelona.

Beckman, S. L.; Barry, M. (2008): Developing Design Thinking Capabilities. Academic Research Library Jul/Aug 2008; 24, 4; (24).

Brown, T. (2009) Change By Design. HarperCollins, New York.

Bucolo, S. & Matthews, J. (2011) Design Led Innovation : exploring the synthesis of needs, technologies and business models. Proceedings of Participatory Interaction Conference 2011, Sønderborg, Denmark.

Bucolo, S. & Wrigley, C. (2011) Design led innovation as a means to sustain social innovation enterprises. In Design Business Conference 2011, 17-18 November 2011, IED Barcelona, Barcelona.

Chhatpar, R. (2007) Innovate Faster by Melding Design and Strategy, Harvard Business Review September: 1-2.

Chesbrough, H. W. (2006): Open business models. How to thrive in the new innovation landscape. Boston: Harvard Business School Press.

Chesbrough, H.W. (2010): Business Model Innovation: Opportunities and Barriers. Business Models. Long Range Planning 43 (2-3).

Cross, N. (2006).Designerly Ways of Knowing. Springer Birkhäuser, Berlin.

Cross, N., Christiaans, H., & Dorst, K. (1996). Analysing Design Activity, Wiley.

Dell'Era, C., A. Marchesi & Verganti, R. (2010). Mastering Technologies in Design-Driven Innovation. Research Technology Management March 2010.

Johnson, W. M.; Christensen, M. C.; Kagermann, H. (2008): Reinventing Your Business Model. Harvard business review Dec 2008 86.

Margretta, J. (2002): Why Business Models Matter. Harvard Business Review.

O'Mahony, S.; Bechky, Beth A. (2008): Boundary Organizations: Enabling Collaboration among Unexpected Allies. Administrative Science Quarterly 53 (3), S. 422–459.

Osterwalder A. & Pigneur Y (2010). Business Model Generation – A Handbook for Visionaries, Game Changers and Challengers. John Wiley and Sons, Inc., Hoboken, New Jersey.

Sosna, M.; Trevinyo-Rodríguez, R. N.; Velamuri, S. R. (2010): Business Model Innovation through Trial-and-Error LearningThe Naturhouse Case. Long Range Planning 43 (2-3), S. 383–407.

Stickdorn, M. & Schneider, J. (2010). This is Service Design Thinking. Amsterdam: BIS Publishers.

Teece, D. J. (2010): Business Models, Business Strategy and Innovation. Long Range Planning 43 (2-3), S. 172–194.

Thomke, S.; Hippel, E. von; Franke, R. (1998): Modes of experimentation: an innovation process—and competitive—variable. Research Policy 27 (3).

Verganti, R. (2008). Design meanings and radical innovation: A meta model and a research agenda. Journal of Innovation Management 25: 436-456.

Verganti, R. (2011): Radical Design and Technology Epiphanies: A New Focus for Research on Design Management. Journal of Product Innovation Management 28 (3), S. 384–388.

Yazdani, B. (1999). Four Models of Design Definition: Sequential, Design Centered, Concurrent and Dynamic. Journal of engineering design(0954-4828), 10 (1), 25.

Zott, C.; Amit, R. (2010): Business Model Design: An Activity System Perspective. In: Long Range Planning 43 (2-3).

Reducing CO_2 emission through the promotion of the local potentialities and sustainable logistics: A focus on transportation of materials and packaging supplies.

Clara Ceppa[5], Gian Paolo Marino[6]

Abstract

In times of global warming, climate change and international summits, the debate, even in the field of design, is often limited to materials, production and technologies. Today, however, through a "systemic planned management" is finally possible to improve, albeit in part, these criticisms in particular by acting on the efficiency of logistics flows of packaging (input) of business processes. The systemic methodology, here presented, promotes precisely this type of management by creating new networks in which local companies/suppliers, geographically close one another, work together to achieve economic and environmental benefits both immediate and tangible. The positive benefits are given substance thanks to a greater traceability of materials and packaging components and their suppliers, as well as a higher quality of the entire supply-chain and a significant reduction of logistics costs and CO_2 emissions.

According to this methodology, the next step will be that one of extending the logistics improvement process to the management phase of packaging waste (output).

Companies will then have advantage in selling their waste to local companies who will use them as raw materials for their processes, in making the best use of resources already on site and in promoting the local economy by exploiting territorial potentialities.

Keywords: CO_2 emission reduction, food-pack sustainable logistic, systemic design

Introduction

Logistics is a complex activity, which acts in a transversal way inside every kind of company. Furthermore, it affects the entire flow of materials, information and services needed to support different types of activities, whether commercial or productive.

The logistics network is not limited to transportation, storage or packaging issues, but is rather a discipline that can handle the set of all those operations that provide support and maintenance of such a complex and branched network. It covers, explicitly or implicitly, all stages of the supply-chain within which it develops itself among all parties involved.

The environmental impact of the entire management system is definitely high and dependent on:

- transportation of goods;
- disposal of waste products throughout the whole supply-chain;
- packaging or re-packaging operations and return of unloaded pallets;

[5] Politecnico di Torino, DAD - Department of Architecture and Design, Italy, +39 011 0908828, clara.ceppa@polito.it

[6] Politecnico di Torino, DAD - Department of Architecture and Design, Italy, +39 011 0908828, gianpaolo.marino@polito.it

- energy consumption of storage facilities, logistics platforms and warehouses storing goods.

Focusing on the first two points, one becomes immediately aware of how much the virgin raw materials transportation – as well as that one of their relative packaging that, after having fulfilled its protection containment function, is immediately discarded – is environmentally impacting.

In 2009, Italy produced 14,558,000 tonnes of packaging with sales that reached nearly 24 billion euros. With 6% of the entire world production, Italy is today one of the top ten countries producing packaging. Of this vast amount of different material, only 30% comes from the field of non-edible products (non-food), while as many as 70% results from the food sector. Therefore, the food packaging turnover is greater because of the rapid consumption of edible products. Accordingly, it is found a large amount of waste matter as well as an equal production of new packaging.

The spending of 24 billion euros (data from the website: www.istitutoimballaggio.it) invested to produce more than 14 million tons of short-duration material to be immediately dropped after the post-use phase and the large amount of virgin material used, as well, are both relevant topics from both the environmental and economic point of view. They need for an immediate solution.

In this paper it will not be considered the problem of post-consumption packaging, widely discussed by the scientific literature already, but rather its ecological footprint in the pre-industrial production phase.

The choice of aiming the investigation "upstream" the production process rather than "downstream" (i.e. when economic/political/social efforts put in action for facing the waste management question tend to stem too tardily a "damage" already done), is channelled into a design process that seeks to eliminate such a damage before it is generated, transforming it into an advantage in post-consumption phases.

By deeply focusing the attention on the food sector, are then highlighted the routes taken by packaging that gravitate around a generic food processing company.

Packaging producers manufacture and send the secondary and tertiary packaging to raw materials suppliers. They, in turn, use them to store and send to the processing plant agricultural products and livestock.

Where feasible, there is an agreement between the company and transformation suppliers by which one party agrees to return to the other still usable containers (e.g. pallets). This does not happen when the packaging has been damaged during transport or is no longer usable because of the possible presence of organic matter which would undermine the subsequent supply of raw material (e.g. mildew).

At the same time primary, secondary and tertiary packaging are directly sent to the food company; they will be used to pack the finished products intended for mass distribution (Large-Scale Retail Trade).

At Large-Scale Retail Trade points of sale all secondary packaging are still discarded, especially boxes and crates, while the tertiary ones, such as pallets, are collected and sent back to packaging producers.

In the light of these considerations it is evident that kilometres covered by packaging and end-of-life waste matter are very high: the world situation, ecologically speaking, does not allow us to use throwaway packaging that comes, in addition, from distant places from the consume site.

The packaging does not weigh on the environment only after carrying out its protective function, but also during the supplying phase of the same.

In order to minimize the use of external resources in support of local markets (Ceppa, & Fassio, & Marino, 2008), the design principle of "territoriality" of Systemic Design methodology (explained below), allows us to map the relationships operating in a specific area, to geographically identify possible new local suppliers capable of fully meeting the needs of those producers who currently supply packaging abroad and, then, to manage the new relationships between actors acting within the trade relations and territorial network.

Thanks to a "systemic planned management", it is possible to improve the efficiency of logistics flows of packaging (input) of a business process. Thus, realized benefits increase the traceability of materials, packaging components and that of their suppliers. Furthermore, these benefits result in a higher quality of the entire supply-chain, in a significant decrease of logistics costs as well as in the consequent reduction of CO_2 emissions.

1. Methodological approach: Systemic Design

Our current productive activities produce a large amount of waste and squander most of the resources they take from Nature. If we think that over 90% of the water used in a brewery does not end up in the bottle, and over 20% of the grain after threshing is buried (Pauli, 1996), we can understand how dramatically urgent it is to do more with the resources that we have in hand.

In addition, when we extract cellulose from wood to make paper, we cut down an entire forest but use only 20-25% of the trees while the remaining 70-80% are thrown away as waste. Palm oil makes up only 4% of the overall biomass of the palm tree; coffee beans make up only 4% of coffee bushes. Breweries extract only 8% of the nutritional elements contained in barley or rice for fermentation (Capra, 2004).

Humans have recognized the problem too late and have tried to solve it downstream of the process of using the product. These actions that later proved to be inefficient. This occurred because we have always thought of production processes as a sequence of actions, independent from one another, implemented to produce a commodity.

Along with said commodity a huge amount of waste is produced. Said waste is considered an obvious result, along with the finished product, of the manufacturing process. And as such it is accepted.

In the current-day manufacturing model, the focus is exclusively on the product. By thinking of the product as of the main focus of the project, we immediately outline the values correlated to it, such as its economic value, its value as a status symbol, possession, communication. Nonetheless today harming the environment, lacking resources and the myth of unlimited development favor that more and more consumers begin to purchase product in a conscious way and buy more environmental friendly products (Paulesich, 2008: 149-159).

Figure 1. *Schema of the linear production process*

In a world that is ever more complex, like the world we inhabit today and will inhabit in the future, we must extend our gaze to the entire production process and see it in its entirety, i.e. not by single phases. We must deal with everything produced, products and waste, to start implementing targeted actions to achieve a substantial harmonization of the relationship between the environment and local communities. This is one of the principles underlying systemic design: to think by connections allows us to see each anthropic process in a new light, and by viewing the entire system we can pursue the goal of zero emissions.

Therefore we need to seek out new ways of producing that guarantee remarkable results in social, ethical and environmental terms and lead to an improvement in the quality of life. We need to be conscious that we are part of a complex system that is not linear: it is an ecosystem (Capra, 2004).

In a sustainable community the foremost concern, i.e. what needs to be sustained, is not economic growth and development but the entire web of life on which long-term survival depends. It is designed in a way that its lifestyles, economic and financial organization, physical structures and technologies do not interfere with the intrinsic capacity of Nature to sustain life. Sustainability is not an individual property but the property of an entire network of relationships. In other words it involves the whole community. A sustainable human community interacts with other living systems, human and nonhuman, in ways that allow these the systems to live and develop according to nature. In the human sphere sustainability is fully compatible with having respect for cultural integrity, cultural diversity and the fundamental rights of the various communities to self-determination and self-organization.

In this kind of scenario producers are stimulated to design and manufacture ecologically sustainable products and services that will be in harmony with the system of the natural world: the productive process must turn to Nature (Gallopoulos, 2006) in order to understand the complexity of a system made up of relations between different beings and the continuous evolving flow of matter.

In terms of sustainability, the "projects" and "technologies" of Nature are far superior to human science and technology. We must apply our ecological knowledge and know-how to the fundamental redesign of our technologies and social institutions in order to fill the gap that today separates human design from the ecologically sustainable systems of nature.

Moreover in Nature there is no such thing as waste and even surpluses are metabolized by the system itself (Bistagnino, 2008: 104-105). If these conditions, which are fundamental for a living system, are adopted in production, they will promote the development of a zero-emissions production precisely because the waste (output) of one process is used as a resource (input) for another one. The outputs are enriched with new value and become a resource available to be in the manufacture of new products closely associated with the local skills.

Therefore it becomes possible to create new manufacturing scenarios where the output of one company, a useless material to be eliminated incurring expenses only, can be reused to ensure the survival of another company related to the business category or physical location of the first company. In this sense all in industrial production must reduce the use of no-renewable materials and evolve toward less energy-consuming processes, making uncontaminated outputs that can be reused for their qualities.

The above mentioned concept is the first of the five principles of Systemic Design (Bistagnino, 2011) which are:

- the output of a system becomes the input for another one;
- self-producing systems sustain themselves by reproducing automatically, thus allowing them to define their own paths of actions, and jointly co-evolve;
- the local context is fundamental cause it values local resources (e.g. human, culture, materials) and helps resolve local problem by creating new opportunities;
- the systemic approach is based on relationships: each one contributes to the system and the relationships can be within the system or outside of it;
- man connected to own environmental, social, cultural and ethical context.

Thanks to the proposed methodology and the corresponding re-evaluation of the rejected material, it becomes possible to skip treatment costs and create a network for selling one's own output. This generates greater profits and benefits to the territory due to the realization of new enterprises, the development and improvement of the already established enterprises and the creation of new jobs.

It is a process that can be applied to any production sector. It is deliberately applied locally to enhance local potentials and specificities and strengthen the bond with tradition. Another reason it is applied locally is to avoid the high costs of transportation along with the air pollution it creates.

The methodology of Systemic Design, therefore, substantially contributes to totally rethink the approach to the design and production of finished products, both upstream and downstream.

If until now the major industries were the real "engine" of such a growth model which then also small companies were forced to adapt to not succumb, from now on it seems that these latter will just have the opportunity to demonstrate the productive world how the "systemic thinking" could concretely be effective and efficient. In a period of economic crisis like the one we are dramatically experiencing, a "down-top" approach seems to be the answer to globalization that ultimately made it. Finding alternative ways to use what is called "waste" (be it both industrial and household), would include the development of new business, new products and the strengthening of local markets with consequent positive impact on the environment and living beings.

The following case study, in which the management of food-pack logistic has been revised on the basis of Systemic Design principles, shows us how a small local company alone may already contribute to the sustainability. If many other small local businesses would similarly act, then the positive effects would be very substantial indeed.

2. Case study

2.1 Packaging suppliers of an artisanal chocolate workshop.

The specific case study refers to an Italian artisanal chocolate workshop located in the North-West of Italy (company size: 5 employees; turnover: ≤ € 1 million) and shows how it can be possible to successfully redesign the logistics of all its packaging, currently coming from places outside the Italian territory, namely France and Belgium.

In particular, the Belgian company is located about 1,000 km and more than 10 hours of travel on wheeled vehicles. This company produces all kinds of accessories: from cases to envelopes, from packets to bags, from ribbons to moulds made of any material and shape. The owner of the workshop purchases, from the Belgian company, customized paper bags.

On the other hand, the chocolate manufacturer buys cotton ribbons to package cases of “cremini”, truffles, spicy chocolates and “giandujotti” from a French firm located about 350 km away from the workshop.

While located in France, this company is still closer to the workshop than two other Italian suppliers, located respectively at 450 and 430 km.

Specifically, the first one realizes artefacts made of cellulosic material suitable for the food sector, such as tissue papers, tablecloths and traycloths. The product purchased by the chocolate manufacturer is the customized tissue paper to wrap the chocolate bars.

The second one mainly produces cases typically conceived for the jewelery sector; the chocolate maker buys them to emphasize and pack its deliciousnesses such as sweet creams, truffles, spicy chocolates and “giandujotti”.

On a local level (area enclosed within a radius of about 150 km from the workshop), the chocolate manufacturer buys:

- *aluminium foil to wrap loose “giandujotti”. The goods are sent to destination on wheeled vehicles and cover a trip of 148 km before reaching their destination;*
- *bottles, tubes and plastic jars, (mainly used by pharmaceutical and cosmetic sectors) to pack chocolate creams. The distance is equal to about 146 km;*
- *self-adhesive labels for the packaging of chocolate bars and cases of “cremini”. The distance is approximately 70 km;*
- *tissue papers to show different flavour of “cremini”, truffles, chocolate bars and dragées. The firm is located 12 km away from the workshop;*
- *transparent plastic labels used to seal sweet creams. The distance is approximately 11 km.*

As for what concerns smaller elements such as staples, pastry cases, adhesive tape and small-sized adhesive labels, the chocolate artisan directly purchases them from a local wholesaler.

In order to estimate the amount of CO_2 derived from combustion of diesel fuel, it is necessary to consider two different models of vehicles used for shipments: the van and the truck. The first one, with a loading space of 17 m^3 and a total mass at full load of 7 t, emits 0.05 t of carbon dioxide per 100 km. The second one, with a loading space of 60 m^3 and a total mass of 44 t at full load, produces 0.30 t per 100 km.

These emissions should be considered as the maximum allowable at full load.

Sometimes it is possible that the shipments do not exploit the maximum volume of used vehicle and it is equally possible that the second trip (the return to the plant of origin) happens on half load conditions. It strictly depends on choices of the carrier to optimize shipments of goods.

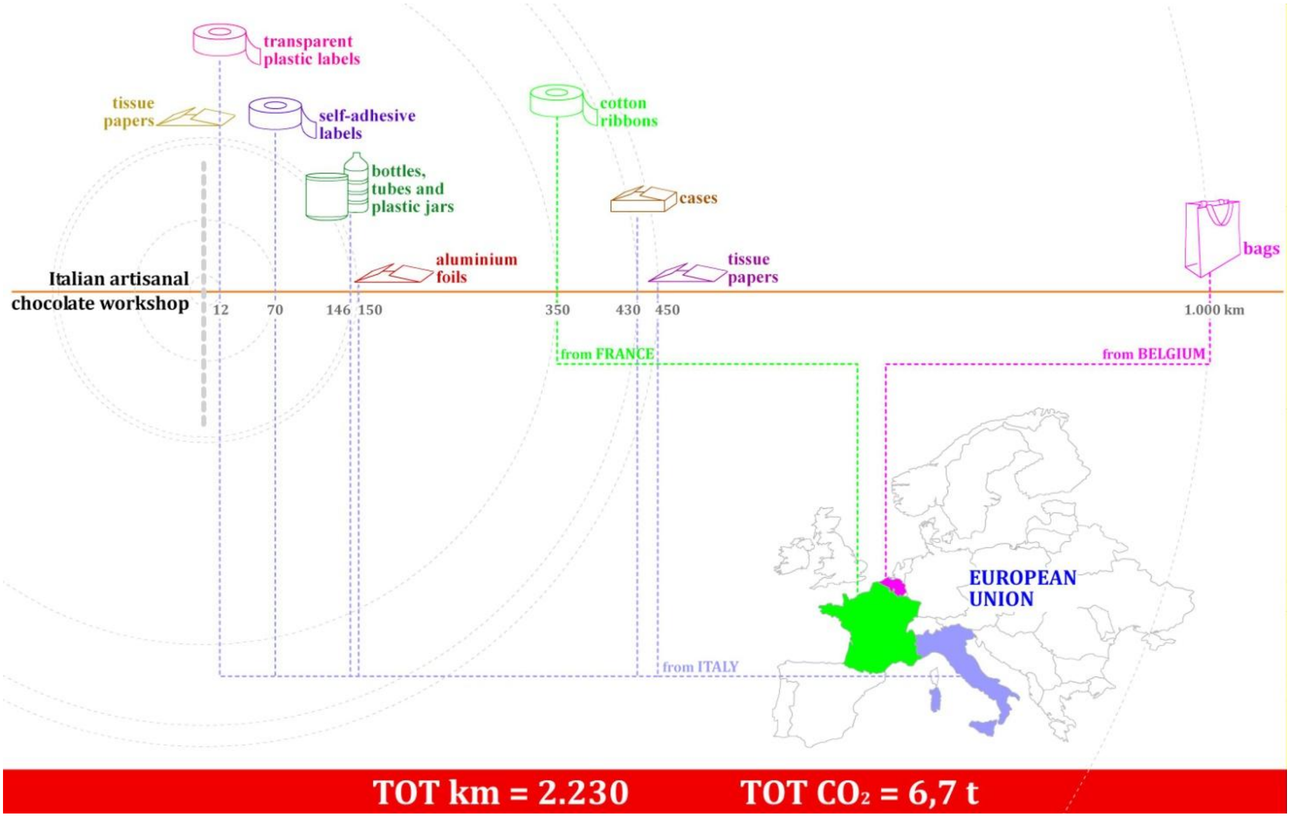


Figure 2. *Case study: geographical distances between the current suppliers and the artisanal workshop*

In terms of CO_2 emissions, on equal conditions of distances at full load, six by-van shipments are necessary to equal just one by-truck trip: 0.05 t CO_2 = 0.30 x 6 km t/100.

Considering, then, the potential volume of the two types of vehicles, it is clear that six shipments made with the van yield about 70% more of transported goods if compared to that which occurs with the truck:

- $60m^3$ x 1 = 60 m^3;
- $17m^3$ x 6 = 102 m^3;
- $60m^3$ + 70% = 102 m^3.

Empirically, we can say that it is quite convenient the by-vans good shipments solution, rather than the by-truck one.

2.1 Ameliorative systemic proposal: the new network of local suppliers.

The study of a systemic proposal that improves the network of suppliers so to reduce CO_2 emissions through the promotion of the local potentialities and sustainable logistics, means in the first place to give answer to a series of questions about the supply of packaging components used by the workshop.

Is that possible that the only one company, which manufactures paper bags, is sited in Belgium to over 1,000 km away from the workshop? And yet, why rely on a supplier of cases, which is about 430 km, or on a producer of tissue paper, tablecloths and traycloths, sited at 450 km?

To choose the best companies producing packaging components it would be appropriate evaluating different aspects, such as:

- the quality of the product;
- the distance to be travelled by the shipment;
- CO_2 emissions;

- the link between the territory and firms;
- the price of the components; this results in being a very competitive issue because costs related to transportations and logistics from medium/long distances will not be taken into consideration. In fact the new components will be produced by local businesses close one to other. By approaching as close as possible suppliers to the chocolate workshop it does mean reducing costs of shipment, boosting circulation of smaller and more environmentally friendly means of transportation, saving on mileage and lowering the amount of emitted CO_2.

To replace the Belgian supplier four companies, producing customized paper bags, have been identified. They are all located within a radius of 65 km away from the workshop.

Among these new possible suppliers, the company located at 26 km is considered to be better than that one placed only 20 km away from the workshop, because the former produces bags of quality level as equal as to that of Belgium.

The French company, which produces cotton ribbons, can be replaced by four closest possible Italian companies: the best one appears to be that one located 50 km from the workshop.

Instead, as for the market of tissue papers, it was possible to identify just only one company within the area of interest, which is situated 42 km from the laboratory. Anyway, this firm fortunately offers a product that fully meets those characteristics required by the chocolate artisan.

Currently, cases produced miles away and then transported along a distance of 428 km, are also manufactured by some companies that are closest to the workshop (within a radius of 40 km). In particular, the company placed at 31 km from the laboratory, results in being the most appropriate.

From these new proposals seems to be clear what is the potential gap between the current solution (long/very long-range logistics) and that one proposed (short-range logistics). Companies, identified in an area adjacent to the laboratory, shall not be deemed the best ever – and therefore a point of final destination of every kind of systemic design planning operation – but the preferable at this time. In the prospective event a new competitor supplier should establish its activity nearer than those ones actually chosen, the chocolate artisan will feel free to take it into consideration, because of sustainable and cost reasons, so to ameliorate its entire network of suppliers.

In the current situation only the supply of these four packaging components – bags, ribbons, tissue papers and cases – run a one-way trip equal to 2,235 km. This ends with the generation of 6.7 tonnes of CO_2.

Thanks to the new network of suppliers, instead, the total mileage of covered distances is drastically reduced to 150 km and the production of CO_2 emissions fall to 0.075 tons.

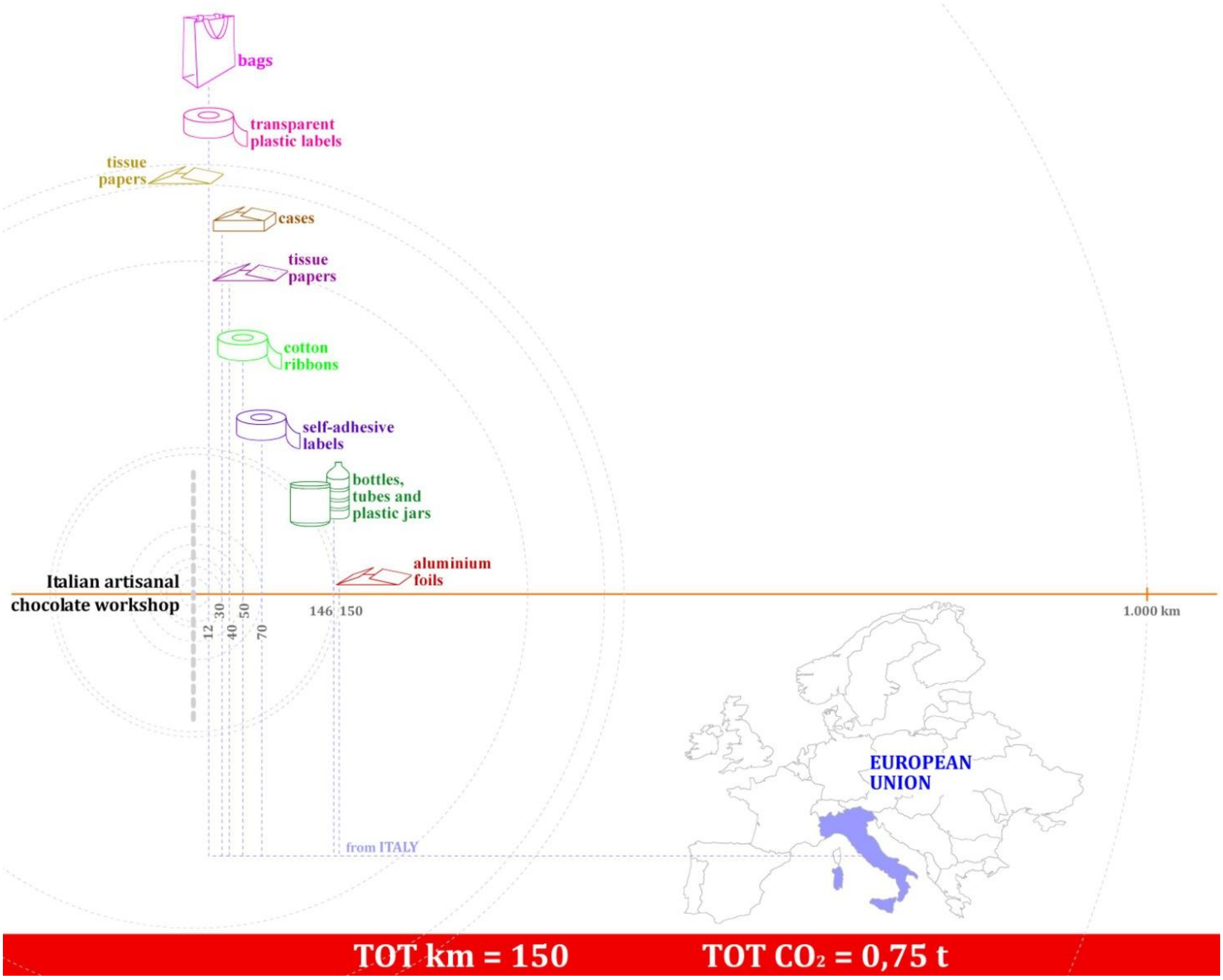


Figure 2. Case study: geographical distances between the new proposed suppliers and the artisanal workshop

By acting in such a manner:

- 2,085 km are no more covered;
- 6.6 tonnes of CO_2 are no longer produced;

3. Conclusions

The work of investigation and theoretical application highlighted by the case study, allowed us to fully understand everything about the supply cycle of materials for the packaging of chocolate products, which is handled within a small company. As noticed, such an approach offers a possible solution to both problems of useless transportation and CO_2 production thanks to the proactive collaboration of some productive and commercial activities geographically close to the artisanal firm.

Today, through a "systemic planned management" is finally possible to improve, albeit in part, these criticisms in particular by acting on the efficiency of logistics flows of packaging supplies (input) as well as their related transportation from grand distances to the chocolate workshop. The systemic methodology, here presented, promotes precisely this type of management by creating new networks in which local companies/suppliers, geographically close one another, work together so to achieve economic and environmental benefits both immediate and tangible.

In the end, the positive benefits and future potentiality of the project are:

- greater traceability of materials and packaging components and their suppliers;
- packaging and chocolate products quality levels still guaranteed;
- higher quality of the entire supply-chain;
- significant reduction of logistics costs;
- significant reduction of CO_2 emissions and unnecessary movement of goods from large distances (which cause, among other things, the wastage of non-renewable energy resources);
- creation of a synergistic and territorial cluster of small/medium enterprises (SMEs);
- promotion of the system concept (and subsequently that of Systemic Design) for a smarter management of inputs (packaging, materials, products, etc.);
- creation of possible new jobs for the management, administration and transportation of packaging supplies;
- promotion of local potentialities and sustainable logistic.

The final project should not be considered as a final destination point, but a theoretical basis from which to start promoting future developments in the field of systemic requalification instead.

According to this methodology, the next step will be that one of extending the transportation/supply logistics improvement process to the management phase of packaging waste (output).

Companies will then have advantage in selling their waste to local companies who will use them as raw materials for their processes, in making the best use of resources already on site and in promoting the local economy by exploiting territorial potentialities.

This work is therefore a first attempt in wanting to sustainably manage the problem of transportation of materials and packaging supplies by following some basic notions of the systemic approach. The privilege of being able to dissect every aspect of a specific case study, allowed us to work on complex realistic data without having to resort to incorrect speculation or aseptic statistics.

It is hoped that in time the proposals suggested by the case study can serve as a basis for developing further research in this direction or become a concrete reality, both economically and environmentally advantageous, which can then be shared by a growing number of businesses scattered over the territory.

4. References

Bistagnino, L. 2008. Ispirati alla natura. *Journal Slowfood* n. 34, June 2008; Bra (CN): Slow Food Editore.

Bistagnino, L. 2011. *Design Sistemico/Systemic Design*, 2a edition, Milano: Edizioni Ambiente.

Capra, F. 2004. *The Hidden Connections*, New York: Doubleday.

Ceppa, C., & Fassio, F., & Marino, G.P. 2008. *Food-Pack Guidelines*, Torino: Time&Mind Press.

Conte, F. 2011. *Nuova applicazione web per lo sviluppo di un sistema di relazioni commerciali a livello territoriale. Il caso studio dell'Atelier del Cioccolato di Guido Castagna*. master thesis.

Gallopoulos, N.E. 2006. Industrial ecology: an overviewed. *International Journal Progress in Industrial Ecology*. Vol. 3, no. 1/2.

Paulesich, R. 2008. Sustainable consumption: a crucial aspect of research in economics. Peer reviewed article in the *International Journal Progress in Industrial Ecology*. Vol. 5, no. 1/2.

Pauli, G. 1996, *Breakthroughs - What business can offer society*, Surrey, UK: Epsilon Press: 153.

Effects of Involvement-Stimulating Technologies and Design in Creating Brand Experience: A Study on Retail Applications in the Turkish Market

Deniz Atik[7] *and Dicle Yurdakul Şahin*[8]

Abstract

Today, changes in consumers' lifestyles and preferences, new technologies and rapidly growing online sales figures are raising concerns about the future of traditional retailing and retail stores. From the consumers' perspective; the shopping experience becomes more like an entertainment, a theatrical act, rather than a must-to-do. Owing to these transformations, the retailing environments have also started to change in order to provide customers an intense brand experience. New experience stores using creative designs and involvement-stimulating technologies creates an interactive environment which presents the customers a sense of control over the shopping experience as well as entertainment. In consideration of the previous studies which reveal the relationship between involvement-stimulating environments and brand loyalty, this study aims to shed light on the effects of different design dimensions on brand experience and brand loyalty. Different brands operating in the Turkish market with different applications of these design dimensions were evaluated by the respondents in terms of the intensity of the brand experience and brand loyalty. Through the findings of this study, we hope to contribute to current knowledge by shedding light on the successful in-store applications of design and technology which stimulate involvement and create an intense brand experience.

Keywords: Brand experience, Brand loyalty, Customer involvement, Design, Technology

1. Introduction

Owing to the rapidly changing technology and its effects on consumers' lives, preferences and experiences, the future of traditional retailing and retail stores is a topic of interest in retailing and marketing literatures. On one hand, contemporary consumers are searching for new experiences in the retail environment which might pose a threat to traditional retail stores. On the other hand, online sales figures are continuously growing which is raising concerns about brick and mortar stores.

Due to these transformations, the traditional retail stores have also started to change in order to provide customers an intense shopping and brand experience. New experience stores using creative designs and involvement-stimulating technologies creates an interactive environment which presents the customers a sense of control over the shopping experience as well as entertainment. Considering the importance of these experiences for the contemporary consumers, and in light of the previous studies which reveal the relationships between involvement-stimulating environments and brand loyalty, this study aims to shed light on the effects of creative design and in-store applications of design and technology on brand experience and brand loyalty.

7 Izmir University of Economics, Turkey, +90 232 4888202, deniz.atik@ieu.edu.tr
8 Izmir University of Economics, Turkey, +90 232 4888380, dicle.yurdakul@ieu.edu.tr

2. Literature Review

In today's retailing environment, customers' experiences have started to take the stage as one of the most important factors which contribute to developing strong relationships between customers and brands. The highly competitive market requires brands to differentiate themselves in many aspects including products, services, communications activities and consumers' experiences. According to Voss (2003), organizations are focusing more on experiences as an effective way for differentiation in today's highly competitive markets. Although experience retailing is discussed to be dating back to nineteenth century (Barbaro, 2007), the new technologies transformed the retail business in a brand new way through immersing the customer into the setting, namely, the retail store to appeal to senses in a deeper way in order to create stronger bonds between the brand and the customer.

Considering the importance of experiences in creating value, differentiation and loyalty, many major companies, especially major electronics companies, have started to develop the experience store concept (Jones et al., 2010). Rather than building their stores on the simple idea of "try before you buy", these companies are adopting a more focused perspective on experiences through using different dimensions of design and immersive technologies. Jones et al. (2010) argues that these technologies transformed the shopping experience as well as the emotional bond created between the brand and the customer.

Through this increasing attention in the concept of experience, marketing practitioners started to focus on the importance of brand experiences in creating marketing strategies (Brakus et al., 2009). Before Brakus et al.'s (2009) conceptualization of brand experiences, marketing scholars paid attention to the effects of physical environment and atmospheric variables on brand preference and brand loyalty (Keller 1987, Fournier 1998, Jones 1999, Mandel and Johnson 2002, Arnold et al. 2005). Yet, in spite of defining and measuring the relationship between specific brand related stimuli and brand loyalty, a holistic approach needs to be adopted in order to have a deeper understanding on the relationship between the brand and the consumer. Through such a perspective, Brakus et al. (2009;53) define brand experience as "subjective internal consumer responses (sensations, feelings, and cognitions) and behavioral responses evoked by brand-related stimuli that are a part of brand's design and identity, packaging, communications and environments."

The concept of brand experience includes many different dimensions such as sensory, affective, intellectual and behavioral dimensions (Brakus et al. 2009, Zarantonello and Schmitt, 2010), and the strength of the effects of these dimensions determine the intensity of the brand experience. Sensory dimension refers to the impressions made through the brand related stimuli on visual sense and other senses. It is proposed that the more the brand appeals to senses, the more intense will be the brand experience. Affective dimension includes feelings, sensations and emotions. If the brand related stimuli is able to induce feelings and emotions, the brand experience will be perceived as more intense and strong. On the other hand, behavioral dimension of brand experience refers to brand's ability to direct customers to action, while the intellectual dimension refers to brand's effect on curiosity, thinking and problem solving. All these dimensions contribute to the intensity of the perceived brand experience (Brakus et al. 2009, Zarantonello and Schmitt, 2010).

Brand experiences are related to other brand concepts which were studied intensively in the literature such as brand image, brand awareness and brand knowledge. Though all these different aspects of branding contribute to the formation of brand experiences, the concept of experience includes more intense feelings such as emotions and sensations. In addition, brand experiences can be created throughout different interactions of the brand and the consumer, including searching, purchasing and using the product or taking the service. (Brakus, Schmitt & Zarantonello, 2008; Chang & Chieng, 2006, Choi, Ok & Hyun, 2011). From information search to after sales, all interactions between the brand and the consumer can contribute to creating intense brand experiences. In addition, previous studies reveal that, brand experiences also contributes to different dimensions of the brand such as brand awareness or knowledge, as intense brand experiences affect consumers' ability to remember the characteristics of the brand (Weinberg, 2001).

Although brand experience can be considered as a relatively new concept, brand loyalty has been a topic of intense interest in the previous literature as one of the most desirable outcomes of the branding activities. Brand loyalty is considered to be consumers' way of expressing satisfaction with the performance of the product or the service (Bloamer and Kasper, 1995, Dick and Basu 1994; Fornell et al. , 1996, Oliver, 1996). Today, rather than giving importance to cognitive aspects of an experience with the brand, more attention is devoted to creating emotional brand experiences in order to ensure loyalty. Previous studies in the literature reveal that consumers no longer simply buy or use products or services, but they are in search for more intense, emotional experiences in their consumption activities (Gobe 2001, Ratneshwar and Mick, 2005). According to Pine and Gilmore (1998), an intense and successful experience can be defined as a unique, memorable and desirable experience which directs the consumer to repeat it and spread the word of mouth about it. This desire for repeating the experience means that successful brand experiences can lead to brand loyalty as the customer will be willing to experience different aspects of the same brand over and over in time because of the positive feelings, sensations and behaviors it stimulates. As Morrison and Crane (2007) argue, creating an intense brand experience requires an integrated effort with all brand aspects to make customers not only satisfied but also feel good. Creating and managing this emotional experience can lead to brand differentiation and brand loyalty (Gapper, 2004).

According to Bitner (1992), one of the most important factors affecting the intensity of these emotional experiences is the design of the servicescape. Servicescape is described as the environment in which the service is realized and the experience is created (Bitner, 1992). Bitner (1992) specifically focuses on the importance of environmental factors in a servicescape in creating emotional responses and behavioral responses such as approach or avoidance. In addition, today, the technology allows us to create interactive and immersive environments which may create more intense experiences compared to physical artifacts or ambient conditions. In their study of hyperreal prepurchase experience, Edvarsson et al. (2005) argue that as well as physical artifacts (signs, symbols, products)designing an experience-centric store requires other dimensions such as intangible artifacts (brand image, brand reputation), technology, customer placement and customer involvement. Edvardsson et al.'s (2005) study reveals the importance of different design dimensions on customers' experiences with the brand and their perceptions of value. They argue that, as well as the physical and intangible artifacts, the nature and role of the technology within the customer experience, the "staging" of the customer in the physical environment and the involvement of the customer in the experience will affect the intensity of the experience and will increase the perceived value. In a similar vein, Morrison and Crane (2007) state that, in order to ensure the effective management of brand experience, an environment should be crafted in which the physical context (sights, sounds, texture and smells, etc.) create clues which communicate with the customer and arouse desirable feelings and sensations. Therefore, it can be argued that the design elements of the service environment are an important part of the basic emotional responses of the customers which create intense brand experiences.

In their study of store image, store satisfaction and loyalty, Bloamer and Ruyter (1997) state that in the contemporary markets, there is an increased competition with the entry of new store concepts and formats which expresses the importance of store loyalty which is highly related to store image. Store image is considered to be consisting of different elements of the retail marketing mix such as location, service and store atmosphere (Ghosh, 1990). Therefore, in-store experiences of the customer stimulated by different dimensions of design and atmosphere are argued to be affecting store loyalty, which, in return, create brand loyalty. Although the effects of atmospherics and design have been a topic of interest in retailing and marketing literatures for many decades, effects of new experiences created through developing technologies requires further investigations.

Considering all these discussions in the literature regarding the relationship between design elements, brand experiences and brand loyalty, this study aims to reveal the relationship between different design dimensions of a retail store, perceived intensity of the brand experience and brand loyalty.

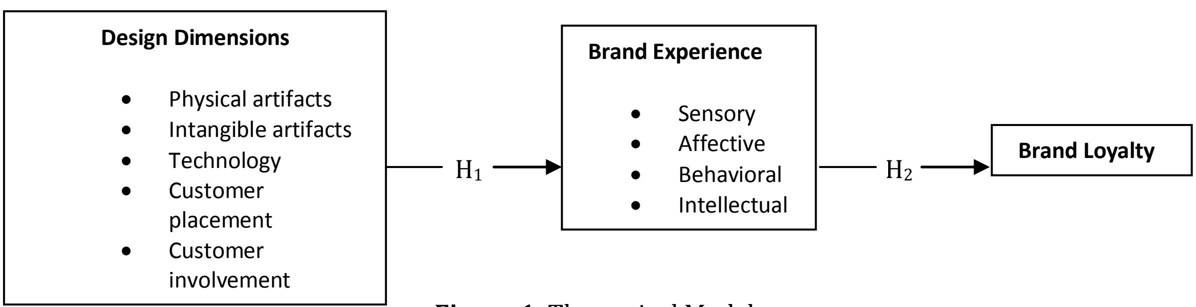


Figure 1. Theoretical Model

3. Research Hypotheses

Considering the previous studies and the need for further studies in explaining the effects of different in-store design dimensions on brand experiences and brand loyalty, this study aims to reveal the relationships between different design dimensions such as physical artifacts, intangible artifacts, technology, customer placement and customer involvement, brand experience dimensions and brand loyalty.

We hypothesize that;

H_1: Consumers' positive evaluations about the design dimensions are positively related to the perceived intensity of brand experience.

$H_{1a:}$ Consumers' positive evaluations about the physical artifacts are positively related to the perceived intensity of brand experience.

$H_{1b:}$ Consumers' positive evaluations about the intangible artifacts are positively related to the perceived intensity of brand experience.

$H_{1c:}$ Consumers' positive evaluations about the use of technology are positively related to the perceived intensity of brand experience.

$H_{1d:}$ Consumers' positive evaluations about customer placement are positively related to the perceived intensity of brand experience.

$H_{1e:}$ Consumers' positive evaluations about customer involvement are positively related to the perceived intensity of brand experience.

H_2: Consumers' perceptions of brand experience intensity are positively related to brand loyalty.

$H_{2a:}$ Consumers' perceptions of the intensity of sensory dimension of brand experience are positively related to brand loyalty.

$H_{2b:}$ Consumers' perceptions of the intensity of affective dimension of brand experience are positively related to brand loyalty.

$H_{2c:}$ Consumers' perceptions of the intensity of behavioral dimension of brand experience are positively related to brand loyalty.

$H_{2d:}$ Consumers' perceptions of the intensity of intellectual dimension of brand experience are positively related to brand loyalty.

These hypotheses were tested through correlation analysis which will be discussed in detail in the forthcoming sections.

4. Methodology

A draft questionnaire was formed with scales from previous studies on design dimensions, brand experience and brand loyalty. After providing participants with a brief information about brand experience (specifically in-store brand experience), respondents were asked to name a brand which they think provided them intense experiences. We requested the participants to think about the named brand while answering the rest of the questions. The rest of the survey consists of brand's design dimensions, brand experience and brand loyalty as well as the questions about demographics.

The scale was crafted with design dimensions scale (Edvardsson et al., 2005), brand experience scale (Brakus et al., 2009) and brand loyalty scales (You and Donthu, 2001). All items were measured on a 5-point Likert scale. Demographic information included gender, age and education levels of the participants.

The draft scale was then translated into Turkish, and two experts were asked to check and comment on the accuracy of the translation. Prior to finalizing the questionnaire, a short pretest was conducted and the questionnaire was then revised based on the results of the pretest. A pilot-test was conducted to assess the reliability of the measures resulting in a Cronbach's Alpha value over ,7. The questionnaire was distributed online and 188 responses were received. 20 questionnaires with missing information were eliminated and 168 were used for further data analysis. Finally, alpha score was calculated as 0,864 which indicates that the scale has high internal consistency.

Demographic data reveals that most of the respondents of the survey were female (62 %, n=104) and the ages of the respondents was ranging from 18 to 52 with a mean of 31. Majority of the respondents were college graduates (76 %). Data analysis was conducted through SPSS software.

5. Findings

The hypothesis testing has been conducted through correlation analysis. Reverse-worded items were recoded prior to data analysis. Given the fact that all variables were ordinal, we computed Spearman's rank correlation coefficients to investigate the hypothesis. Table 1 shows the correlation coefficients for the variables specified in the hypothesis:

Table 1. Correlation Analysis Results (Spearman's)

Hypothesis	Relationship Hypothesized	Correlation Analysis Results
H_1	Design dimensions - Brand experience	0,430 $p < 0,01$
H_{1a}	Physical artifacts - Brand experience	0,471 $p < 0,01$
H_{1b}	Intangible artifacts - Brand experience	0,465 $p < 0,01$
H_{1c}	Technology - Brand experience	0,371 $p < 0,01$
H_{1d}	Customer placement - Brand experience	0,346 $p < 0,01$
H_{1e}	Customer involvement - Brand experience	0,497 $p < 0,01$
H_2	Brand experience - Brand loyalty	0,564 $p < 0,01$
H_{2a}	Sensory dimension - Brand Loyalty	Not significant
H_{2b}	Affective dimension - Brand Loyalty	Not significant
H_{2c}	Behavioral dimension - Brand Loyalty	0,595 $p < 0,01$
H_{2d}	Intellectual dimension - Brand Loyalty	0,392 $p < 0,01$

The results reveal that most of the hypotheses were confirmed through positive correlations within pairs of variables. Two hypotheses (H_{2a} and H_{2b}) were rejected. For the confirmed hypotheses, the correlations were moderately strong with Rho values > 0,5. However, some correlation scores were higher than others which show that there is a stronger correlation between those pair of variables. For example, the strongest correlation was identified between the behavioral dimension of brand experience and brand loyalty (Rho = 0,595).

In the first hypothesis, we tried to investigate the relationships between consumers' positive evaluations about different design dimensions and the perceived intensity of brand experience. This hypothesis was confirmed as the correlation coefficient (0,430) reveals a positive relationship between two variables. To have a deeper understanding on which design dimensions affect this relationship more than others, we developed different sub-hypothesis.

According to the results of the analysis, the strongest correlation for H_1 hypotheses was found to be between customer involvement and brand experience, which is followed by physical artifacts, intangible artifacts, technology and customer placement (with Rho values varying between 0,497 and 0,346). Accordingly, it can be argued that customers attach more importance to some design dimensions in creating brand experiences more than others, which provides further insights about brand experiences.

The second hypothesis about the relationship between brand experience and brand loyalty was also confirmed with a Rho value of 0,564 which indicates a moderate positive relationship between the two variables. Two of the sub-hypothesis of H_2 which explains the relationship between sensory and affective dimensions of brand experience and brand loyalty were rejected. Contrary to previous studies, sensory and affective brand experience dimensions were not significantly related to brand loyalty.

On the other hand, as hypothesized in H_{2c} , a moderately strong relationship was found between behavioral dimensions of brand experience and brand loyalty. This finding is in line with the previous discussions in the literature regarding the importance of active involvement in creating brand experience and brand loyalty. In addition, a positive, yet weak relationship was found between intellectual dimension of brand experience and brand loyalty (Rho= 0,392).

As a summary, the results of the Spearman's correlation analysis show that, positive evaluations about the design dimensions are positively related to the perceived intensity of brand experience, and consumers' perceptions of brand experience intensity are positively related to brand loyalty. Figure 2 reveals the results of the analysis as a summary. Findings of the study will be discussed in detail in the next section.

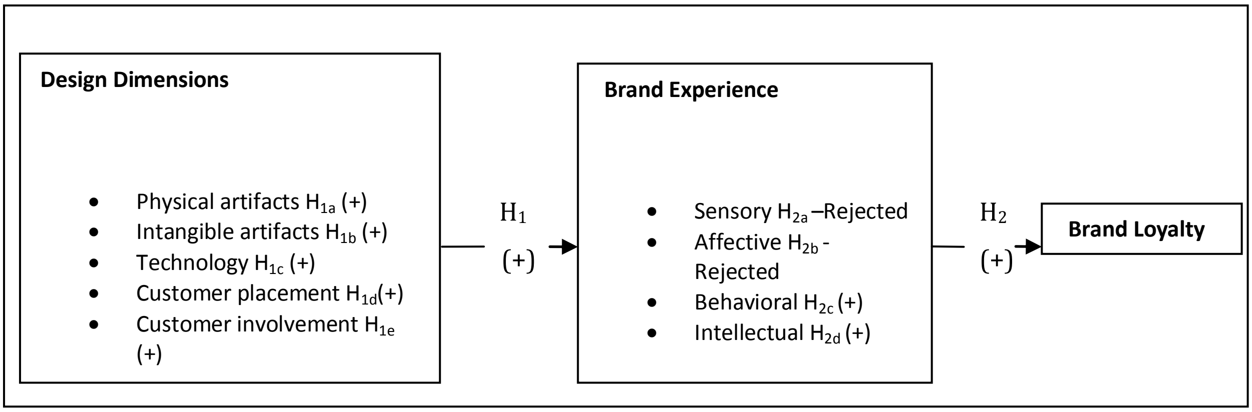


Figure 1. Confirmed and rejected relationships

6. Discussion and Limitations

In the contemporary markets of intense competition, brand experience is becoming more important in creating value for the customer, differentiation and brand loyalty. These experiences may arise in different settings, yet, retail stores can still be regarded as one of the most important contexts in terms of the interaction between the brand and the customer. Considering the rising expectations of the customer and the threat posed by online shopping to traditional retail stores, creating experiences through these stores is becoming a key issue. Therefore, within the context of this study, we aimed to focus on the relationships between different in-store design dimensions, perceived intensity of the brand experiences and brand loyalty.

The results of the analysis show that the variables are moderately correlated and hypothesized relationships are mostly confirmed. The main hypotheses of the study which are about the relationships between different in-store design applications (design dimensions), brand experience and brand loyalty were confirmed. According to the results of the analysis for the first set of hypotheses, customer involvement, physical artifacts and intangible artifacts was found to be more strongly correlated with perceived intensity of brand experience. Customer involvement refers to the first hand experiences of customers within the store such as being able to use the product, or being a part of the created experience. This also involves the behavioral participation of the customer into in-store activities. Considering the results of the analysis, it can be argued that customer involvement is one of the most important factors contributing to the intensity of the brand experience. Therefore, designing stores with applications for customer involvement may result in an increase in perceived value, intensity of brand experience, and finally, brand loyalty. In addition, physical artifacts such as the store atmospherics and intangible artifacts related to the brand such as reflecting the brand image with in-store applications and design are other important factors which needs to be taken into consideration.

Findings of this study also reveal that there is a positive relationship between perceived intensity of brand experiences and brand loyalty. This means that the more intense the customer perceives the brand experience, the more loyal they become. This finding also confirms the findings of the previous studies (Brakus et al., 2009). The second group of sub-hypotheses were not fully confirmed as the correlation analysis results reveal that there is no significant relationship between sensory and affective dimensions of brand experience and brand loyalty. Although previous studies claim that contemporary consumers are in search for emotional and sensational experiences in their consumption activities (Gobe 2001, Ratneshwar and Mick, 2005), the results of this study reveal that sensory and affective dimensions of brand experience may not necessarily create brand loyalty. However, the findings also indicate that behavioral and intellectual dimensions of brand experience have a positive relationship with brand loyalty. Behavioral dimension of brand experience refers to the active physical involvement of the customer in in-store activities and experiences. Similarly, intellectual dimension refers to a mental involvement. As also confirmed by the first set of hypotheses (H_{1e}), customer involvement is a key factor in creating both brand experience and brand loyalty. It can be argued that customers prefer to be active participants of the in-store experience, rather than being emotionally affected by different stimuli in a passive state. Therefore, in order to design an experience store to create an intense brand experience, different design applications and activities should be crafted in which customers can be actively involved both in terms of physical and mental activity.

Finally, this study has many limitations. One of the major limitations of the study is the lack of control over the effects of other variables which might affect brand experience and brand loyalty such as effects of communication. In order to reach a comprehensive understanding on the effects of different variables, future studies may adopt an experimental design approach to control other variables which might affect perceived brand experience. In addition, it is possible to reach different results through the same framework in different sectors such as fashion or food. Therefore, potential applications in a specific context might lead to different results which are industry-specific. Future studies can contribute to the body of knowledge through explaining these industy-specific factors which might affect the perceived intensity of the brand experience of customers in the research context.

7. References

Arnold, M.J., Reynolds, K.E, Ponder, N. & Lueg, J.E. 2005. Customer Delight in a Retail Context: Investigating Delightful and Terrible Shopping Experiences. *Journal of Business Research*, 58(8): 1132–1145.

Barbaro, M. 2007. At the experience store, a new concept in retailing, loitering is the right idea. *The International Herald Tribune*. www.iht.com/articles/2007/03/18/business/shop.php (accessed on 20.05.2012).

Bitner, M.J. 1992. Servicescapes: The Impact of Physical Surroundings on Customers and Employees. *Journal of Marketing,* 56(2): 57-71.

Bloemer, J.M.M. & Kasper, J.D.P. 1995. The complex relationship between consumer satisfaction and brand loyalty. Journal of Economic Psychology, 16(2): 311-329

Brakus, J.J., Schmitt, B.H. & Zarantonello,L. 2009. Brand experience: What is it? How is it measured? Does it affect loyalty?. *Journal of Marketing* 73(May), 52-68.

Chang, P., & Chieng, M. 2006. Building consumer-brand relationship: A cross-cultural experience view. Psychology & Marketing, 23(11): 927-959.

Choi, Y.G.,Ok, C. & Hyun, S.S. 2011. Evaluating Relationships among Brand Experience, Brand Personality, Brand Prestige, Brand Relationship Quality, and Brand Loyalty: An Empirical Study of Coffeehouse Brands.http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1283&context=gradconf_hospitality (accessed on 02.07.2012)

Dick, A.S. & Basu, K. 1994. Customer loyalty: toward an integrated conceptual framework.Journal of the Academy of Marketing Science, 22(2): 99-113.

Edvarsson, B., Enquist, B. & Johnston, R. 2005. Cocreating Customer Value Through Hyperreality in the Prepurchase Service Experience. *Journal of Service Research*, 8(2):149-161.

Fornell, C., Johnson, M.D., Anderson, E.W., Cha, J. & Bryant, B.E. 1996. The American customer satisfaction index: nature, purpose, and findings. Journal of Marketing, 60(4): 7-18.

Fournier, S. 1998. Consumers and Their Brands: Developing Relationship Theory in Consumer Research. Journal of Consumer Research, 24(Mar): 343–373.

Gapper , J . 2004. The challenge of turning a brand into an object of love . Financial Times (March), 23.

Ghosh, A. 1990. Retail Management, 2nd ed., The Dryden Press: Chicago, IL.

Gobe , M . 2001. Emotional Branding . Allworth Press, New York, NY .

Jones, P., Comfort, D., Clarke-Hill, C. & Hillier, D. 2010. Retail experience stores: experiencing the brand at first hand. *Marketing Intelligence and Planning*, 28(3):241-248.

Jones, M. A. 1999. Entertaining Shopping Experiences: An Exploratory Investigation. *Journal of Retailing and Consumer Services*, 6(3): 129–139.

Keller, K.L. 1987. Memory Factors in Advertising: The Effects of Advertising Retrieval Cues on Brand Evaluations. *Journal of Consumer Research*, 14 (Dec): 316–333.

Mandel, N. & Johnson, E.J. 2002. When Web Pages Influence Choice: Effects of Visual Primes on Experts and Novices. *Journal of Consumer Research*, 29(Sept), 235–245.

Morrison, S. & Crane, F.G. 2007. Building the service brand by creating and managing an emotional brand experience. *Brand Management*, 14(5): 410-421.

Oliver, R.L. 1996. *Satisfaction. A Behavioral Perspective on the Consumer*. McGraw-Hill: New York, NY.

Pine II , B . J . & Gilmore , J . H . 1998. Welcome to the experience economy ' , *Harvard Business Review* (July – August), 76(4): 97–105.

Ratneshwar , S . & Mick , D . 2005. *Inside Consumption*. Routledge, London.

Voss, C. 2003. *The Experience Profit Cycle* (research report). Center for Operations and Technology Management, London Business School. London.

Weinberg, B.D. 2001. Research in exploring the online consumer experience. *Advances in Consumer Research*, 28(1): 227-232.

Zarantonello, L. &Schmitt, B. 2010. Using the Brand Experience Scale to Profile Consumers and Predict Consumer Behaviour. *Journal of Brand Management,* 17:532-540.

A tool to include intermodal transport in the supply chain of companies: The LAMBIT website

Ethem Pekin[9], Cathy Macharis[10], Tom van Lier[11], Dries Meers[12] and Lieselot Vanhaverbeke[13]

Abstract

One of the opportunities of intermodal transport is integration of intermodal transport into the supply chain of companies. In parallel to the various policy measures, intermodal transport also has to be promoted so that shippers become aware of intermodal solutions that are offered to them. Unlike road transport, the complex structure of intermodal transport underlines the need of a toolkit for shippers to plan their transport flows. Can intermodal transport be a viable solution considering the prices, carbon footprint and other modal choice variables? If so, who should be contacted to arrange the transport? In order to answer these questions, an interactive website has been established where companies can choose their origin and destinations to transport their containers using intermodal transport. The website is based on the Location Analysis Model for Belgian Intermodal Terminals (LAMBIT).

Keywords: Intermodal transport, Modal choice, Website

1. Introduction

Intermodal transport is the combination of at least two modes of transport in a single transport chain, without a change of container for the goods, with most of the route travelled by rail, inland waterway or ocean-going vessel and with the shortest possible initial and final journeys by road (Macharis and Bontekoning, 2004). Intermodal transport may include various types of transport modes, but in this paper we concentrate on the combination rail/road and waterways/road in maritime chains using containers as loading units. A typical maritime-based intermodal transport chain is shown in Figure 1. The main haulage is performed by barge or train, while the post-haulage is done by truck.

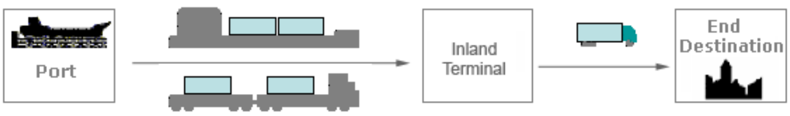


Figure 1. The intermodal transport chain

As intermodal transport is more interesting in terms of energy, efficiency, external costs and may help reduce congestion problems on the road, it receives attention on several policy levels (Kreutzberger et al., 2006). However, intermodal transport has difficulties in competing with unimodal transport in particular

[9] Vrije Universiteit Brussel, Belgium, +32 2 629 20 87, ethem.pekin@vub.ac.be
[10] Vrije Universiteit Brussel, Belgium, +32 2 629 22 86, cathy.macharis@vub.ac.be
[11] Vrije Universiteit Brussel, Belgium, +32 2 629 20 67, Tom.Van.Lier@vub.ac.be
[12] Vrije Universiteit Brussel, Belgium, +32 2 629 24 00, dries.meers@vub.ac.be
[13] Vrije Universiteit Brussel, Belgium, +32 2 629 20 65, Lieselot.Vanhaverbeke@vub.ac.be

over the short distances (Bärthel and Woxenius, 2004). Specifically for the maritime-based inland flows, intermodal transport is an important tool to decongest the port area which has to deal with an ever increasing flow of containers to be handled and transported to the hinterland. A virtuous circle between this increasing amount of maritime containers and the setup of new container terminals enables the intermodal sector to become an important solution for maritime flows.

In this paper we describe a web-based tool that enables shippers and other interested parties to check if intermodal transport is an interesting option for them. The website is built upon the LAMBIT (Location Analysis Model for Belgian Intermodal Terminals) which is a GIS-based tool that shows the market area of intermodal terminals. The model has been used extensively to aid decision makers in the location analysis of new terminals and the analysis of subsidies schemes (Macharis and Pekin, 2009 and Macharis et al., 2010). The website enables to use the benefits of the model for the demand side. Within the website, we provide the user with two main sources of information, namely the transportation cost compared to unimodal road transport and the amount of CO_2 emissions that will be emitted in the different transport options. The goal of the website is then to inform potential users of intermodal transport about the services that are currently available. To achieve this goal, the information complexity barrier had to be overcome. Hence, the target audience addressed consists of transport planners and heads of logistics departments but also managers of small and medium enterprises (SMEs).

In the next section, the intermodal value chain and modal choice is briefly introduced. In section 3, the LAMBIT model is described, since our website is built on this model. This section is followed by thorough descriptions of the cost structure of intermodal transport (section 4) and the CO_2 emissions (section 5). Finally, in section 6 the website is described and the reactions of the web-based tool users are discussed. Section 7 concludes the paper.

2. Intermodal value chain and modal choice

Intermodal transport has a pivotal role in proving that both economy and environment can grow in harmony thanks to an integrated transport system. To this end an intermodal value chain has to be created. Intermodal value chains can be explained by the two principal actors: shippers, initiating the demand for intermodal freight transportation; and carriers, supplying the intermodal freight transportation services. Usually an intermodal network including intermodal terminals is established to facilitate an intermodal value chain, where users are offered transport services. In their overview on shipper's perspectives on intermodal transports, Bektas and Crainic (2007) conclude that the shipper's perception is a central input component to the decision making processes in mode selection.

All intermodal stakeholders (shippers, intermodal operators, logistics providers and public authorities) involved in freight transport are expected to benefit from the intermodal value chain. Benefits of intermodal transport can be grouped as: creating cost and operation efficiencies, improving global accessibility, providing increased options and new services for a niche market, utilizing the inherent advantages of each transport mode, and minimizing the impact of transport mode's disadvantages (Palšatis and Bazaras, 2004).

In this setting intermodal transport competes with unimodal road transport. Next to the freight rates, other modal choice criteria, such as reliability, time, frequency, safety and customer satisfaction also play a role in the choice of the shippers or shipping companies for using intermodal or road transport. Although freight rates have a significant importance, since shippers expect intermodal services to provide similar services compared to unimodal road transport.

Global economy, represented by the high degree of containerization, indicates potentials for intermodal transport. There has been a strong growth in container traffic in the major European ports for the last three decades until the recent decline in 2008 following the global economic crisis. The Belgian ports of Antwerp and Zeebrugge have sustained an average of respectively 10 and 9 percent growth between 1980 and 2011. In order to support this growth and to open up the ports for the hinterland by inland waterways and railways, intermodal policy measures were formulated in Belgium. As for the intermodal infrastructure, several new intermodal terminals were set up. Considering inland navigation, the Flemish government developed a policy measure that stimulates the construction of new quay walls coupled with a reduction of canal-dues. The regional governments introduced various subsidy schemes for container barge waterways transport. Subsidy schemes were also granted for rail transport which is on a federal level.

Still, the full potential of intermodal transport is not yet exploited. Several bottlenecks exist to match demand and supply (Macharis and Verbeke, 2004; Tsamboulas, 2008). Intermodal transport chains assemble a complex web of actors and certain prejudices remain. Shippers see this as more complicated than unimodal road transport and do often not know who to contact (Eng-Larsson and Kohn, 2012). Additionally, they often think intermodal transport will be more expensive. The website described below proves this last prejudice to be untrue on certain trajectories.

3. LAMBIT

The website is based on the Location Analysis Model for Belgian Intermodal Terminals (LAMBIT). LAMBIT is a GIS-based location analysis model which makes it possible to conduct ex-ante and ex-post analysis of policy measures relating to intermodal transport (Macharis, 2000 and 2004). The main aim of the model is to explore the relative attractiveness of each transportation mode through price (cost) minimization. The model has the capability of analyzing several scenarios, namely policy measures that might influence the use of intermodal transport.

LAMBIT is served by three main inputs: transportation networks, transport prices and container flows from the municipalities to and from the sea port. For the website, a GIS network was set up by including four different layers: the road network, the rail network, the inland waterways network and the final haulage network. The geographic locations of the intermodal terminals, the ports of Antwerp and Zeebrugge and the municipality centers are defined and connected to the different network layers.

An important input for the LAMBIT model is information on the market prices of each of the modal options. The transport prices are calculated based on the real market price structures for each transport mode and they are associated with the network layers. The variable costs are uploaded to the network layers and the fixed costs are attached to the nodes (e.g. transshipment costs linked to intermodal terminals), which also indicate the origin and destination for each path. The distances used in the formula are calculated using shortest path algorithms, as developed by Dijkstra (1959), minimizing transport distance. The following formula contains the calculation of the total price of intermodal transport:

$$P=T_s^i+p_m^i(d)\ d_m+T_t^i+P_p^i+p_p^i(d_r-\ d)$$

Where:

- P: price of intermodal transport;
- $\mathrm{T_s^i}$: price of container transhipment in the seaport;
- $\mathrm{p_m^i}(d)$: price of main haulage by barge or rail transport. This is in function (per kilometre) of a distance d;
- $\mathrm{T_t^i}$: price of container transhipment in the inland terminal;
- $\mathrm{P_p^i}$: fixed costs of post-haulage by road transport;
- $\mathrm{p_p^i}$: price per kilometre for post-haulage by road transport;
- d: the distance between the seaport and an inland terminal;
- d_r: distance by road transport;
- d_m: distance by main haulage;
- d_r- d: distance of post-haulage by road transport;

Although the functionality of the website developed is based on the LAMBIT methodology, three major changes have been made. First, the geographic scope has changed. The original version dealt with container transport from and to the port of Antwerp. Now, the second largest container sea port in Belgium, the port of Zeebrugge, was added. Only transport from and to the province of Flemish Brabant was considered, since this province and the provincial development agency (POM Vlaams-Brabant) were the co-initiators of this project. Second, a change in output was initiated. Instead of simulating the market areas of intermodal terminals, for each municipality the cost of the three transport alternatives are weighted and compared. A third change is the transformation from a static model to a fully interactive and publicly accessible web-based tool, were users can input specific requests. Additionally, a CO_2 calculator was added to compare the three transport alternatives regarding their environmental impact.

4. Cost comparison

Shippers in an inland location would like to compare transport costs of intermodal transport and unimodal road transport to send/receive containers from/to the port. Since several types of transport are included in a maritime-based intermodal transport chain, intermodal transport costs involve a variety of transport activities. At the port, intermodal transport has larger handling costs. This is due to the cranes that are being used for the transhipment of containers on barges. For rail transport, in theory, the same equipment as for road transport can be used (i.e. reach stackers). The advantage of intermodal transport lies in the smaller unit costs, as a result of the scale economies that are obtained by the large capacities that can be transported at the same time. At the end of the chain, this advantage is partly compensated by the extra handling cost that has to be paid for the inland terminal handling. Also the end haulage by road has to be taken into account.

The total costs of unimodal road transport and intermodal transport from the port of Antwerp are shown in Figure 2. In this analysis the costs of transhipment and post haulage of intermodal barge transport are included. For post haulage a distance of 20 kilometers is foreseen from the intermodal terminal. The graph shows that unimodal road transport performs better compared to intermodal transport for short distances. Once a certain distance is reached, the costs of road and intermodal transport are equal. This is called the break-even point. The figure also shows that unimodal road transport has a lower fixed cost. This is explained by the costs of transhipment and drayage that are incurred in an intermodal transport chain. Above the break-even point, intermodal transport costs are lower than those of unimodal road transport.

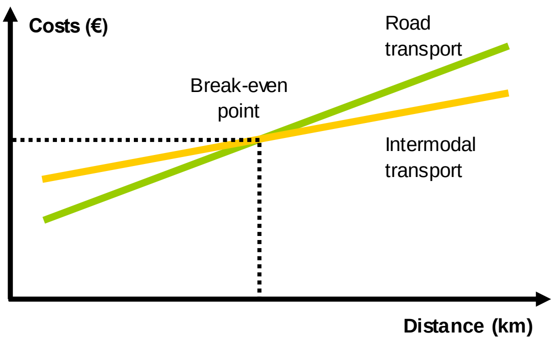


Figure 2. Break-even point (Source: Macharis, 2004)

The break-even distance reacts to the changes in the cost components of road and intermodal transport. The lines will move downward, if the fixed costs decrease. For example, a decrease in the dues for intermodal transport would shift the yellow line downwards and reduce the break-even distance. The slope of the lines reacts to the changes in the variable costs. For example, an increase in fuel prices would make the road transport cost function steeper, shifting the break-even point to the left.

An important modal choice criterion is the transport cost, which correlates with the distance travelled. This relationship enables us to understand which transport alternative is preferred in a given situation based on the concept of break-even analysis. In order to highlight the competitiveness of intermodal transport, the literature on break-even distance can be consulted. From a broader perspective, Woxenius (2007) discusses transport network design, which is useful to understand the relationship between distance and intermodal freight transport. Kreutzberger (2008) focuses on the impact of distance and time on the modal choice in terms of competitiveness of intermodal transport with the introduction of the bundling concept for railway services. Bottani and Rizzi (2007) introduce a methodology to estimate the potential of an intermodal terminal. Their methodology, which compares the economic competitiveness of rail-road transportation to road transport through "affinity index", is applied to a case in Italy. Another case study is developed by Dandotiya et al. (2011) for India, relating to a rail freight corridor to demonstrate optimal pricing and terminal locations. Their study points to the relative importance of distance between demand centers and intermodal terminals. Zhao and Goodchild (2011) focus on the final component of intermodal transport chains, the drayage services. Their research aims to predict travel time from the port locations. Fremont and

Franc (2010) also consider hinterland transportation in Europe with a case study in Le Havre port region. Eng-Larsson and Kohn (2012) present shippers perspective for a modal shift leading to greener logistics. Kim and Van Wee (2011) evaluated the relative importance of the factors that influence the critical distance.

Studies have been commissioned specifically to analyse the break-even distances for each transport mode. Janic (2007) shows that break-even distances can vary depending on underlying assumptions, as for example a demand increase can shorten the break-even distance. In this way, intermodal transport can become more competitive by increasing frequencies on shorter distance services. In 1994, the Dutch Ministry of Transport calculated break-even distances of 100-250 kilometres for inland navigation and 200-400 kilometres for railways (Van Duin and Van Ham, 2001). In Belgium, inland waterway transport can be cheaper than road transport above 99 kilometres (Pekin, 2010). At the European scale, intermodal rail services over 600 kilometres usually prove viable, while services for barge transport below distances of 100 kilometres can rarely compete with road transport (Vrenken et al., 2005).

These studies are mainly using average costs. Scale economies gained by the main haulage leg of an intermodal transport chain can further be increased by an introduction of larger vessels or longer train wagons. Also thanks to intermodal transport, empty container transport can be avoided, for example if the intermodal terminal can function as an empty depot for containers, again the total cost will decrease (Notteboom and Rodrigue, 2005; Pekin et al., 2012).

Since the price of transport is one of the main determinants in modal choice (Cullinane and Toy, 2000) or even the most important one (Kreutzberger, 2008), a price index is created for comparison within the web-based tool. Cardebring et al. (2008) nuance this, by claiming that price is more important for users of intermodal transport, while for users of road transport quality variables are more important in mode choice. Feo-Valero et al. (2011) provide an overview of case studies including different modal choice variables, among others quality and cost attributes. Danielis et al. (2005) conclude that quality attributes are dominating in mode choice, over cost attributes. Eng-Larsson and Kohn (2012) observe a trade-off between purchase conveniences versus price, rather than one between transport quality and price.

5. CO_2 emission comparison

Within the website a CO_2 calculator is inserted. In this section, the external costs of transport with a focus on CO_2 and intermodal transport are elaborated on, in order to show the different choices that were made for the website.

Standard economic theory states that a voluntary exchange is mutually beneficial to both parties involved in the trade, since either the buyer or the seller would refuse the trade if both do not benefit from it. However, an exchange can cause additional effects on third parties that can be either negative (e.g. greenhouse gas emissions from traffic), or positive (e.g. real estate price increase due to a new road connection). In economics, such an effect is called an externality (or transaction spillover) and is defined as a cost or benefit, not transmitted through prices, incurred by a party who did not agree to the action causing the cost or benefit. A benefit in this context is called a positive externality or external benefit, while a cost is called a negative externality or external cost (Laffont, 2008).

In the case of transport, the existence of mostly negative externalities causes the market prices of transport to not fully reflect the societal cost of the transport activity. As a result, transport activity levels are generally above the social optimum. This failure of the market mechanism to allocate resources efficiently can provide a rationale for government intervention (Schmidtchen et al., 2009).

A rather impressive list of negative externalities is associated with transport activities. Most well-known are negative consequences of emissions (climate change and air pollution), accidents and health impacts, noise, soil contamination, interference in the ecological system, damage to infrastructure, visual nuisance and congestion. There are also transport related externalities which are connected to so-called up- and downstream processes, such as extracting, refining and transporting fuels for transport modes (pre-combustion processes), as well as the externalities associated with building and demolishing transport modes and infrastructure. Especially in urban areas, additional externalities can occur such as pressure on public space and separation effects by barrier formation (van Lier et al., 2010a).

The environmental damage costs, which are most frequently studied in scientific literature, are climate change costs (caused by CO_2, CH_4 and N_2O emissions) and air pollution costs (caused by SO_2, NO_x, VOCs, heavy metals emissions). A major share of these emissions can be related to transport. The web-based tool takes into account only one particular externality, namely CO_2 emissions, which are linked to climate change costs.

5.1 Climate change

The impact of transport on climate change or global warming is mainly caused by the emission of greenhouse gases carbon dioxide (CO_2), nitrogen oxide or laughing gas (N_2O) and methane (CH4) and less by the emission of coolants (hydrofluorocarbons) of Mobile Air Conditioners (MAC's) (Maibach et al., 2008). Transport related emissions can be subdivided into direct and indirect emissions. Direct emissions occur during the vehicle use itself, while indirect emissions occur during up- and downstream processes. As direct emissions are concerned, a distinction can be made between exhaust emissions (so-called tailpipe emissions) and non-exhaust emissions in road and rail transport. These non-exhaust emissions of particulates and heavy metals are caused by the friction exerted by the ground and rail tracks (Delhaye et al., 2010; van Lier and Macharis, 2009).

As environmental damage costs are concerned, there are two aspects: the measurement and the monetarisation of the environmental effects. Measuring the environmental effects and determing the size and impact of the emissions is considered part of the domain of environmental technology science (amongst others by using dose-response-functions), while the conversion in monetary valued belongs to the field of economic science. For the monetarisation of climate change costs, key figures in € per ton CO_2-eq. exist in literature, but this monetary estimation is characterized by a high complexity and uncertainty rate associated with predicting long term effects on a global scale and risk patterns which are hard to anticipate (Maibach et al, 2008). In the web-based tool, therefore only the carbon footprint of different transport options will be calculated without monetarisation, more specifically the emission of CO_2-equivalents that indicate the global warming potential.

5.2 CO_2 emissions of intermodal freight transport

Emissions of intermodal transport are harder to calculate than emissions of unimodal transport due to the composition of the transport route. Depending on the transport mode, a number of (often different) influential factors need to be taken into account, making an carbon footprint calculation for intermodal transport more complex. Usually it is stated that, on average, intermodal transport has lower climate change impacts costs than unimodal road transport (Kreutzberger et al., 2003), as in most cases the sum of the emissions of the main transport in the intermodal chain (by water or rail) added to the emissions of the pre and/or post road haulage for the intermodal route are lower than the emissions of the unimodal road transport. This is helped by the fact that in average circumstances, the distance of the pre and post road haulage for intermodal transport needs to be rather limited if intermodal transport wants to be commercially attractive (Macharis and Van Mierlo, 2010).

As emissions of a certain mode can vary heavily depending on the circumstances, this does not mean it is always the case. For emissions, the most important drivers are load factor, vehicle size, speed of vehicle, fuel type, emission standards, driving pattern, geographical conditions (e.g. sailing direction for barges or road gradient for trucks) etc. The lower emissionst advantage of the intermodal route is mainly determined by the economies of scale which can be obtained during the inland navigation or railway part, so it is clear that if the load factor of the intermodal main haulage is (too) low, this benefit is cancelled. Transport by a unimodal road route and operated by an optimally loaded, fuel efficient truck of the most recent environmental class (currently EURO-5) usually generates less emissions per ton kilometre than transport of the same load by an intermodal route with an obsolete waterway vessel or a polluting diesel train with a low load factor and a rather high level of pre and post road haulage. So overlapping bandwidths of different emission categories make it hard to generalize on the environmental performance of intermodal transport compared to unimodal transport. Therefore, in practice, environmental impact of greenhouse gas emissions on specific routes need to be observed into detail, in order to decide upon the total carbon footprint of intermodal transport routes compared to these of unimodal road routes.

In our web-based tool, the calculation of CO_2 emissions is based on two loading units:

- standard 20-feet dry containers (1 TEU) with an average net load of 10,8 tonnes (based on an average loading for a Flemish Heavy Duty Vehicle (HDV)) (De Vlieger et al., 2004) and a tare weight of 2,2 tonnes (based on data from NYK shipping Lines), resulting in a gross container weight of 13 tonnes.
- standard 40-feet dry container (2 TEU) with an average net load of 21,6 tonnes (double of 1 TEU) and a tare weight of 3,6 tonnes (based on data from NYK shipping Lines), resulting in a gross container weight of 25,2 tonnes.

For reasons of comparability, CO_2 emissions are calculated expressed in kg CO_2-eq. per 1 TEU-kilometer (for 20-feet containers) and in kg CO_2-eq. per 2 TEU-kilometer (for 40-feet containers), resulting in "emissions per loading unit" times "kilometer" for the different transport modes. CO_2-eq. stands for CO_2 equivalent and indicates that also other greenhouse gasses such as methane (CH_4) and nitrous oxide (N_2O) are included, recalculated to the same comparison base expressed in CO_2 through their global warming potential. The average CO_2-eq. emission factors used for calculations in the web-based tool are based on the values published in the overview report on transport related carbon emissions published by McKinnon and Piecyk in 2010.

Based on McKinnon en Piecyk (2010), the CO_2-eq. for every mode were calculated:

- For truck, an average value of 1,1284 kg CO_2-eq. per TEU-kilometer is employed for a 20-feet container, with the assumption of a load of 13 ton in a 40-44 ton articulated truck with 25% empty runs (86,8 g CO_2 per tonkm). For a 40-feet container, a value of 1,4137 kg CO_2-eq. per 2 TEU-kilometer is calculated with the assumption of a load of 25,2 ton in a 40-44 ton articulated truck with 25% empty runs (56,1 g CO_2 per tonkm for 25 ton)).
- For barges, an average emission factor of 31 g CO_2 per tonkm is used, which results in 0,4030 kg CO_2-eq. per TEU-kilometer for 20-feet containers and 0,7812 kg CO_2-eq. per 2 TEU-kilometer for 40-feet containers. For rail, an average emission factor of 22 g CO_2 per tonkm is assumed, which results in 0,2860 kg CO_2-eq. per TEU-kilometer for 20-feet containers and 0,5544 kg CO_2-eq. per 2 TEU-kilometer for 40-feet containers.

As indicated before, the carbon footprint on a particular intermodal or unimodal trajectory will however depend on a number of cost drivers, so that the web-based tool only provides an estimate of the CO_2 emissions based on averages. A more detailed carbon footprint calculation using more specific data can however be performed on a case by case basis in order to refine the analysis.

6. Web-based tool

It is clear from the above that taking into account the relevant information about monetary costs and external effects to analyze and compare intermodal freight transport options requires a lot of insight in these matters. Given that the main goal of the website is to inform potential users of intermodal transport about the solutions that are currently available for them, the main concern was to overcome the information complexity barrier. By installing a steering committee for the follow-up of the functional and technical development, practitioners and policy makers helped to keep the focus on the user friendliness of the website interface.

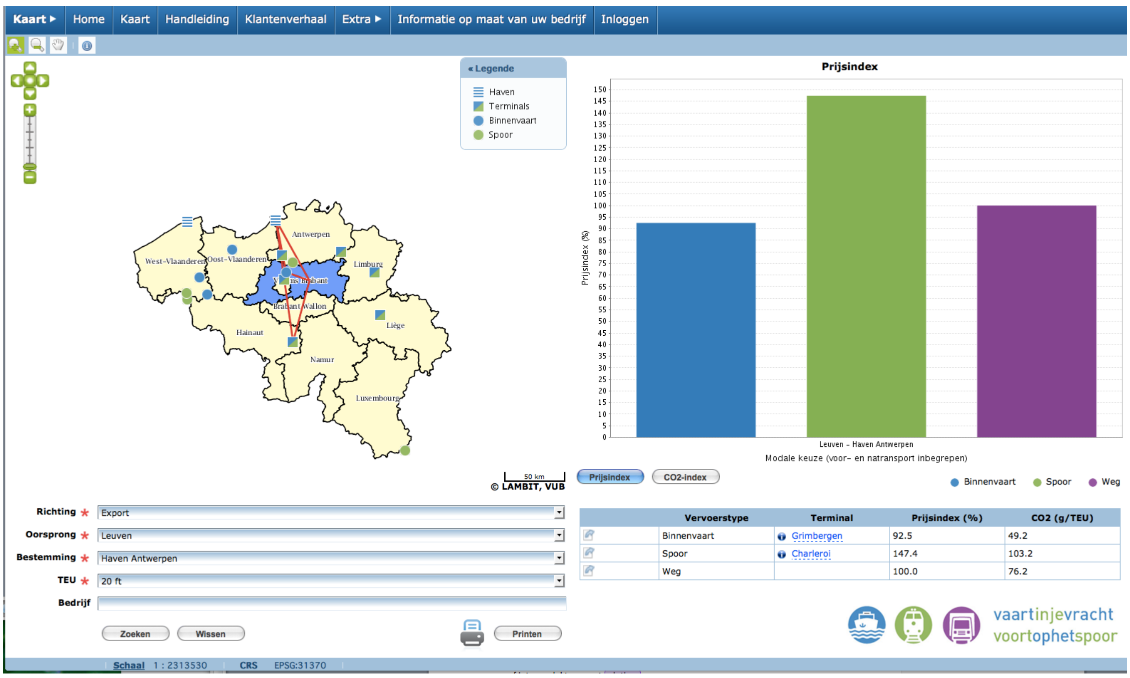


Figure 3. Screenshot of the website (http://www.multimodaalvlaamsbrabant.be)

The home page of the website draws the attention of the user to the map-based model shift tool page. This screen is split in four, to comprehensibly show the user query and the results. In the left upper part, a map of Belgium is displayed with a clear indication of the maritime ports, the intermodal terminals and the rail and barge terminals. The user needs to enter the specific information request in the left lower part of the screen, by using the drop-down boxes. Input is required for the following fields:

- the transport direction: export or import, indicating the direction of the flow of goods to or from a maritime port – this field serves to correctly provide the information in the following two drop-down boxes;
- the origin of the goods: in case the goods are exported, the drop-down box contains a complete list of all the municipalities in Flemish-Brabant, in case of import, the two maritime ports are given as choices;
- the destination of the goods: in case of export, the two maritime ports, and in case of import, a complete list of all the municipalities in Flemish-Brabant;
- the size of the containers in TEU: 20-feet or 40-feet.

The field for filling out the company name is optional. When the query details are complete, the user hits the search button. The query results are presented in a geographical, graphical and tabular manner. The map at the upper left side zooms to the optimal extent to visualise the rail and barge connections. The column chart in the right upper part of the screen displays the proportional costs of the transport by barge (blue), rail (green) and road (purple). When the user hits the CO_2-index button below the chart, the indices for the CO_2 emissions are shown. The table at the right lower screen part gives an overview of the relevant solutions, the numbers and the terminal information. When the user places the mouse indicator over the name of the terminal, the contact details are displayed. In order to have the information available in an off-line format, the user can choose to print the results by hitting the print button below the information field. This generates a printer-friendly document with all the above information.

By providing only the relevant information, the tool stimulates the mind shift about intermodal transport with the intention to actually realize a modal shift of the traffic. To accomplish this goal to the fullest, the website was launched on the 27th of February 2012 during a press event to raise awareness about the topic. Also the alternative website addresses (www.vaartinjevracht.be and www.voortophetspoor.be; translated as "speedy freight" – in Dutch it relates to barge transport – and "forward on rails") are part of the communication plan to increase the awareness and use of intermodal transport solutions. This communication strategy has until now, July 10th 2012, resulted in 18.832 hits after it was launched at February, 27nd 2012. During the last four months a total of 585 queries have been run through the web-based tool. 75% of the queries are to /from the port of Antwerp. 70% of the queries are export and 30% import to the region. In Figure 4 municipalities with more than 10 queries in Flemish Brabant are presented. Eight out of the ten most entered queries are part of the top ten municipalities with the greatest container import and export in the province.

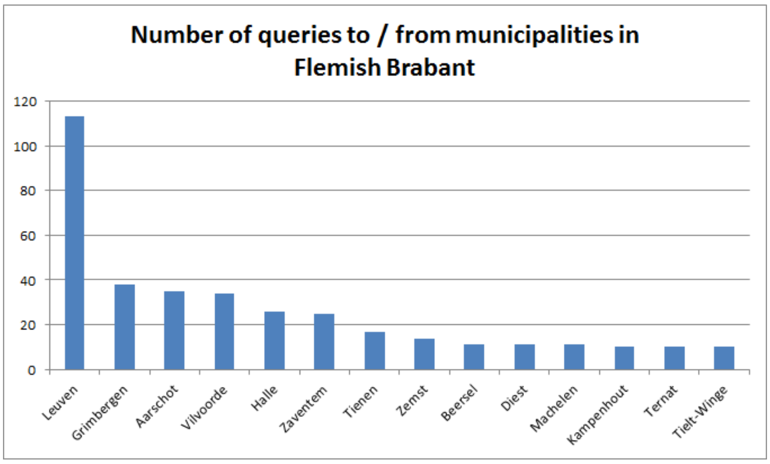


Figure 4. Number of queries to / from municipalities in Flemish Brabant

An important critical success factor of the website is measured by estimating the potential modal shift, as a consequence of the previously mentioned mind shift. The current total volume of containers transported by truck between the province of Flemish Brabant and the ports of Antwerp and Zeebrugge accounts for 56.561 TEU per year (data of ADSEI, 2010), leaving a great potential for a modal shift. Performing all possible queries on the website, one can select the communes where intermodal transport is cheaper in comparison to road transport. Before elaborating on the potential modal shift for these communes, places where intermodal transport can be competitive are described.

Table 1 show the amount of communes which are preferably served by the different modes, only considering the price of transport as a modal choice variable. Intermodal barge transport to and from Antwerp can be cheaper in many cases, especially for 20-feet containers. Train is not very competitive for the same trajectories due to the higher break-even distance of rail and the absence of an operational rail terminal in the vicinity of the province of Flemish Brabant. Transport to and from the port of Zeebrugge is always cheaper by truck. This is related to the poor inland waterway connections for barge and again the higher break-even distance for rail.

Table 1. Amount of municipalities in Flemish Brabant being preferably served by road, barge or train from a cost perspective, for transport to and from the ports of Antwerp and Zeebrugge, according to the LAMBIT website

	20-feet.			40-feet.		
	Road	Barge	Train	Road	Barge	Train
Antwerp	21	44	0	59	6	0
Zeebrugge	65	0	0	65	0	0

Relating the communes, where intermodal barge transport can be performed cheaper than unimodal road transport, to the existing freight flows to and from the port Antwerp, one can calculate a potential modal shift. If price/cost would be the only modal choice variable, all reasonable operators would switch to barge for transport to and from these 44 or 6 communes (depending on the TEU). Several estimates are represented in Table 2. These estimates are based on an origin-destination (OD) matrix, given the total tonnage transported in containers for each OD-pair. For this, we assume that the ratio 20-feet: 40-feet containers is 50:50 (based on Yun and Choi, 1999; Dekker et al., 2006).

Table 2. Maximum modal shift in the communes where intermodal barge transport is cheaper than unimodal road transport, according to LAMBIT

	To Antwerp		From Antwerp		To and From Antwerp	
	# containers	tonnage	# containers	tonnage	# containers	tonnage
Potential modal shift 20-feet.	5057	60.681	4512	54.147	9569	114.828
Potential modal shift 40-feet.	7877	189.038	2539	60.705	10.416	249.744
Potential modal shift total (TEU)	20.810	249.719	9591	114.852	30.401	364.572

Using the values from Table 2, one can also estimate the environmental effects of certain modal shifts. As more modal choice variables exist (Cullinane and Toy, 2000) and a modal shift needs a total mind shift, it can be more plausible to assume a limited modal shift (5-15%) from road to barge in the short term. A modal shift of for instance 15% in these favorable communes can lead to a saving of 160,8 ton CO_2.

Table 3. Potential CO_2 reductions (ton) for different modal shift scenario's (5, 10, 15 and 100% modal shift in the communes where barge is cheaper than road according to LAMBIT)

	Modal shift percentage			
	5 %	10 %	15 %	100 %
20-feet Containers	17,5	34,9	52,4	349,2
40-feet Containers	36,5	72,3	108,5	723,0
Total	54,0	107,2	160,8	1072,2

7. Conclusions

Despite the policy measures directed towards promoting intermodal transport in Belgium, its potential is not yet fully exploited. To raise awareness among the potential users, we developed a web tool based on the LAMBIT model. This tool especially aids the transportation decision makers in the logistics departments of large enterprises and in the general management of SMEs with the relevant information concerning intermodal transport services in Belgium.

The web-based tool with a user-friendly interface instantly displays a cost comparison for three different transport modes, as well as an assessment of the respective CO_2 emissions. We have argued in this paper that the cost structure of intermodal transport allows offering cost effective alternatives to unimodal services once a break-even distance, or beyond, is covered. The competitiveness of intermodal transport in terms of costs is significantly amplified by the reduced external costs of this type of transportation. Climate change costs of intermodal transport are harder to calculate than for the case of unimodal transport, however the outcome is significantly more favorable. We choose to include a comparison of the CO_2 emissions for the modal alternatives on the website, in analogy with the price comparison.

To further increase the usability and the relevance of the website for the demand side, three directions for further development are followed. First, the limited geographical scope – the region of Flemish-Brabant – will be expanded so that the queries can be performed for all municipalities in Flanders. Second, by the addition of international connections, also longer distance intermodal transport can be taken into account. Especially for rail, this can be decisive, since the break-even distance for intermodal rail is longer than for intermodal barge transport. Third, the transport time can be introduced as a third modal choice variable, next to the transport cost and CO_2 emissions. Besides these advances, improvements on the administration part of the website are planned to monitor the queries in detail and to track the incoming and outgoing website traffic. This allows the monitoring of users, to better estimate the actual contribution of the website to a modal shift.

Acknowledgements

We gratefully acknowledge the financial support of POM Vlaams-Brabant through the project Website Multimodaal Vlaams-Brabant.

References

Algemene Directie Statistiek en Economische informatie (ADSEI), 2010 [available online on-line:http://statbel.fgov.be/]

Bärthel, F. and Woxenius, J. 2004. Developing intermodal transport for small flows over short distances, *Transportation Planning and Technology*, Vol. 27, N. 5, pp. 403-424.

Bektas, T. and T. G. Crainic. 2007. A Brief Overview of Intermodal Transportation. January 2007, CIRRELT-2007-03.

Bickel, P. and R. Friedrich, 2005, ExternE. Externalities of Energy. methodology 2005 Update, European Commission, Luxembourg, 270 p.

Bottani E., and Rizzi, A. 2007. An analytical methodology to estimate the potential volume attracted by a rail-road intermodal terminal, *International Journal of Logistics: Research and Applications*, 10(1), 11-28.

Cardebring, P.W., Fiedler, R., Reynauld, Ch., Weaver, P. 2000. Summary of the IQ project. Analysing Intermodal Quality; a Key Step Towards Enhancing Intermodal Performance and Market Share in Europe. TFK and Inrets, Hamburg and Paris.

Cullinane, K. and Toy, N. 2000. Identifying influential attributes in freight route/mode choice decisions: a content analysis, *Transportation Research Part E*, Vol. 36, No. 1, p. 41-53.

Dandotiya, R. Nath Banerjee, R., Ghodrati, B. and A. Parida. 2011. Optimal pricing and terminal location for a rail–truck intermodal service – a case study. *International Journal of Logistics Research and Applications*, 14(5), 335-349.

Danielis, R., Marcucci, E. and Rotaris, L. 2005. Logistics managers stated preferences for freight service attributes*, Transportation Research Part E*, Vol. 41, p. 201–215.

De Vlieger, I., Cornelis, E., Joul, H., Int Panis, L., 2004. Milieuprestaties van de binnenvaart in Vlaanderen [eindrapport]. Vlaanderen: VITO.

Dekker, R., Voogd, P. and van Asperen, E. 2006. Advanced methods for container stacking, *OR Spectrum*, 28:563–586

Delhaye E., De Ceuster G. and S. Maerivoet. 2010. *Internalisering van externe kosten van transport in Vlaanderen*; Study performed for Vlaamse Milieumaatschappij, MIRA, MIRA/2010/10, Transport & Mobility Leuven, Belgium

Dijkstra, E.W. 1959. A note on two problems in connection with graphs, *Numerical Mathematics*, 1, pp. 269-271.

Eng-Larsson, F. and Kohn, C. 2012. Modal shift for greener logistics - the shipper's perspective, *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 1, pp. 36-59.

Feo-Valero, M., García-Menédez, L. & Garrido-Hidalgo, R. 2011. Valuing Freight Transport Time using Transport Demand Modelling: A Bibliographical Review. *Transport reviews*, 31(5), 625-651.

Fremont, A., and Franc, P. 2010. "Hinterland transportation in Europe: Combined transport versus road transport", *Journal of Transport Geography*, Vol. 18 pp 548-556.

Janic, M. 2007. Modelling the full costs of an intermodal and road freight transport network, *Transportation Research Part D*, Vol. 12, p. 33–44.

Kim, N. S., and Van Wee, B. 2011. "The relative importance of factors that influence the break-even distance of intermodal freight transport systems", *Journal of Transport Geography*, Vol. 19 pp 859-875.

Kreutzberger, E., Macharis, C., Vereecken, L. and Woxenius, J. 2003. Is intermodal freight transport more environmentally friendly than all-road freight transport? A review. Presented at Nectar Conference No. 7, Umeå, June 13-15.

Kreutzberger, E.; Macharis, C. and J. Woxenius. 2006. Intermodal versus unimodal road freight transport - a review of comparisons of the external costs. In: B. Jourquin, P. Rietveld, and K. Westin (Eds.), Transporation Economics: Towards Better Performance Systems. Routledge

Kreutzberger, E. D. 2008. Distance and time in intermodal goods transport networks in Europe: A generic approach, *Transportation Research Part A*, Vol. 42, 973–993

Laffont, J.J. 2008. Externalities. In: Durlauf, S. and Blume, L. (eds) *The New Palgrave Dictionary of Economics*, 2nd Ed., Palgrave Macmillan.

McKinnon, A. & Piecyk, M. 2010. Measuring and Managing CO_2 Emissions of European Chemical Transport. Logistics Research Centre, Heriot-Watt University, Edinburgh, UK

Macharis, C. 2000. Strategische modellering voor intermodale terminals. Socio-economische evaluatie van de locatie van binnenvaart/weg terminals in Vlaanderen, PhD Thesis, Vrije Universiteit Brussel, Brussel.

Macharis, C. 2004. A Methodology to Evaluate Potential Locations for Intermodal Barge Terminals: A Policy Decision Support Tool. In: M. Beuthe, V. Himanen, A. Reggiani and L. Zamparini (Eds.), Transport Developments and Innovations in an Evolving World, Springer, Berlin, pp. 211-234.

Macharis, C. and Y.M. Bontekoning. 2004. Opportunities for OR in intermodal freight transport research: A review, European Journal of Operational Research 153, pp. 400-416.

Macharis, C.; Pekin, E. and T. van Lier. 2010. "A decision analysis framework for intermodal transport. Evaluating different policy measures to stimulate the market". In: M. Givoni & D. Banister (2010), Integrated transport. From policy to practice, Routledge, London, pp. 223-239.

Macharis, C. and A. Verbeke. 2004. Intermodaal binnenvaartvervoer. Economische en strategische aspecten van het intermodaal vervoer in Vlaanderen, Garant, Antwerpen.

Macharis, C. and E. Pekin. 2009. "Assessing policy measures for the stimulation of intermodal transport: a GIS-based policy analysis", Transport Geography, Vol 17(6) pp 500-508.

Macharis, C. and J. Van Mierlo. 2010. Intermodaal vervoer: milieuvriendelijker ook in de toekomst? Een terugblik en vooruitblik na 4 jaar, *Tijdschrift Vervoerswetenschap*, Jubileumnummer, 50 jaar Vervoerswetenschap, jg. 46, No. 3, p. 134-135

Maibach, M., C. Schreyer, D. Sutter (INFRAS), H. P. Van Essen, B. H. Boon, R. Smokers, A. Schroten (CE Delft), C. Doll (Fraunhofer Gesellschaft-ISI), B. Pawlowska, M. Bak (University of Gdansk). 2008. *Handbook on Estimation of External Cost in the Transport Sector. Internalisation Measures and Policies for All external Cost of Transport (IMPACT), Version 1.1.*, European Commission

Notteboom, T.E. and Rodrigue, J.-P. 2005. Port regionalization: towards a new phase in port development, *Maritime Policy & Management: The flagship journal of international shipping and port research*, Vol. 32, No.3, pp. 297-313.

Palšatis, R., and Bazaras, D. 2004. Analysis of the prospectives of intermodal transport and logistics centres in Lithuania. *Transport*, 19(3), pp. 119-123.

Pekin, E. 2010. A GIS-based Intermodal Transport Policy Evaluation Model. PhD thesis, Vrije Universiteit Brussel, Brussels.

Pekin, E., Macharis, C., Meers, D. and Rietveld, P. (2012) Location Analysis Model for Belgian Intermodal Terminals: importance of the value of time in the intermodal transport chain, Special issue in *Computers in Industry, http://dx.doi.org/10.1016/j.compind.2012.06.001*

Schmidtchen, D., Koboldt, C., Helstroffer, J., Will, B., Haas, G. & S. Witte. 2009. *Transport, Welfare and Externalities. Replacing the Polluter Pays Principle with the Cheapest Cost Avoider Principle*. Edward Elgar, Cheltenham, UK

Tsamboulas, D. (2008) Development strategies for intermodal transport in Europe. In: Konings, R., Priemus, H. and Nijkamp, P. (eds.) *The Future of Intermodal Freight Transport*, MPG Nooks Ltd, Bodmin, Cornwall, pp. 271-301.

Van Duin, R. and Van Ham, H., 2001. A Three-Stage Modeling Approach for the Design and Organization of Intermodal Transportation Services. IEEE

van Lier, T. and C. Macharis. 2009. Calculating the impact of the external costs of an inland port. In: Macharis, C. & L. Turcksin (eds.) *Proceedings of the BIVEC-GIBET Transport Research Day 2009 Part 1*. 27 May 2009, Brussels, Belgium

van Lier, T., Macharis, C., Van Hoeck, E. and E. Pekin. 2010a. Comparing the effect of fuel price increases with the internalization of external costs: a decision analysis framework for intermodal transport. In: Witlox, F. & S. Weijers (eds.) *Vervoerslogistieke werkdagen 2010*. 18 and 19 november, Antwerp, Belgium, p. 267-280.

van Lier, T., Pekin, E. and C. Macharis. 2010b. *Carbon Footprint van Transportactiviteiten & Totale Logistieke kosten*. Report for: IWT Innovation project "De ontwikkeling van een 'business case' methodiek voor het opzetten van horizontale logistieke samenwerking"

Vrenken, H., Macharis. C. and Wolters, P. 2005. *Intermodal Transport in Europe*, European Intermodal Association, Brussels.

Yun, W. Y. and Choi, Y. S. 1999. A simulation model for container-terminal operation analysis using an object-oriented approach, *Int. J. Production Economics*, 59:221-230.

Woxenius, J. 2007. Generic Framework for Transport Network Designs: Applications and Treatment in Intermodal Freight Transport Literature, *Transport Reviews*, 27(6), 733-749.

Zhao, W. and Goodchild, A. 2011. Truck travel time reliability and prediction in a port drayage network, *Maritime Economics & Logistics,* 13, 387–418.

Reengineering the Supply Chains of Pallets to the Inland Waterways: Where Practice and Theory Meet

Filip Verbeke[14], Cathy Macharis[15], Koen Mommens[16]

Abstract

The distribution of building materials in Belgium creates a large number of truck movements with an associated environmental impact. A relatively limited number of producers deliver to a large number of big and small distributors of building materials, thus creating a high further pressure on mobility to. An innovative solution to overcome this problem is to bundle these transports over the inland waterways and organize the last mile distribution via a limited number of local water-bound warehouses, hereby reducing the truck transport distances to an absolute minimum. From the definition of this concept on, a cost price gap was found in pre-haulage, handling and warehousing. The first step in reengineering the supply chain was to optimize handling techniques during intensive practical experiments, followed by a practical experiment with two water-bound warehouses and 6 producers, to investigate the feasibility of introducing new elements in this distribution supply chain. Also the impact on this highly competitive commercial landscape is being investigated. A parallel distribution and clustering analysis was performed with a location analysis model, which optimizes the locations of water-bound warehouses. The CO2 emission savings thanks to this new way of distribution are also calculated.

Keywords: Pallets, Clustering, Supply Chain, Inland waterways, Warehouses, CO2 reduction of transport.

1. Introduction: pallets via inland waterways

1.1. History of inland waterway transport (IWT)

In Belgium, The Netherlands, Germany and France there is an old tradition in inland waterways. In the 16th century, a very large portion of merchant transport was executed by barges. All kinds of goods were delivered to many inner cities. This means that in that era, the distribution part of the supply chain of all types of goods was for a large portion done over the inland waterways (IWW). The following ages this type of distribution disappeared bit by bit, many canals in the cities were dumped. The scale of inland waterways and barges increased and Inland Waterway Transport (IWT) was only used for big bulk transports, dry and liquid. Until the maritime container was developed in 1956, causing a rapid standardization and a quickly expanding volume of containers on the inland waterways. We call this renewed importance of the inland waterways the second wave.

1.2. Transport of palletized goods via IWT

After the introduction of maritime containers as cargo type on the IWW, there remained the transport of pallets via the inland waterways, the so-called 3rd wave.

The challenge is big enough: in Belgium the ADSEI (Algemene Directie Statistiek en Economische Informatie, 2010) mentions that a yearly volume of approximately 53 million tonnes of palletized goods is

[14] Filip Verbeke, Essenciál Supply Chain Architects, Belgium, +32 472 31 88 75, filip.verbeke@essencial.be
[15] Cathy Macharis, Vrije Universiteit Brussel, Belgium, +32 2 629 22 86, cathy.macharis@vub.ac.be
[16] Koen Mommens, Vrije Universiteit Brussel, Belgium, +32 2 629 21 66, koen.mommens@vub.ac.be

transported via road. The related congestion and pollution is therefore high and every modal shift of even a part of these flows would be welcome (European Commision, 2011a; Kreutzberger et.al., 2006).

In the Netherlands, in 2002-2003 the Distrivaart study was executed by TNO, setting up a concept of distribution of palletized consumer goods via the inland waterways. In the second phase a sophisticated pallet-warehouse-barge was build and launched for a pilot (Groothedde et.al., 2005; TNO Inro, 2003). This pilot – involving several beverage manufacturers – had to prove the feasibility of the concept. In the beginning of 2004 the pilot was continued by two companies. They concluded, during that same year, that the network couldn't be filled up at reasonable costs and the whole project stopped (Poppink, 2005).

The supply chain of palletized goods has very different logistical characteristics to deal with in comparison with bulk and containers. In table 1. we resume these characteristics to indicate the challenge we are confronted with when we want to create innovative solutions for a modal shift of these goods to the IWW.

Table 1. Supply chain characteristics of different cargo types.

Supply Chain Characteristic	Bulk	Containers	Pallets	IWT typical
Number of SKU's	few	no issue	many	few
Volume per SKU	high	no issue	low	high
Speed of delivery	low	high	very high	very low
Number of drops	low	low	high	very low

Most of these characteristics are contrary to IWT typical values: ships have huge volumes for economic reasons, speed is traditionally low and number of drops is low because of the complexity of loading and unloading.

The only solution to match the characteristics of the supply chains of final products on pallets with the characteristics of typical IWT is to enter well-chosen water-bound warehouses in these supply chains. Thus bringing the stock for delivery to customers close to these customers and transporting the bundled volumes via inland waterways. In Belgium a number of 50 producers of building materials delivers to some 250 dealers of building materials. Besides that, there exists a huge number of transports of fast moving consumer goods. The research group VUB-MOBI delivered a study on this topic in 2006, where a concept of a network of water-bound distribution centers – located at the IWW and logically spread over Flanders region – organized the distribution of pallets for 4 building materials producers. These distribution centers were called 'RWDC's', Regional Water-bound Distribution Centers'. The concept is represented in Figure 1. below:

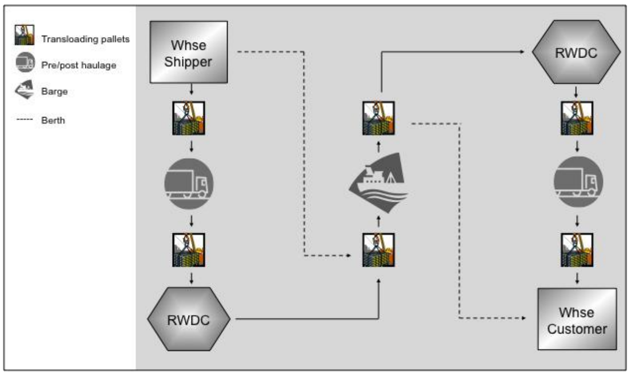


Figure 1. Regional Water-bound Distribution centers: the concept. (VUB/COMiSOL 2006)

In comparison with a direct road transport from production to customer, one introduces different extra steps in the supply chain, such as pre-haulage, loading of barges, unloading of barges and post-haulage. In the ideal case both shipper and customer are located at the IWW. At the moment of the study, the cost of loading and unloading a pallet in a barge was so high that the feasibility of the concept was very difficult.

However, thanks to that project producers of building materials started experimenting with different loading and unloading techniques in practice under the guidance of the Flemish transport experts. These experiments are described in the next section.

2. Practice: fields tests and cost model based upon field tests

Two variables had to be tested during the field tests: the type of ship and the technique of loading and unloading.

Ships type: beside classical barges like Kempenaars en Rhine Herne canalships, tests were run with a pontoon and a push barge. A short description and further evaluation of the numerous field tests follows here:

2.1. Barge + mobile crane

A classical box shape barge in different sizes (600 tonnes, 1.100 tonnes and 1.400 tonnes) was combined with a standard mobile crane. Different types of pallet hooks were tested in combination with these cranes. Hooks which could manipulate 1, 2, 3 pallets at the same type and even a test with 4 and 8. The conclusion was that at the end an extra thin pallet hook for 2 or ideally 3 pallets could reduce handling cost even on tidal rivers towards about € 1 per tonne, with a rhythm of max 180 tonnes per hour. Sailing cost is at market level and capacity of these standard dry cargo barges is sufficiently available.

Figure 2. Barge + mobile crane

2.2. Barge + autocrane

In this test the loading and unloading of the box shaped barge was performed with autocranes on a lorry. Pallets were manipulated one by one. Loading and unloading rhythm was not higher than 45 tonnes per hour and costs remained between € 2.8 and € 4.5 per tonne. Also a lot of damage was encountered. The sailing cost is low, once again at competitive prices.

Figure 3. Barge + autocrane

2.3. Pontoon + forklifts

A small pontoon pushed by a push barge allowed to load and unload with 6 pins forklifts at speeds of up to 180 tonnes per hour and even more, giving a low cost of about € 0.75 per tonne. Unfortunately the hire of these pontoons and push barges is not in a competitive environment and results in a very high sailing cost, making this technique out of reach for the products and transport relations within scope.

Figure 4. Pontoon, push barge and forklifts

2.4. Barge + forklifts

The combination of manipulation by forklifts which is very standard in industry and the use of a convenient barge appeared as the optimal solution. Transport capacity is available at competitive prices and a manipulation technique which is an industry standard gave the best results. Handling costs revealed to reach a level of a little bit below € 1 per tonne and handling speed reached easily levels of about 180 tonnes per hour.

Figure 5. Barge + forklifts

2.5. Conclusion on handling techniques and transport means

Both forklifts and mobile cranes appear to be a good handling alternative when optimized technically. Transloading volumes go up to 180 tonnes per hour and costs go under € 2 per tonnes for two moves (see Figure 6). As transport mean a standard barge, preferably box shaped, is most economical. A pontoon is not affordable.

Further it is clearly demonstrated in the experiments that for the long distance multimodal transports (WB/EG n), competitively with road transport is easily reached because the price difference of the IWT part of the transport - which is 55% of road transport – permits a lot of extra pre-haulage and handlings. For all other experiments the competitively with unimodal road transport is only reached with one of the experiments, using forklifts in the hold and on the quay.

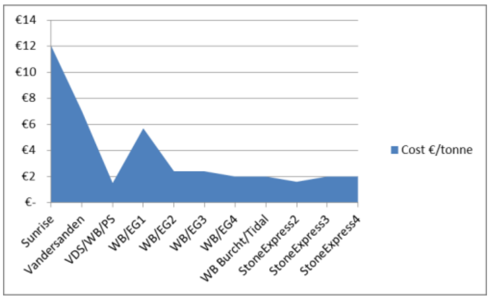


Figure 6. Handling cost evolution of field tests

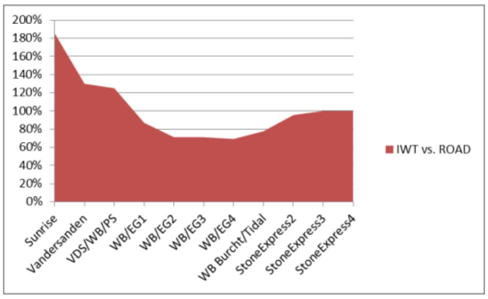


Figure 7. Difference Multimodal IWT vs Unimodal Road Transport

2.6. Comprehensive cost model based on field tests

In 2011 a comprehensive cost model was build up to analyze the perimeter where-in multimodal IWT could become competitive with Unimodal Road Transport (Essenciál Supply Chain Architects, 2011). The basis were actual cost parameters with estimated high handling rhythms and including eventual pre-haulage and post-haulage. A generic cost function was build up which looks like:

$$C_{MMB} = C_{PH} + C_{LB} + C_{S} + C_{UB} + C_{EH} \text{ € per tonne.} \qquad (1)$$

With: C_{MMB}: Cost of multimodal IWT transport

C_{PH}: Pre-haulage cost

C_{LB}: Cost of loading barge

C_{S}: Sailing cost

C_{UB}: Cost of unloading barge

C_{EH}: Cost of end-haulage

For mapping of this function different scenarios were calculated where a combination of pre-haulage and post-haulage were used. The different scenarios are marked as 'Scenario x/x', where the x formulates respectively the number of kilometers of pre-haulages and post-haulage. As an example; 'Scenario 10/5' is a scenario with 10 kilometers of pre-haulage and 5 kilometers of post-haulage.

In the graph, Figure 8., a number of real commercial offers were plotted against the theoretical cost function. The blue line is the cost of Unimodal Road Transport.

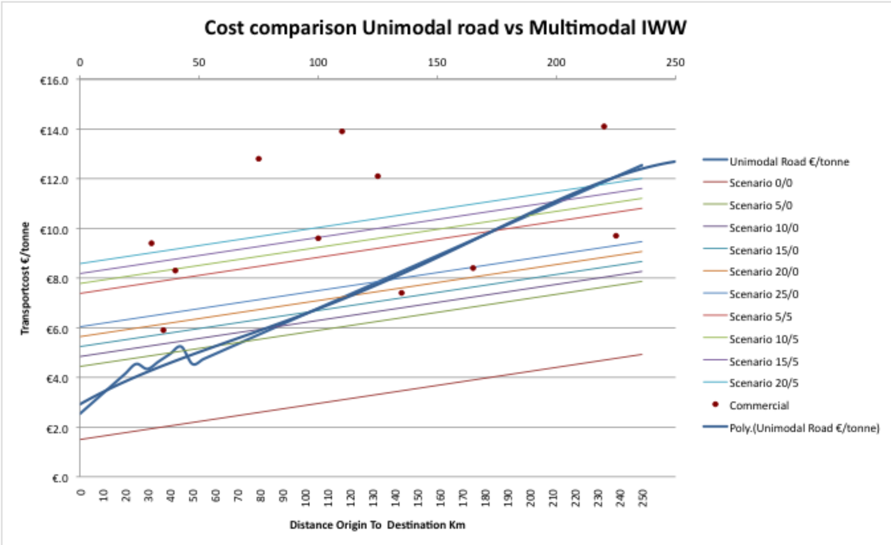


Figure 8. Cost comparison unimodal road transport for pallets versus multimodal IWW.

The main conclusions on these generic cost differences can be formulated as follows:

- When no pre- nor end-haulage is needed, transport of palletized goods is competitive via IWW from 30km. However, the generic costs of IWW transport in the lower range (<30km) are a bit underestimated as one depends heavily on the availability of barges close to the loading quay. This is something you can not include in a formula but will play a role in reality.
- With a very short pre-haulage or end-haulage (5 km), the range of competitive trajectories between shipper and consignee starts from about 75 km.
- In the other extreme of the graph (Scenario 20/5), you need a distance of about 225 km to have a competitive IWW transport. At the short distances in this scenario (left side of the graph) we see that the cost difference is at about € 6,5.
- Scenario 15/5 is a very realistic scenario in the market of palletized construction materials, as many producers and costumers are located within a limited distance of an inland waterway. When you want to realize the modal shift to IWW, you have to cope with a cost difference of € 4 at short distances and on average € 2,5.
- The real commercial offers which were plotted against the theoretical model, indicate that in this market the commercial parties are integrating a 'risk premium' in their prices. This kind of transport is not mature yet and the target prices of the generic model, although realistic and based on the real cases and experiments, still remain a target and not the reality.

3. Theory: a model for palletized goods on the inland waterway

3.1. Introduction on the location analysis

The above mentioned cost comparison shows a financial potential for multimodal IWW transport scenario's, and certainly when there is limited pre- and/or post-haulages. The more that the Flemish Regional Government has set aside 1,5 million euro for the support of the modal shift of palletized goods to the IWW over the next three years, starting in 2012 in order to compensate for the startup losses (European Commission, 2011b; Waterwegen en Zeekanaal NV & NV De Scheepvaart, 2011). The innovative concept could soon start.

As not every producer or costumer of palletized goods has a location near an IWW, a network of RWDC's needs to be implanted (VUB/COMiSOL 2006), whereby the determination of the optimal location of these RWDC's is crucial for all stakeholders. These locations define also the potential turnover of the RWDC's and have a large impact on the profitability of the multimodal transports(Kayikci, 2010). The LAMBTOP

(Location Analysis Model for Barge Transport Of Pallets) was created to analyze the optimal RWDC locations.

3.2. Methodology

The LAMBTOP is a GIS (Geographic Information System) based model, that consists of different network layers, each representing a transport mode (road and barge). The municipality centers – acting as departure and destination locations – are connected to the network layers by their corresponding nodes (see Fig. 9).

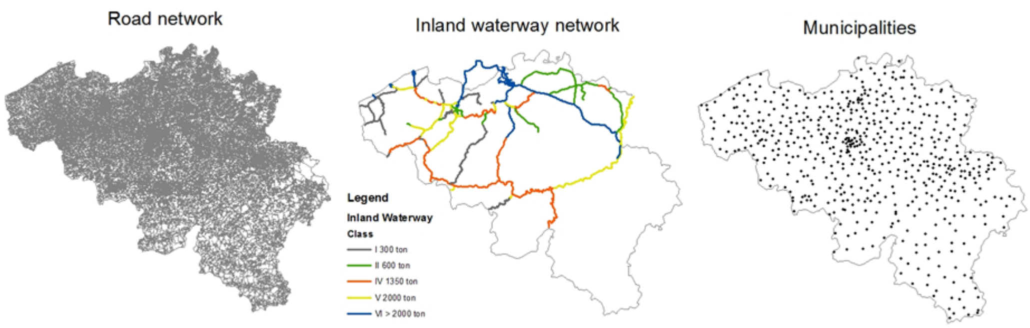


Figure 9. The network in ArcGis.

The network for Belgium was built by combining the following digital databases:

- The inland waterways layer is obtained from the ESRI (Environmental Systems Research Institute) dataset for Europe
- The road and municipality layer are extracted from the MultiNet database of Tele Atlas.

The model is set up for Belgium, but the methodology can easily be used for other regions and preferably on an international or European scale.

As a first step, the transport routes of the palletized goods are uploaded to the model in form of an origin-destination matrix (OD-matrix). This OD-matrix is linked to the municipality layer through the zip-code, which enable us to identify and map the distribution of palletized goods.

For the second step – namely the location analysis of the water-bound warehouses – the market of transport of palletized goods needs to be defined. This market will determine the future locations of the RWDC's. In the calculations, transports longer than 80km (straight) are excluded. This step is justified, given that at this time no information is known about the use of water-bound sites by the supplier and/or costumer. Moreover the origins and destinations are given at municipality level, so by consequence pre- and post-haulages are inevitable. This affects the cost of the intermodal transport to such an extent (see scenario 5/5 in paragraph 2.6), that transports under 80km are in no way profitable (Essenciál Supply Chain Architects, 2011).

The model identifies the OD-combinations which meet this first precondition, and defines the routes travelled by road. These routes are calculated by a shortest time path algorithm, using the algorithm of Dijkstra (Dijkstra, 1959).

The distribution locations (municipalities) are weighted with the sum of the tonnage of all the routes that start and arrive in these municipalities. Thereafter a second precondition is formulated, namely the distribution locations used as 'market' are limited to the municipalities located within an predefined buffer of an IWW (illustrated in figure 10). This buffer is fixed at 30km using the road network by a shortest time path algorithm, according the algorithm of Dijkstra. Although the critical maximum distance of the pre- and post-haulage necessary for the overall intermodal transport to be profitable, depends on the overall transport distance and the used cost structure, it can be assumed that for the Belgian case 30 kilometers of pre- and post-haulage is the ultimate maximum (Cornillie & Macharis, 2006; Essenciál

Supply Chain Architects, 2011; Poppink, 2005). By using of this delimitation, routes with too expensive pre- and post-haulages will be excluded.

The potential locations of the RWDC's are defined as locations on an IWW, and lying within a predefined distance (50m) of a trafficable road. Thank to this precondition, the future RWDC's will not be located in a pedestrian urban city centre or in a protected nature reserve. Furthermore the RWDC's will already have a direct connection to the existing road network, thereby avoiding heavy investments in road infrastructure.

The determination of the optimal locations is based on the 'Location-Allocation' procedure of the 'ArcGIS Network Analyst' tool. The procedure starts with the calculation of the shortest path between every distribution location and every potential warehouse location, using the road network and the algorithm of Dijkstra. Then an edited version of the obtained cost matrix is constructed (Hillsman, 1984) which enables the heuristic to solve a variety of different problem types. Next, the location-allocation process generates a set of semi-randomized solutions and applies the vertex substitution heuristic of Teitz and Bart (1968) to create a group of good solutions. A metaheuristic then combines this group to create better solutions, until no additional improvement is found. Finally the metaheuristic delivers the best solution found (ESRI, 2010).

The location of future RWDC's depends on the number of chosen RWDC's. This number depends on the 'marketshare' and the spatial distribution of the RWDC's, given that it is recommended to enlarge one water-bound warehouses rather than to open two of them in the same 'marketarea'.

Once the number and the optimal location of the future RWDC's is set, a GIS network is created specific for the intermodal transport. It combines the road layer (for the pre- and post-haulage), the RWDC locations (as transshipment nodes) and the inland waterway network layer. Within this created intermodal network a shortest route algorithm – once again according to the algorithm of Dijkstra – is performed.

The respective distances of the unimodal routes by road and the intermodal routes – with pre- and post-haulage by road and main haulage by barge – are calculated and linked with the cost structure (Essenciál Supply Chain Architects, 2011). A cost analysis is performed for every individual route from the OD-matrix of which the origin and destination is situated within a predetermined range of the future RWDC's. This predetermined range is fixed on 30km using the road network by a shortest time path algorithm, according the algorithm of Dijkstra and following the same justification as with the predefined market buffer (see above).

The combination of all routes gives a global overview, whereby the routes for which the modal shift is profitable will describe a realistic potential for modal shift and a realistic potential turnover (in ton) of the future water-bound warehouses. Assuming that the transports will be shifted towards the inland waterways, it is possible to calculate the saved main haulages by truck and consequently an estimation of the reached CO_2 reduction.

For the calculation of the CO_2 emissions some assumptions have to be made. First of all, the haulages via road are assumed to be done by a 40 tonne truck gross weight, as no information is given about the vehicle type. On the bases of information about the average load, the CO_2 emissions for the haulages by road (unimodal variant, and pre- and post-haulage) are calculated, using the data of the Handbook Emission Factors for Road Transport 3.1 (INFRAS, 2010). The CO_2 emission calculations for the barge transport are calculated on the bases of VMM study which uses the EMMOSS model (2012). Here the assumption is made that the transport is done by a barge of the Rhine Herne Canaltype (1350 tonne) with an average load factor of 95%.

4. Results and discussion

To identify the transport routes of palletized goods in Belgium, we used transport data for 2010 collected by ADSEI. These data contain information about type of goods (container, pallets,…), the tonnage, tonkm, distance and the origin and destination (level of municipality) of the inland transports. No distinction can be made on the goods itself. International transportations are also available, but not at the municipality level. They are therefore excluded from this analysis.

The data are obtained by a weekly at random sample of 1000 truck or trailers. All vehicles with a capacity of 1 ton or more are included, with the exception of agricultural, military and public vehicles. Every truck or trailer can be counted only once a year. The trailers are exhaustive questioned once a year, the trucks are on average questioned once every 2 years. The ADSEI data are thereby a clear indicator of the transport movements in Belgium and their tonnage.

In 2010, almost 53 million tonnes palletized goods are transported by truck within the Belgian borders, creating a OD-matrix of 11 244 combinations. This matrix is uploaded in the LAMBTOP model. Due to the fact that the origin and destination of the transports are spatially joined to the municipality centers, pre- and post-haulage by truck and additional transshipments become inevitable. This affects the financial costs of the intermodal routes to such an extent that there is no prospect of developing intermodal transport of palletized goods over distances shorter than 80km. As we see that one additional transshipment – under the current cost structure – equals a break-even distance of 76,8 km. Naturally when information is given on the water-bound location of the shipper and / or the costumer, the presumption is an can easily be removed from the location analysis.

Only 8,6 million tonnes of palletized goods survived this presumption of 80km, reducing the OD-matrix to 2 955 combinations.

The model identifies the origin destination combinations which meet this first precondition, and the distribution locations of these OD-combinations are weighted with the sum of the tonnage of all the routes that start and arrive in that municipality (illustrated in figure 10). The ones within a buffer of 30km by road of an IWW are selected as the market area of the future water-bound warehouses (delimited by the buffer).

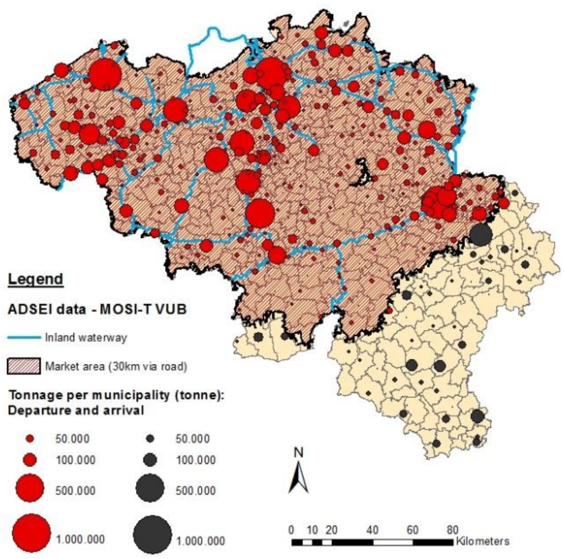


Figure 10. Distribution analysis + potential market area

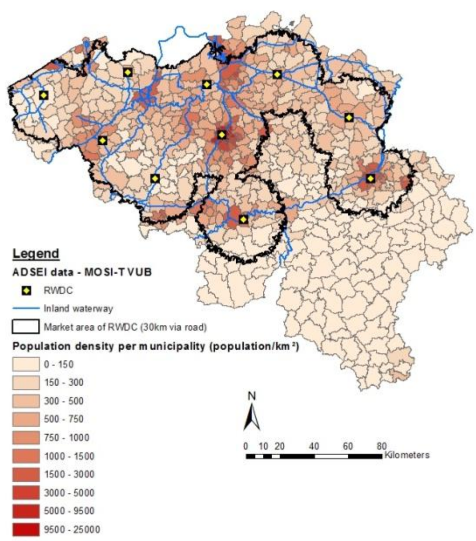


Figure 11. RWDC locations and their market area relative to the population density

In general the main Belgian cities are representing the largest tonnages. Also 4 main geographic concentrations can be distinguished. Firstly there is a clear concentration in the south of the province of West-Flandres. Second main concentration is the so called ABC-axis (Antwerp, Brussels, Charleroi), going from north to south in the centre of the country. A third concentration can be found in the Kempen. Note also the higher values there for the municipalities along the Albertkanaal (IWW). The last concentration is situated around the city of Liège. All 4 spatial concentrations are taken into account in market area for the location analysis of the RWDC's (red color in figure 10). In total 7,9 million of the 8,6 tonnes is taken into account.

The number of ten RWDC's is chosen. Together they cover 94,3% of the 7,9 million tonne. Each one of them operates more or less within its own market area of approximately 30 km. When less than ten RWDC's are chosen, they lack to serve some significant market areas lying within a reasonable pre- and post-haulage distance. Once more than ten RWDC's are selected, there is a considerable spatial overlap of the RWDC market areas. Consequently they are operating in the same spatial market segment, and their added value decline. In such cases where two or more optimal RWDC locations are situated near to each other, it is recommended to enlarge one of them instead of opening two of them in the same area.

Figure 11 illustrates the ten optimal RWDC's locations in respect of the population density on the municipality level. Most of the RWDC's are located in or close to a main Belgian city. Consequently the future RWDC's can be integrated in the problematic of the city distribution. They can function as multimodal city distribution centers, saving many trucks entering the city and convergent caused external costs (congestion, emissions, accidents and noise). The last urban mile can then be bundled and organized by sustainable transport modes.

Note that the more RWDC's are chosen, the more the main city are selected as optimal locations. With an increasing number of RWDC's - as the tonnage is used as weight - they tend to concentrate near to these high tonnages. It is logical that the optimal locations are moving towards th cities, since these cities represent the highest tonnages of palletized goods.

The ten optimal RWDC locations are once again mapped in figure 12, with their overall potential turnover. This overall potential turnover of one RWDC is the tonnage of palletized goods that passes through the RWDC, if all transports - longer than 80km (straight flight) – of which the departure and arrival location are situated within 30km by road of a water-bound warehouse are shifted towards the intermodal network. The costs of the modal shift are not taken into account. In total 1852 OD-combinations meet to these conditions. Together they transport 5,7 million tonnes palletized goods.

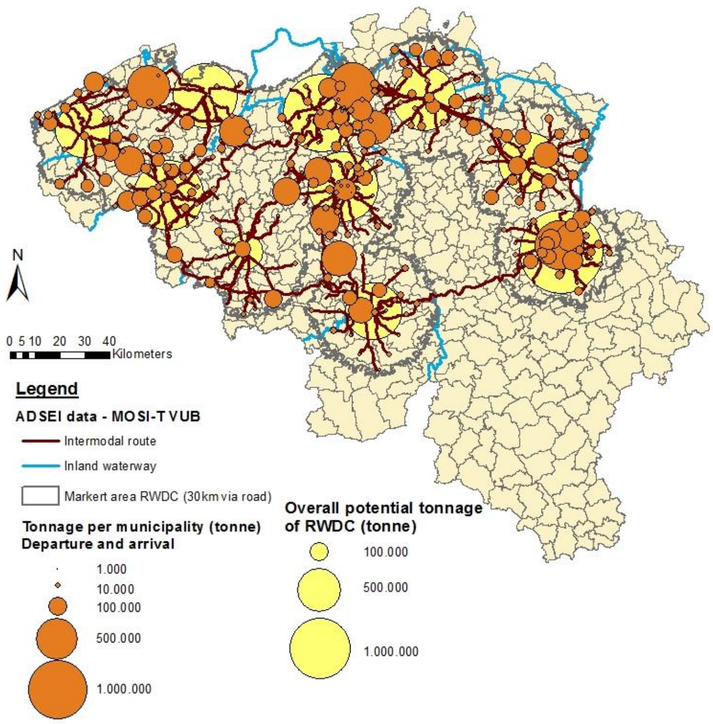


Figure 12. Overall potential turnover of RWDC and the multimodal routes

If all these transports can be shifted towards the IWW, one could reduce almost 513 thousand long unimodal truck movements to a short pre- and post-haulages. The comparison of the overall CO_2-emissions of these unimodal movements with the multimodal alternative (main haulage by barge and pre- and post-haulage by truck) demonstrates that a reduction of 34 325 tonnes CO_2 could be obtained when all 1 852 OD-combinations would be shifted.

5. Conclusion

The innovative concept of transporting palletized goods via the Belgian inland waterways has gone a long way already. The initial feasibility analysis illustrated a clear potential and interest for the concept. This resulted in different practical tests, who were performed for the construction sector during the past years. The interest and willingness of the construction sector illustrates that the time trade-offs of the intermodal concept are compensated and justified by the gain in reliability and costs. Furthermore, by experimenting with different techniques, the most optimal techniques could be picked out and a cost structure was developed.

This cost structure shows that there is a clear financial potential for the modal shift of transports of palletized goods when both producer as costumer are located near the inland waterway. When only one or none of them has water-bound facilities, a critical distance is needed which depends on the length of the pre- and/or post-haulage. It is obvious that the shorter these haulages are, the more feasible it will be to shift the palletized goods.

If pre- and/or post-haulages are needed, one need to implement intermodal hubs or so called regional water-bound distribution centers. The locations of these RWDC's are crucial for the further development of the concept. Therefore a location analysis model – the LAMBTOP was created. The model advises ten optimal RWDC locations. These optimal locations are mostly situated in or close to main Belgian cities. This makes it possible to combine the innovative concept with multimodal and sustainable city distribution, as the future RWDC's could function as multimodal city distribution centers from which the last urban mile can be bundled and transported by sustainable transport modes.

Furthermore the results of the LAMBTOP model point the turnover and ecological potential of the concept, as 5,7 million tonnes or 513 thousand main truck haulages could be shifted to the inland waterway which could reduce the transport related CO_2–emissions by 34 325 tonnes.

Further research will be devoted to the concepts as for the operator also the costs of the RWDC's should be taken into account. Also an analysis of the water-bound activities will be done, in order to find more synergy with already existing activities.

6. References

Algemene Directie Statistiek en Economische Informatie (ADSEI), 2010 [available online on-line: http://statbel.fgov.be/]

Cornillie I. & Macharis C., 2006. Palletvervoer via de binnenvaart, een haalbaar alternatief? In: Despontin M. & Macharis C., *Mobiliteit en (groot)stedenbeleid*. VUB-press: 207-238

Dijkstra E.W., 1959. A Note on Two Problems in connexion with Graphs. *Numerische Mathematik 1*: 269-271

Essenciál Supply Chain Architects 2011, ir. Verbeke F. : Comparative cost analysis between inland navigation and road transport, for palletised goods. p. 14

ESRI, 2010. ARCMAP 10. Network Analyst Users Guide

European Commission, 2011a. Impact assessment: accompanying document to the White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. Brussel, 28/03/2011 *SEC (2011) 359 final, SEC (2011) 360 final , COM (2011) 144 final, SEC(2011) 358 final*. p. 170

European Commission, 2011b. Steunmaatregel SA.30987 (N/2010) – België: Steunregeling van het Vlaams Gewest betreffende exploitatiesteun ten behoeve van het vervoer van palletgoederen via de waterwegen (N554/2010). Brussel, 08/08/2011. *C(2011) 5801 def*. p. 11

Groothedde B., Ruijgrok C. & Tavasszy L., 2005. Towards collaborative, intermodal hub networks. A case study in the fast moving consumer goods market. *Transport Research Part E,* vol. 41: 567-583

Hillsman E.L., 1984. The p-median structure as a unified linear model for location-allocation analysis. *Environment and Planning A*, 16(3): 305-318

INFRAS, 2010. Keller M. et.al., INFRAS et.al. *Handbook Emission Factors for Road Transport*. Ver. 3.1, Bern

Kayikci Y., 2010. A conceptual model for intermodal freight logistics centre location decisions. *Procedia Social and Behavioral Sciences*, vol. 2: 6297-6311

Kreutzberger, E., Macharis, C. & Woxenius J., 2006. Intermodal versus unimodal road freight transport – a review of comparisons of the external costs. In: Jourquin B., Rietveld P. & Westin L. (Eds.), *Towards Better Performing Transport Systems*. Taylor and Francis, London: 17-42

Poppink P., 2005. Project roept vragen op: Distrivaart laat beperkingen modal shift zien. *Transport en Logistiek*, vol. 4: 26-27

Teitz M.B. & Bart P., 1968. Heuristic methods for estimating the generalized vertex median of a weighted graph. *Operations Research*, vol. 16: 955-961

TNO Inro, 2003. Groothedde B. & Rustenburg M. : Distrivaart Netwerkontwikkeling. De weg naar een volwaardig netwerk in de binnenvaart. Delft. p. 91

Vlaamse Milieumaatschappij on the bases of the EMMOSS model (Transport & Mobility Leuven), 2012

VUB & COM*i*SOL, 2006. Haalbaarheidsstudie voor de concrete implementatie van de binnenvaart voor vervoer van pallets en de daarmee verbonden stadsbevoorrading. p. 66

Waterwegen en Zeekanaal NV & NV De Scheepvaart, 2011. Steunmaatregel voor het vervoer van palletten via de waterwegen: Handleiding voor de gebruiker. [available online on-line: http://www.binnenvaart.be/documents/HandleidingSteunmaatregelPalletvervoer.pdf], p.15

An Approach to Drive Benefits from Item Based RFID to Improve Manual Reverse Logistics Processes

Kenan Dinç[17]

Abstract

Reverse logistics deals with the products returned from the customers to the manufacturers to create or recapture value or to dispose properly. Reverse logistics requires more labor compared to the forward logistics in classifying products according to their condition. When a product arrives to a warehouse, collection or distribution center employees evaluate the condition of the item and decide to the best operation that they will apply to product. Reverse operations need more labor to handle and more time to classify. That makes reverse logistics more costly than the forward logistics which is well defined and accountable. Information Technology can help improving the process. A subgroup of auto-id systems, RFID, uses RF signal to identify the product. With a used or reused RFID tag, the information required in each phases of supply chain such as operation to apply, reason of return, return address, and price change can be provided besides the requirement of other supply chain stages. This paper addresses the accelerating involvement of RFID in an interdisciplinary way to time and labor consuming processes of reverse logistics.

Keywords: Reverse logistics, RFID, information technology, Auto-ID

1. Introduction

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 (SCL, 2012). Reverse logistics manages used products return from the customers to the producers for the purpose of creating or recapturing value or for proper disposal (Tibben-Lembke and Rogers 2002). 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 (Jayaraman, 2003). 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 (Prahinski and Kocabasoglu, 2006).

Estimations of product returns are between from 15% for mass merchandisers to 35% for e-commerce retailers in developed countries. 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 (Stock and Mulki, 2009). 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

[17] Beykoz Vocational School of Logistics, Turkey, +90 216 444 2569, kenandinc@beykoz.edu.tr

products, warranties, recalls or environmental disposal. It can be clearly stated that the process of reverse logistics has a long way to go to be understood thoroughly and to be effectively used in most of the commercial companies (Hsu, Alexander and Zhu, 2009).

On the other hand, the emerging technology of radio frequency identification (RFID) raises great opportunities for effective and efficient traceability system design. Based on automated data capture, traceability information can be obtained at significantly reduced labor costs and with small changes in the enterprise's business processes. Furthermore, RFID technology combined with the appropriate information infrastructure can enable end-to-end traceability in the supply chain (Kelepouris, Pramatari and Doukidis, 2007).

A growing number of companies (e.g. Wal-Mart) and government entities (e.g. the US Department of Defense) have begun investigating and in some cases adopting radio frequency identification (RFID) systems. Academic research and industry practices have suggested that RFID has the potential to offer some superior performance opportunities and benefits for companies, such as lower operating and overhead costs, reduced inventory, reduced lead time, improved supply chain visibility, increased information accuracy, enhanced efficiency and productivity, and strengthened buyer-seller relationship, etc. Given anecdotal evidence, it is expected that RFID technology can bring significant positive return on investment (Kros, Richey, Chen, and Nadler, 2011)

The aim of this study is to offer an RFID solution approach to the burden of manually executing reverse logistics activities. Applying and getting data from RFID for all of the stages and parties of the forward and reverse supply chain will take time due to its requirement of commonality and profitability among all chain members. RFID confined in local reverse activities within the supply chain of vertically integrated companies, that means companies which own retailers and collection centers, may have a transitional step from current non-RFID state to fully RFID adopted state to improve operations and lower labor cost. One of the important contributions will be the item visibility in the reverse flow monitored by IT. The scope is limited from retailer to collection center geographically, and also limited with just returned items

This paper focuses on generic distribution centers (DC) of major retailers mainly to propose RFID involvement to accelerate the backward logistics processes of a closed loop supply chain. The rest of the paper is organized as follows. The process of reverse logistics is discussed in the next section. Information technologies and RFID are presented in the following sections. Next, a proposed hybrid, manual reverse logistic process approach combined with RFID is described in a DC operating at the same time as a central returns center (CRC). Last section discusses predicted facts and future research.

2. Reverse Logistics

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 (REVLOG, 2012). In this process a manufacturer systematically accepts previously shipped products or parts from the point of consumption for possible recycling, remanufacturing, or disposal (Dowlatshahi, 2000). The most intuitively related notion with such reverse activities involves the physical transportation of used products from the end user back to the producer (Jayaraman, Patterson and Rolland, 2003).

Regardless of how relations with external suppliers develop, just as with other organizations, waste elimination and product recalls are of growing. In the private sector, product recalls appear to be becoming an increasingly frequent occurrence (Kumar, Dieveney, and Dieveney, 2009).

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 (Dinç, 2011b).

A portion of a DC is allocated to be the CRC that handles most returns from retail stores. Approximately, 70 percent of the companies used a CRC for processing returns in 2001. 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 consumers' perspective, products can be returned based on defective/unwanted products, warranties, recalls, or environmental disposals. How a CRC sorts the returns and then channels each return to the right place at the right time is extremely difficult. The difficulty comes from uncertainty involving how the inventory and information flow in the reverse logistics process. Furthermore, when a CRC stationed in a DC works as a profit center, the business process gets more complicated than when a DC is only a channel to move product back and forth (Hsu, Alexander, and Zhu, 2009).

Inventory flow uncertainty contributes to the fact that the cost of holding returned product is quite high. The longer it is held in a DC, the more the product value declines. Uncertainty increases as returns are moved through the various channels of the reverse logistics supply chain. As internet technologies are introduced to logistics processes, information, and cash flows within a DC become increasingly fast paced. In addition, information and cash flows can occur in multiple different directions. These increased flows make logistics management much more complicated. The old-fashioned warehouses have been transformed into DCs which are equipped with forms of information technology that extend the information sharing beyond the outbound operation. With products moving back and forth, flowing upstream and downstream in the supply chain, the major cost should still be the transportation cost. However, the coordination cost, which is the cost of exchanging information and incorporating the information into a decision making process, should also be considered. From this rationale, it is logical to ask what types of information technology and/or systems are needed in reverse logistics and how the information sharing increases the performance of reverse logistics (Hsu, Alexander, and Zhu, 2009).

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, Universal Product Coded (UPC) returns are shipped to DC or CRC according to the structure of the chain. 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. 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 (Dinç, 2011b)

3. Information Technology in Reverse Logistics

Reverse logistics is a very heavily IT-driven process because of the need to provide for and improve visibility into the goods in motion throughout the reverse supply chain (Li and Olorunniwo, 2008). The four suggested elements of traceability are:

- Physical lot integrity, which determines the traceability resolution
- Collection of tracing and process data
- Product identification and process linking
- Reporting/system data retrieval

Similarly, four key traceability principles are:

- Unique identification of products, logistic units and locations;
- Traceability data capture and recording;
- Links management and traceability data retrieval; and
- Traceability data communication (Kelepouris, Pramatari and Doukidis, 2007)

In general, IT is a necessary infrastructure for both the company itself and its supply chain partners. However, whether the choice of a particular IT type differentially affects a company's performance as desired is not clear. Heavy IT investment does not necessarily improve companies' productivity – this is the so-called productivity paradox of IT. Though IT is critical to SCM, the adoption and use of IT in SCM also falls short of expectation. Many technologies are more costly and complex than previously thought: electronic data interchange (EDI), radio frequency identification (RFID), and internet marketplaces (Olorunniwo and Li, 2010).

The more companies invest in information technology, the better the economic benefits of reverse logistics.

4. RFID

Over the decades, many information systems have been developed to help firms to achieve better intra- and inter-organizational information flow. Indeed, information technology enables firms involved in a supply chain to share demand and inventory data quickly and inexpensively. From an SCM perspective, IT can improve inventory management by reducing inventory levels, holding costs, and spoilage, and thus contributes to increased profitability. In this broader context of SCM, IT is considered to be a critical enabler of supply chain optimization. In the context of intra-business process optimization, Enterprise Resource Planning (ERP) systems have been adopted to achieve flexible information flows, enabling quick deliverability through shorter planning cycles, availability of up-to-date information, reduction of transmission times, elimination of double data handling and, as a result, enhanced intra-organizational communications and data visibility and increased productivity of work processes (Gupta and Kohli, 2006).

Among Automatic Identification and Data Capture (AIDC) technologies, bar coding has been used to reduce information distortion within a supply chain leading to better information quality and overall supply chain performance. In the retail industry context, in addition to information technology applications such as Materials Requirement Planning (MRP), Manufacturing Resources Planning (MRPII), Warehouse Management System (WMS) and Advanced Planning and Scheduling (APS), many firms are exploring the potential of new customer-focused concepts listed in introduction part in order to support their intra- and inter-organizational business processes and information flow (Wamba and Boeck, 2008).

RFID is a technology that uses radio waves to automatically identify objects. The identification is done by storing a serial number, and perhaps other information, on a microchip that is attached to an antenna. This bundle is called an RFID tag. The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can be passed on to an enterprise information system. RFID technology has been extensively used for a diversity of applications ranging from access control systems to airport baggage handling, livestock management systems, automated toll collection systems, theft-prevention systems, electronic payment systems, and automated production systems. Nevertheless, what has made this technology extremely popular nowadays is the application of RFID for the identification of consumer products and supply chain management. Traditionally, the retail sector uses barcodes as the main identifier for cases, pallets and products. Over 5 billion products are scanned every day in 141 countries. However, many in the industry are already looking to the business case of RFID as the "next generation of barcode" through its ability to identify products automatically not requiring line-of-sight and store much more information, thus enabling mass serialized identification of every single product instance in the supply chain (Kelepouris, Pramatari and Doukidis, 2007) The RFID application mechanisms can be classified into three types, namely pallet tagging, case tagging and item tagging (Hou and Huang, 2006)

Starting with out-of-stock management, various authors argue that RFID has great potential to reduce the stock outs at points of sale, generating benefits for both the manufacturer and the retailer. RFID could reduce stock outs through:

- Automatic identification of goods, which increases the accuracy of both the shipping and the receiving processes; and
- Improved product visibility along the supply chain, which increases the accuracy of the inventory information and, consequently, the service level at both the manufacturer and the retailer facilities. At the retail store, increased visibility can trigger a stock out on the sales floor, while there may be stock in the backroom (Miragliotta, Perego and Tumino, 2009).

Although RFID took place in production and warehouse part of supply chain operations, retail usage is limited by several experiments. Distribution companies do not disclose the name of two large scaled apparel stores built and tested the RFID system in their retail business. But, one of them is a well-known multinational company; the other is a larger national chain.

Number one of the barrier is declared as the relatively high prices of passive RFID tags which are 0,08 USD in the market currently. Top retail stores including the largest food chains are following the "wait-and-see" policy (Dinç, 2011a).

5. Item Based RFID Approach for Reverse Logistics

In apparel suppliers of Turkey around 20-40% of employees in major warehouses are assigned to reverse logistics activities due to the major differences that exist between forward and reverse retail logistics. Those significant differences are:

Forecast: In the forward logistics production is planned according to the demand. However in the reverse logistics, the customers initiate the activities.

Damaged package: Except the unsold products that have the original package, most of the time returns travels through backward chain without proper 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.

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 (Dinç, 2011b)

The proposed approach in this paper, the forward and reverse logistics channels are connected and the network that is formed is called "closed loop reverse logistics". In the closed loop reverse logistics, the products that are delivered to the customer, damaged or not sold are collected by the retailer. Under regular circumstances, the goods are kept until the amount reaches to a certain level or until the delivery time and then they are sent to the DC/CRC. In the DC/CRC, the products are inspected and classified manually which requires item based effort at the expense of diseconomies of scale. The next step is determined according to the classification. Limited information is provided even if there is an advanced software in the DC/CRC . Clearly, this process lacks some important supply chain aspects: visibility, speed, low cost.

The proposed approach starts with the collection of returns from customers similar to the legacy approach. Processes differentiate when the returns are attached with a reusable RFID tag in the retail store. Retailer scans the tag and enters the necessary data about return reason and matches the RFID key with the record key in the database of retailer so that the product data relates with the return data. Usually a retailer either accumulates the items until they reach to the level required to start a transportation process or the incoming vehicle collects returned items based on a schedule of forward logistics.

When the products are unloaded from the vehicles in a DC/CRC, they should be classified and inspected to estimate the value that can be obtained from the product. In the proposed approach, information travels before the returned item and should be matched with the product. An RFID reader can accomplish such a task. A reader before the sorting and classifying process reads the RFID tags of returns while they are moving, for example on a conveyor, and directs to the appropriate classification pool with a speed relatively much higher than manual process, and with less fault.

If necessary, optional second or more readers can be used for other detailing processes like sub-classification, boxing or palletizing the products regarding to the type, size, and assortment.

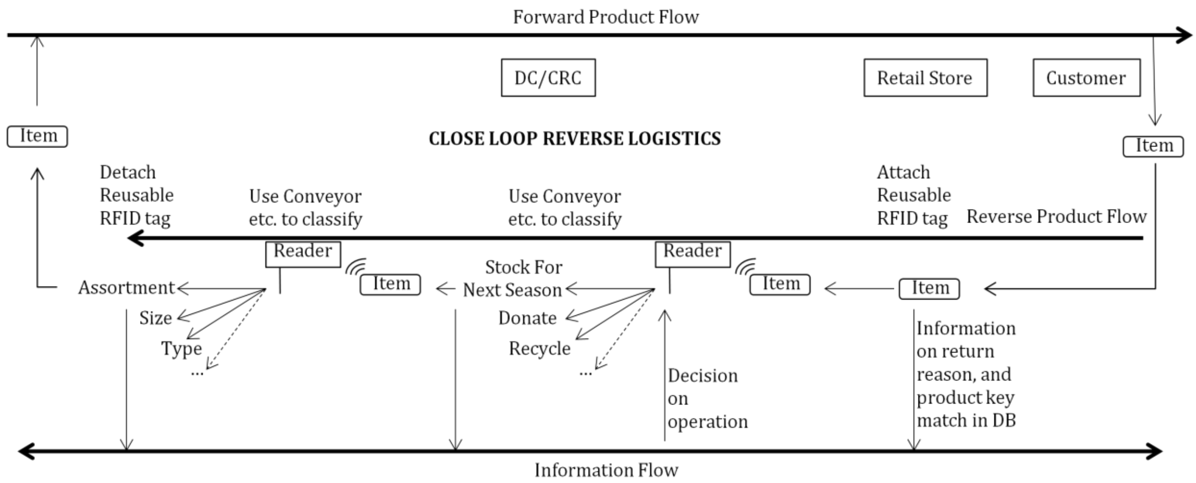


Figure 1. Proposed flow of returned items in closed loop reverse logistics

At the end of the reverse processes, reusable RFID tags are detached from the returned items and sent to the retailers. After that last step, products can fallow the forward flow processes (Figure 1).

Advantages of the approach can be stated as:

- Entering the reason of return correctly on the origin of return.
- Matching the return information with the product information
- Sending the information before the product and help to make better decision
- Classifying the items with high speed and less fault
- Reduce the human involvement. Decrease the number of error.
- Apply the automated decisions coming from information backbone in each of the stages.

6. 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. Unfortunately, in reverse logistics "one size fits all" rule does not apply. 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 (Dinç, 2011b).

Technology is not mature yet to set internationally acceptable standards and it is not a standalone system. Most of the companies likely has some bad memories in integrating a new technology/software to their existing systems in the past. A large amount of data will be processed by the information system. The way people are doing their job will surely change. There will be a lack of RFID expert in deployment and maintaining phases. However, in spite of the mentioned disadvantages, hybrid reverse logistics RFID technology will provide cost savings, shipping time reduction, optimization, either automation or elimination of processes, work force minimization, feeding the information system with correct data in a faster way and will help supply chain to operate in more digitized manner. In the reverse flow of materials like product returns where most of the costs is made up of manual operations RFID solutions offer relatively cheaper solutions to carry the information along with the items that are usually damaged or lack the original packages.

With the hybrid closed loop reverse logistics method provided in this study, the most important obstacle of RFID proliferation, expensiveness of RFID tag, is avoided by reusable RFID tags in just reverse channel. On the other hand, the most time and afford consuming parts of the reverse logistics, classification and inspection, are accelerated by RFID inclusion. The return data is entered at the source with the minimum data entry errors, and linked with the forward flow record of item. Information arrives to DC/CRC in advance. So that, the classification process is automated. The burden of decision making process transferred at a great scale to the central authority.

References

Dinç, K., 2011a, Bottlenecks of RFID technology and its utilizations in retail logistics, *IX International Logistics and Supply Chain Congress*, Yasar University, Izmir/Turkey

Dinç, K., 2011b, The importance and effects of reverse logistics activities for the retail companies, *IX International Logistics and Supply Chain Congress*, Yasar University, Izmir/Turkey

Dowlatshahi, S., 2000, Developing a theory of reverse logistics, *Interfaces*, Vol. 30 Iss: 3: pp. 143–154.

Gupta, M., Kohli, A., 2006, Enterprise resource planning systems and its Implications for operations function, *Technovation*, Vol. 26 Iss: 5-6, pp. 687-696.

Hou, J-L., Huang, C-H., 2006, Quantitative performance evaluation of RFID applications in the supply chain of the printing industry, *Industrial Management and Data Systems*, Vol. 106 Iss: 1 pp. 96 – 120

Hsu, H. S., Alexander, C. A., Zhu, Z., 2009, Understanding the reverse logistics operations of a retailer: a pilot study, *Industrial Management and Data Systems*, Vol. 109 Iss: 4 pp. 515 – 531

Jayaraman, V., Patterson, R.A., Rolland, E. , 2003, The design of reverse distribution networks: models and solution procedures, *European Journal of Operational Research*, Vol. 150 Iss: 2: pp. 128–149.

Kelepouris, T., Pramatari, K., Doukidis, G., 2007, RFID-enabled traceability in the food supply chain, *Industrial Management and Data Systems*, Vol. 107 Iss: 2 pp. 183 – 200

Kros, J. F., Glenn, R. R., Chen, H., Nadler, S. S., 2011, Technology emergence between mandate and acceptance: an exploratory examination of RFID, *International Journal of Physical Distribution and Logistics Management*, Vol. 41 Iss: 7 pp. 697 – 716

Kumar, S., Dieveney, E., Dieveney, A., 2009, Reverse logistic process control measures for the pharmaceutical industry supply chain, *International Journal of Productivity and Performance Management*, Vol. 58 Iss: 2 pp. 188 – 204

Li, X., Olorunniwo, F., 2008, An exploration of reverse logistics practices in three companies, *Supply Chain Management: An International Journal*, Vol. 13 Iss: 5 pp. 381 – 386

Miragliotta, G., Perego, Al, Tumino, Angela., 2009, A quantitative model for the introduction of RFId in the fast moving consumer goods supply chain: Are there any profits?, *International Journal of Operations and Production Management*, Vol. 29 Iss: 10 pp. 1049 – 1082

Olorunniwo, F. O., Li, X., 2010, Information sharing and collaboration practices in reverse logistics, *Supply Chain Management: An International Journal*, Vol. 15 Iss: 6 pp. 454 – 462

Prahinski, C., Kocabasoglu, C., 2006, Empirical research opportunities in reverse supply chains, *Omega*, Vol. 34 Iss: 6: pp. 519-532.

REVLOG, *http://www.fbk.eur.nl/OZ/REVLOG/PROJECTS/TERMINOLOGY/Definitions.html*, 2012

SCL, Supply Chain and Logistics Institute, *http://www.scl.gatech.edu/apps/glossary*, Georgia Institute of Technology, 2012.

Shi, X., Li, L.X., Yang, L., Li, Z., Choi, J. Y., Information flow in reverse logistics: an industrial information integration study, *Inf. Technol. Manag*, DOI 10.1007/s10799-012-0116-y

Stock, J. R., Mulki, J.P., 2009, Product returns processing: An examination of practices of manufacturers, wholesalers/distributors, and retailers, *Journal of Business Logistics*, Vol. 30 Iss: 1

Tibben-Lembke, R.S., Rogers, D.S., 2002, Differences between forward and reverse logistics in a retail environment, *Supply Chain Management*, Vol. 7 Iss: 5

Wamba, S. F., Boeck, H., 2008, Enhancing Information Flow in a Retail Supply Chain Using RFID and the EPC Network: A Proof-of-Concept Approach, *Journal of Theoretical and Applied Electronic Commerce Research*, Vol. 3 Iss:1 pp. 92-105.

Value Creation in Closed Loop Supply Chains – A Research Framework

Maren Schenkel[18], Harold Krikke[19], Marjolein Caniëls[20] and Erwin van der Laan[21]

Abstract

In a closed loop supply chain (CLSC) the traditional forward supply chain is extended with a reverse supply chain. In the past, operational research mostly focused on cost minimization and compliance in the reverse supply chain. Less is known about value creating practices and strategies in the CLSC. In this paper we distinguish four types of values that can be created in the CLSC: Sourcing, environmental, customer and information value. We review CLSC and reverse logistics literature with regards to the four types of values and use input from expert interviews to devise a generic framework for value creation in CLSC. Three theoretical models are proposed which demonstrate value creation practices, value interrelationships and synergy effects. The paper concludes with elaborating on our research strategy to test these models.

Keywords: Closed Loop Supply Chains, Value Creation, EPR, Electronic products

1. Introduction

Closed loop supply chain management describes the "design, control and operations (of a system) to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types of returns over time" (Guide & Van Wassenhove, 2009, p. 10). While early closed loop supply chain (CLSC) researcher focus on minimizing costs and compliance with legislation in the return processes, researchers nowadays shift towards the idea of value creation in CLSCs (Kleindorfer, Singhal & Van Wassenhove, 2005). Managing the return flow of products is increasingly recognized as strategically important within and across firms (Mollenkopf, Frankel, & Russo, 2011). Companies must proactively pursue value from return streams and manage the forward and reverse supply chain in a coordinated way towards the common goal of profit maximization (Kleindorfer et al., 2005). Despite the huge potential lying in reverse logistics (Rogers & Tibben-Lemke, 2001), few research studies focused on value creation in the integrated forward and reverse supply chain. This is contrary to (forward) supply chain literature where value creation is commonly accepted as a feasible concept (e.g. Porter, (1996), Martel, (2009)). CLSCs integrate business processes that create additional value for both original and new supply chain actors (Krikke et al. ,2004, p.2-3) Additional value refers to traditional supply chain targets such as cost reduction, customer satisfaction as well as environmental objectives and information management (Krikke, 2009). Based on that Koppius, Ozdemir, & Laan (2010) classify value creation opportunities into four types of values that are environmental, sourcing, customer and information value (see Figure 1).

[18] Open University Netherlands, Netherlands, + 3161017255, maren.schenkel@ou.l
[19] Open University and Tilburg University, Netherlands, +31 (0)13 4662315, Krikke@uvt.nl
[20] Open University, Netherlands, +31 (0)45 5762724, mcc@ou.nl
[21] Erasmus University Rotterdam, Netherlands, +31 10 4082763, elaan@rsm.nl

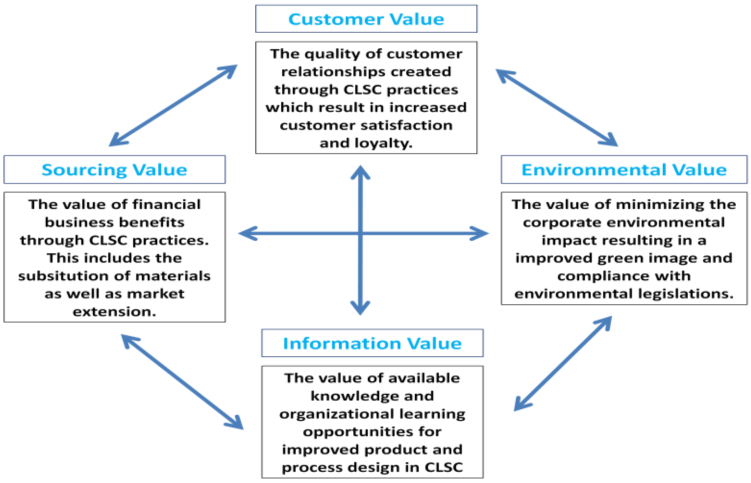


Figure 1. Four types of values in CLSCs

We contribute to existing research by delivering a generic framework on value creation opportunities in CLSC. We aim at identifying types of values, value creating effects and synergies. In this respect we will further develop the four values mentioned by Koppius et al. (2010). Value creation in CLSCs involves many supply chain actors, such as the brand owner, retailer or customer and a huge number of external stakeholders. We chose to research value creation from the perspective of the brand owner (the focal company) because most drivers are addressing this actor and they are further best equipped to direct most key decisions. Guide et al. (2005)) state that brand owners are not fully aware of the strategic potential of the extended lifecycle. As a conclusion this paper attempts to identify

- *How a brand owner can create sourcing, environmental, customer and information value in CLSC ?*
- *How are these different types of values interrelated*
- *and how do various stakeholders in CLSCs influence value creation and may benefit from it?*

The remainder of this paper is structured as it follows: In section 2 we review existing research studies on value creation in CLSC. Based on that we discuss the value creation process and contingencies for value creation. In section 3.1 and 3.2 we propose theoretical models for the investigation of this research paradigm in a explorative qualitative study. More details on the case study design is provided in section 3.3.

2. Literature review

2.1 Fundamentals of value creation in CLSC

There are many reasons for companies to set up a reverse supply chain. Literature reports triggers such as environmental regulations (e.g. EU (2011), Guide & Van Wassenhove (2000)), limited and expensive capacity of landfill (Thierry et al. , 1995), customer demand and growing function selling (servitisation) in service level agreements (Krikke, Blanc, & Velde, 2003) . Product returns continuously increase through shortening product life cycle, catalogue sales, warranty returns or recalls (Krikke et al. 2004). Dynamic markets and technological changes further cause rapid value decreases of unused products putting the time-based value of products more into the focus of attention (Blackburn, Guide, Souza, & Wassenhove, 2004).

Despite upcoming triggers and current trends to close the loop, few studies researched value creation with regards to reverse logistics or CLSC. Mollenkopf et al (2011), Guide, et al. (2005) and Krikke (2011) focus on specific aspect of value creation in reverse logistics which were mostly of economic but also of customer and environmental value. Jayaraman and Luo (2006) summarize benefits of the reverse supply chain by distinguishing between tangible (e.g. cost savings) and intangible (e.g. customer satisfaction) competitive advantages. Other empirical studies research value creation with regards to only one type of product returns such as commercial returns (e.g. Griffis, et al,, 2012) or end of life returns (Le Blanc , 2006). Finally, Kumar and Mageleant (2006) classified business benefits of CLSC into three categories namely service and market, value creation opportunities and environment and safety. Hence literature lacks a generic framework for value creation in CLSC.

Moreover to generate business benefits from product returns companies need to efficiently and effectively operate the reverse supply chain, adopting a clear strategy for value creation. Le Blanc (2006) and Krikke et al. (2004) propose a framework in which the reverse supply chain strategy in respect to the value contained in the product return is determined. To this end value is interpreted in a broad sense including not only the value of materials, components and labor but also taking the corporate brand and image into account. To their understanding value can be driven by the market or the customer, by efficiency and costs or by the environment and safety. Based on that they define three types of values of product returns:

- Time-based value: The time-based value is the value of a product that is highly time dependent and sensitive due to market or technological changes. It is also referred to as marginal value of time or market value.
- Intrinsic value: The intrinsic value of returns might lie in its invested resources in terms of material, labor and energy. Depending on the type of return this value can range from the value of product reuse to the material value of the product.
- Negative externality value: A negative effect resulting from the use or disposal of the product that has not be taken into account at an earlier stage is framed as a negative externality. The consequences from this effect might result in environmental or safety risks which need to be managed in order to limit the impact. Sometimes legislation forces brand owners to undertake measures to reduce negative externalities. Negative influences on the corporate brand or image can also represent negative externalities.

Concluding from that value creation can assume two natures, 1) (re-) new value creation and 2) risk reduction. Referring to the first one, value can be created through the products and services which are offered to customers (Bowman and Ambosini, 2000). Renewed value is generated by developing new ways of doing things using new methods, new technologies or new forms or raw material (Porter, 1985). Beside the aim of creating value, supply chains must further minimize potential risks as risk adjustments reduces the value created (Christopher and Ryals, 1999). Moreover product recovery concepts are often connected to forward supply chain as recovered returns are mostly reused in the forward supply chain thereby creating positive added value (Krikke et al., 2003). Contrary the reverse supply chain's focus is almost at minimizing negative effects (Gooley, 2002) such as recalls or warranty returns.

Value creation is strongly linked to stakeholder management since value is created for or in collaboration with corporate stakeholders. De Brito (2003, p. 65) identified a number CLSC players which include traditional forward supply chain actors, specialized reverse supply chain actors, governmental institutions and third parties such as charity organizations. She argues that there are mostly few or even one focal organization such as the brand owner or original equipment manufacturer (OEM) which manages the CLSC. From the perspective of the brand owner as the focal organization, we define internal stakeholders as (forward and reverse) supply chain members. External to the supply chain are stakeholders which do not directly participate in the value creation process, i.e. the customer, the government, society or the natural environment. In the following we discuss how value creation with regards to the four types of values is present in literature.

2.2 The process of value creation

By closing the loop, that is setting up a return management program, the process of value creation is initiated. Return programs and policies can have a direct impact on customer value through a customer's return experience. Moreover the disposition of product returns and spare parts can enable a brand owner keeping his product in the market. Many studies (e.g. Dowlatashi (2010), Kumar & Putnam (2008),Thierry et al. (1995)) showed that closing the loop often creates direct business value through the substitution effect or the dual sourcing opportunity that is substituting virgin materials with materials from product returns (Krikke et al., 2003). More than just the recovery of the economical value of product returns, the substitution effect also captures the embedded ecological value of a product such as the invested energy and emissioned carbon dioxide (e.g. Krikke (2011), Fleischmann, Van Nunen & Graeve (2003)). The substitution effect consequently generates an eco-efficient situation. In this situation manufacturers moreover comply with environmental regulations, thereby they can avoid fines and create a green image (Chang & Fong, 2010). An increased environmental image could help capture the “green customer trend” and increase business opportunities by competing on the “green market”, i.e. manufacturers increasingly offering environmental friendly products and show responsibility for their products. Previous studies demonstrate that customers reward corporate responsible behavior (Piercy & Lane (2009)) and corporate stewardship (Kassinis & Soteriou, 2009).

Customer value can be further enhanced by effectively managing the relationship with the customer. Literature on customer relationship management (CRM) (e.g. (Coltman, Devinney, & Richard, 2012 & Reimann, Schilke, & Thomas, 2009)), shows that leveraging associations with customers can be a strategic advantage in competitive environments and may have an impact on the firm’s performance. Service level agreements which are based on the extension of the product life cycle through, for example, the availability of spare parts, include extended service and repair agreements or extended warranty. The opportunity to obtain materials and spare parts, as it was mentioned with regards to sourcing value, can result in service models which increase customer satisfaction and loyalty. Passing created value on to the customer, manufacturers can also resell remanufactured products at a lower price with an “as if new” warranty which can increase a customer’s perceived quality (Ayres, Ferrer, & Van Leynseele, 1997, p.6). Service propositions consequently interlink the direct benefits from sourcing value with customer value.

Finally, product returns serve as a vehicle for gathering information (Koppius et al., 2010). A trigger for most organizations to learn is the failure of a process or a project (Gino & Pisano, 2011). In the context of the CLSC, brand owners would learn in the situation of a high number of product returns, product failures, recalls and high return cost. When a failure occurs there are two possible learning mechanisms, first order (single loop) and second order (double loop) learning (Argyris & Schoon, 1978). First order learning refers to the modification of actions by compensating the difference between expected and real outcomes. Whereas second order learning reflects on the actions at first place. Values, assumptions and policies which led to the actions at first place are questioned. The process of value creation is linked to organizational learning based on market needs and feedback (Sinkula, Baker, & Noordewier, 1997). Thereby organizations orientate themselves towards customer feedback. Sharing these information among the supply chain partners is essential for achieving improved processes, product design and customer satisfaction (Spekman, Spear, & Kamauff, 2002). Possible improvements in product design can lead to increasing product modularity such as design for disassembly (Bogue, 2007) is implemented which facilitates product recovery. Thereby sourcing efficiency and environmental value can be interlinked. Moreover Hu, Ko and Weyand et al. (2011) argue that product variety is increasingly shifting from mass production to mass customization. In that case customers are able to design their own, customized, products which supports customer satisfaction. Process improvement through organizational learning can result in uncertainty reduction and CLSC responsiveness and effectiveness. The value of information consequently needs to be considered as a driver of the other three values, thus as a reinforcing loop in value creation.

3. A Value Framework

3.1 Modeling the framework

To develop an integrative model which demonstrates value creation in CLSCs Van Aken’s (1994) approach of the regulative and reflective research cycle will be applied. In the regulative cycle we identify value creation activities by testing a theoretical model in several case studies. In the reflective cycle research results from the different case studies in the regulative cycle will be evaluated for theory deduction. The current research utilizes the method of qualitative research to provide rich data for the exploration of cause and effect relationships in the process of value creation in CLSCs. A multiple case study is applied to achieve external validity via cross-case analysis (Cook & Campbell, 1979). Thereby the unit of analysis will be the CLSC of a product from the viewpoint of the focal company. More information on the research design is given in section 3.3.

For the design of a theoretical integrative model we studied existing literature and case studies on CLSC management and reverse logistics (e.g. Krikke, Van Harten & Schuur (1999); Maslennikova & Foley (2000)) to identify types of values, value attributes and value interconnections. Preliminary results were reflected and further developed in expert interviews with leading scholars in CLSC management. In total we conducted nine expert interviews in an iterative process of design and reflection on work in progress. We concluded with the design of three theoretical models (Figures 2,3 & 4) which form a value framework to be studied in an empirical study. They are explained in section 3.2.

3.2 The value pyramid

Based on literature study, existing case studies and expert discussions, the four types of values (section 1 and 2) were modeled in a pyramid structure (Figure 2). Whereas sourcing, environmental and customer value form the pyramid, information value can be seen as a reinforcing and supporting value to the other three values. The shape of the pyramid represents the cause and effect chain in the process of value creation. Motivated by an element of sourcing, environmental or customer value (e.g. legislation, service business), OEMs close the loop by setting up a reverse supply chain. The three types of values can subsequently be stepwise created in the sequence given in the CLSC. Interrelating elements between the three values lead to synergy effects in the process of value creation. Hence the shape of the pyramid represents a sequence of value creation rather than a hierarchy. This sequence is not universal and may assume a different order depending on the circumstances.

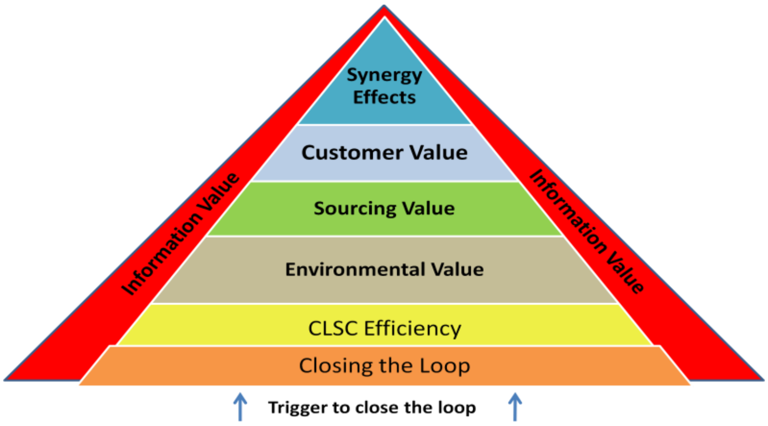


Figure 2. The value pyramid

We further model sourcing, environmental and customer value in detail identifying patterns of value attributes. They are represented in the form of matrices in the following part.

3. 2. 1 Value attributes

Sourcing, environmental and customer value possess various characteristics and elements. Being all three values in the CLSC, they differ on the nature of their composition. Based on section 2. 2 we identified the following two dimensions to classify value attributes:

1) External time based value vs. Internal intrinsic value (horizontal axis) and
2) Positive new value creation in the forward vs. risk reduction of negative externality in the reverse supply chain (vertical axis)

On the horizontal axis values and value creation processes are linked to the corporate stakeholder approach and the idea of internal and external stakeholders (section 2). Given the fact that the concept value in the value chain is mostly referred to as the value in the invested resources, we interlink internal stakeholders with intrinsic value. Time-based value is related to market dynamics and hence customer driven. Therefore it is mostly interrelated with external stakeholders. On the vertical axis we differentiate between positive value creation in the forward supply chain and the avoidance of negative externalities in the reverse supply chain. Using these dimensions we could identify the following three matrices (Figure 3) of value attributes of the previously identified three types of value.

In CLSCs environmental intrinsic value for internal stakeholders is created by reducing the ecological footprint, improving environmental performance by reducing the use of scarce resources in the production process. That also generates externally a green image. The reverse supply chain further supports waste reduction and compliance with environmental regulations whereby hazardous materials in corporate products which could potentially harm external stakeholders are controlled through the reverse supply chain.

Customer value is pursued by offering market based service solutions to customers and create a positive reputation through corporate responsible behavior in the forward supply chain. Thereby stakeholders internally benefit from the trustworthiness of the brand which might increase business opportunities. Time- based interaction with external stakeholders in the reverse supply chain is given through warranty and recall handling that can increase customer loyalty and satisfaction. Brand protection is further enhanced through the reverse supply chain. Thereby OEMs can make sure that no third party recovered products cause customer dissatisfaction.

Sourcing value includes generating financial benefits through a spare parts business as an extension of the forward supply chain and save money by hedging against fluctuating commodity prices. Internally cost reductions are achieved through less resource consumption. Given upcoming emission trading schemes, brand owners could make business by trading carbon credits. Controlling the recycle process in the reverse supply chain, competitors can be prevented from recycling corporate products which would incur costly damage of corporate business. Internally costly fines through environmental legislation is avoided. Further damage to corporate business through the acquisition of corporate technology by reverse engineering can be prevented.

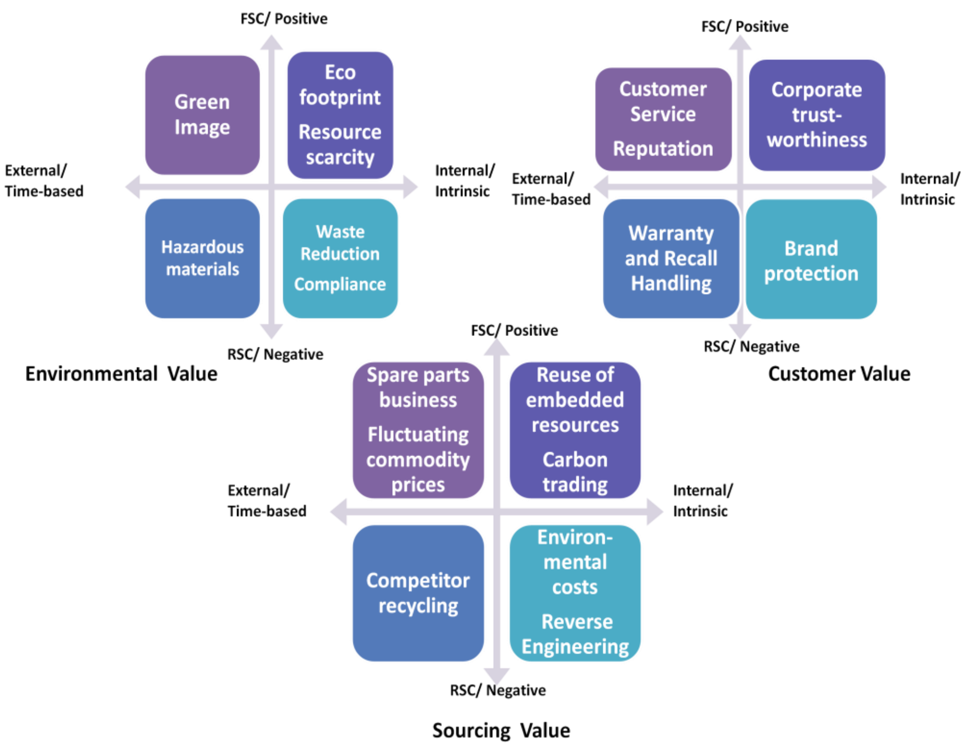


Figure 3. Value matrices

3.2.2 Synergy effects in value creation

Comparable to the balanced scorecard model (Kaplan and Norton (2001)) we use four perspectives, the four identified values, to identify a cause and effect chain of interlinking effects between the four types of values (Figure 4). These effects create win-win situations and pursue two types of strategies, a risk reducing or new value creation. Setting up a CLSC a brand owner can reduce risk by complying with existing laws and regulations. Moreover it is possible to control the products and thereby resources that might prevent potential risk due to hazardous or bad quality material. Controlling products and materials system leaks such as harmful product components or third party recycled products which would generate costs and brand damage can be prevented. To this end, sourcing, environmental and customer value can be maintained. On the other hand, CLSC create business value. In section 2 the substitution effect was already explained generating financial and environmental value. A synergy situation is also achieved between environmental value and customer value, given the fact that controlling product returns and production processes in the CLSC brand owners assume product and process stewardship. Based on the extensions of the product life cycle and the recovery of products and components more business opportunities and models can be pursued. Indeed OEMs can create significant business value by offering more service contracts (service logic) to the customers or invest in green business models for the own brand as well as the customer. In that respect brand owners create new tangible (i.e. economic) and intangible (i.e. image or customer satisfaction) value.

Information value, however, should be considered as a reinforcing, driving value for the three types of values. We previously referred to an organization's capability of learning to make use of the available information in the CLSC. The organizational learning process in the CLSC can be twofold: Firstly brand owners can learn through failure, whereas secondly learning is enhanced through innovation. While learning through failure pursues risk reduction, learning through product innovation rather represents value creation. System and product intervention through organizational learning can consequently reinforce and drive the value creation process. In section 2 we gave examples such as design for the environment or uncertainty reduction.

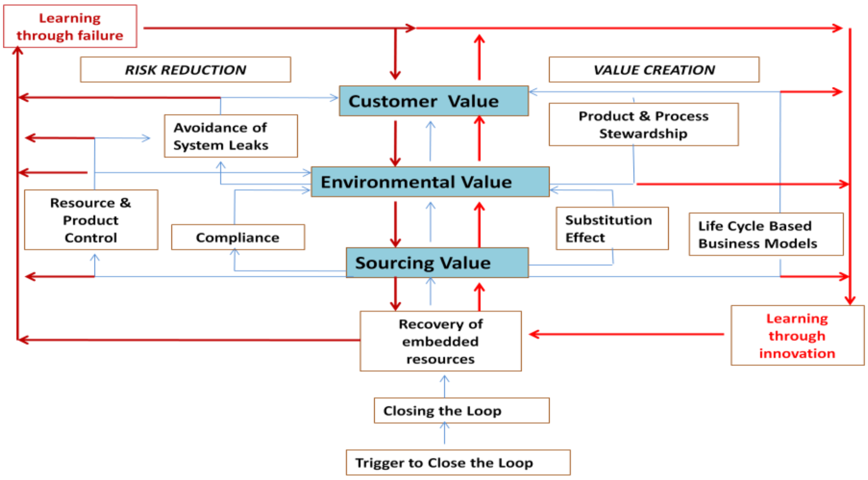


Figure 4. Synergy effects for value creation

3.3 Research design

Based on the presented literature and theoretical models, a series of representative case studies as exemplars in the move towards value creation in CLSCs need to be identified (Swanborn, 2010, p. 52). We choose for the broad field of electronic products as we assume that the recovery of these products is most probable through the embedded financial value and legislation applying to electronic products (e.g. WEEE). Cases are selected according to fixed and variable criteria. Fixed criteria for comparison are the extended life cycle, regulations on the extended producer responsibility (EPR) and service logic. Variable criteria for case selection are based on a product market combination matrix (see Figure 5). De Brito (2003) argues that there are different qualities in the return management of business to business (B2B) and business to customer (B2C) returns. This is due to the fact that B2B aligns with more service business than the B2C sector. Guide and Van Wassenhove (2003) show differences between consumer electronics and industrial electronics recovery in terms of customer education, supplier relationships and uncertainty in return management. Value creation thus differs depending on a B2B and B2C approach. Another factor influencing the value creation process are the characteristics of the product. In the product-process matrix designed by Hayes and Wheelwright (1979) four types of products are identified along the product life cycle: 1) Low volume, low standardization, one of a kind 2) Multiple products, low volume 3) Few major products, higher volume and 4) high volume, high standardization, commodity products. We extend these indicators by the product life time and capital value as these factors might influence the product recovery.

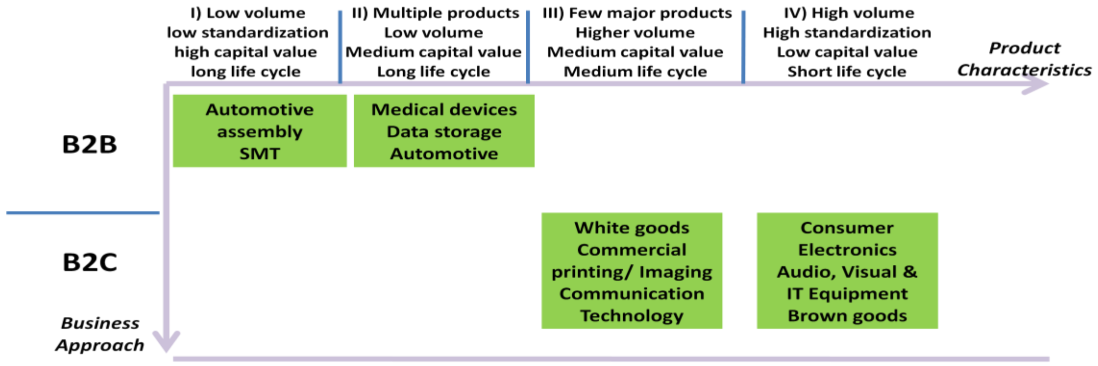


Figure 5: Matrix of electrical products

In the indicated boxes we can identify typical and representative cases based on the combination of a B2B and B2C approach and the product life cycle characteristics. Industries or brand owners which can be located in other fields of the matrix, vary in their strategic approach. Hence we will not consider them as representative cases. We plan to conduct at least ten case studies in total of CLSCs of different products. Interviews will be conducted with (reverse) supply chain managers, financial,- and sustainability managers. Transcripts and drafts will be reviewed by key informants (Gibbert, Ruigrok, & Wicki, 2008). Triangulation in data collection will be achieved by content analysis of corporate documents and interviews with observants. To ensure inter-rater reliability the data analysis will be evaluated with experts working partly for academia and in the field (Jonker & Pennink, 2010).

Further triangulation will be implemented in the data analysis (Denzin, 1978). Firstly, interview transcripts and field notes will be coded via the use of constant comparison and pattern matching (Yin, 1994). Secondly, in line with the balanced scorecard we identified special key performance indexes (KPIs) to measure the four types in CLSCs. KPIs were developed through an operationalization of key concepts and literature on customer, environmental and sourcing value (as indicated in the literature review). KPIs will only be available to the researchers, respondents will only gain access to the final result of this performance evaluation. Thirdly, synergy effects and reinforcing loops as demonstrated in Figure 4 will be researched using a system dynamics approach. System dynamics (SD) is an established method for analyzing dynamic, complex, and ill-structured problems (Sterman, 2000). It enables studying non linear interrelations and various feedback loops for the creation of synergy effects in CLSC.

4. Conclusion

In this paper literature on CLSC management and reverse logistics with regards to the four types of values identified by Koppius et al. (2010), is reviewed. Based on that we propose a value framework which should be studied in an explorative qualitative research study. In this respect this research aims at learning on how to transfer CLSC from a cost of doing business into a value creator. Existing trends in service level agreements, internet business, but also resource scarcity and environmental legislation (e.g. WEEE, RoHs, REACH) increasingly force manufacturers to take back their products. Hence research on the strategic value of the extended supply chain become even more important. Research results from the empirical study of electronic product will identify value creating practices, synergies in value creation and constraints to value creation in CLSCs. Based on that the performance of a CLSC can be reviewed and strategies for value creation in the CLSC can be deducted. .

5. References

Argyris, C. & Schön, D. 1978. *Organisational learning: A theory of action perspective*. Reading, MA: Addison Wesley.

Ayres, R., Ferrer, G., & Van Leynseele, T. (1997). Eco-efficiency, asset recovery and remanufacturing. *European Management Journal, 15(5), 557-574.*

Blackburn, J. D., Guide, V. D. R., Souza, G. C., & Wassenhove, L. N. V. (2004). Reverse Supply Chains for Commercial Returns, *California Management Review, 46*(2), 6-23.

Bogue, R. (2007). Design for Disassembly: a critical twenty-first century discipline. *Assembly Automation, 27 (4), 285 - 289.*

Bowman C, Ambrosini V. 2000. Value creation versus value capture: towards a coherent definition of value in. strategy. *Brillsh Journal of Management (l l), 1 - 1 5 .*

Chang, N.-jen, & Fong, C.-min. (2010). Green product quality , green corporate image , green customer satisfaction , and green customer loyalty, *African Jounral of Business Management, 4*(13), 2836-2844.

Christopher, M. & Ryals, L. (1999). Supply Chain Strategy. Its Impact on Shareholder Value. *The International Journal of Logistics Management*, *10 (1),1 - 10.*

Coltman, T., Devinney, T. M., & Richard, P. J. (n.d.). Aligning firm capabilities with customer needs: Unpacking dynamic managerial capabilities. *institute for Innovation in Business and Social Research.*

De Brito, M.P. , Dekker, R. & Flapper, S.D.P. (2003). Reverse Logistics- a review of case studies. ERIM Report Series Research in Management, Erasmus University

Denzin, N.K. & Lincoln, Y.S. (1994). *Handbook of Qualitative Research.* Sage: Thousand Oaks, CA.

Dowlatshahi, S. (2010). A cost-benefit analysis of for the design and implementation of reverse logistics systems: case study approach. *International Journal of Production Research, 48 (5), 1361-1380.*

EU- European Union (2011). Recast of the WEEE Directive.
http://ec.europa.eu/environment/waste/weee/index_en.htm , Last access: 22.11.2011.

Fleischmann, M., van Nunen, J.A. E.E. & Graeve, B. (2003). Integrating Closed Loop Supply Chains and Spare-Parts Management at IBM*. Interface, 33 (6),* 44-56.

Gibbert, M., Ruigrok, W., & Wicki, B. (2008). What passes a rigorous case study?, *Strategic Management Journal, 29, 1465-1474.*

Gino, F. & Pisano, G.P. (2011). Why Leaders don't learn from success? Failures get a postmortem, why not triumphs. *Havard Business Review, April 2011.*

Gooley T.B. (2002). The who, what and where of reverse logistics. *Logistics Management;42(2):38–44.*

Griffis, S. E., Rao, S., Goldsby, T. J., & Niranjan, T. T. (2012). The customer consequences of returns in online retailing: An empirical analysis. *Journal of Operations Management, 30(4), 282-294.*

Guide, V.D.R Jr. & Van Wassenhove, L.N. (2000). Managing Product Returns from Remanufacturing. *INSEAD Working Paper*

Guide, V. D. R., & Van Wassenhove, L. N. (2009). The Evolution of Closed-Loop Supply Chain Research. *Operations Research*, *57(1), 10-18.*

Guide, V. Daniel R., Muyldermans, L., & Van Wassenhove, L. N. (2005). Hewlett-Packard Company Unlocks the Value Potential from Time-Sensitive Returns. *Interfaces*, *35(4), 281-293.*

Hayes, R. H. and S. C. Wheelwright (1979). Link Manufacturing Process and Product Life Cycles, *Harvard Business Review, January-February, 133-140.*

Hu, S.J. , Ko. J. , Weyand, L. et al. (2011). Assembly system design and operations for product variety. *CIRP Annals, Manufacturing Technology, 60, 715-733.*

Jayaraman, V., & Luo, Y. (2003). Creating Competitive Advantages Through New Value Creation: A Reverse Logistics Perspective. *Academy of Management Review, May 2003, 56-74.*

Jonker, J. & Pennink, B. (2010). *The essence of research methodology- A concise guide for master and PhD students in management research.* Springer Verlag.

Kaplan, R.S. & Norton, D.P. (2001). *The Strategy Focused Organization- How Balanced Scorecard Companies Thrive in the New Business Environment.* Harvard Business School Publishing.

Kassinis, G. I., & Soteriou, A. C. (2009). Greening the Service Profit Chain: the Impact of Environmental Management Practices. *Production and Operations Management*, *12(3), 386-403.*

Kleindorfer, P., Singhal, K. & Van Wassenhove, L. (2005). Sustainable Operations Management. *Product and Operations Management,* 14 (4), 482-492.

Koppius, O., Ozdemir, O., & Laan, E. V. D. (2010). Beyond Waste Reduction : Creating Value with Information Systems in Closed-Loop Supply Chains. *ERIM Report Series*.

Krikke, H.R. , Van Harten, A. & Schuur, P.C. (1999). Business case Océ: Reverse Logistic Network Re-Design for Copiers. *OR Spectrum, 21, 381-409.*

Krikke, H. R., Blanc, H. M., & Velde, S. V. D. (2003). Creating value from returns: The impact of product life cycle management. *Center of Applied Research, Working paper, no. 02-2003.*

Krikke, H.R. , Van Nunen, J.A.E.E. , Zuidwijk, R.A. & Kulk, R. (2004). E-business and circular supply chains: increased business opportunities by IT-based customer orientated return-flow management. *Center of Applied Research Series.*

Krikke, H. (2009). Opposites attract: a happy marriage of forward and reverse supply chain. *Inaugural speech at the Open University*

Krikke, H. (2011). Impact of Closed-Loop Network configurations on carbon footprints: A case study in copiers. *Resources, Conversation and Recycling, 55, 1196-1205.*

Kumar, S. & Malegeant, P. (2006). Strategic alliance in a closed loop supply chain, case of a manufacturer and an eco non-profit organization. *Technovation, 26, 1127-1135.*

Le Blanc, H.M. (2006). *Closing loops in supply chain management. Designing Reverse Supply Chains for End-of-Life Vehicles.* PhD Thesis- Center of Applied Research.

Martel, A. (2009). The Design of Robust Value- Creating Supply Chain Networks: A Critical Review. *CIRRELT 2009-34.*

Maslennnikova, I. & Foley, D. (2000). Xerox's Approach to Sustainability. *Interfaces, 30, 226-233.*

Mollenkopf, D. a., Frankel, R., & Russo, I. (2011). Creating value through returns management: Exploring the marketing–operations interface. *Journal of Operations Management*, *29(5), 391-403.*

Piercy, N. F., & Lane, N. (2009). Corporate social responsibility: impacts on strategic marketing and customer value. *The Marketing Review, 9(4), 335-360.*

Porter, M. E. (1996). What is Strategy ? *Harvard Business Review, November-December 1996, 62-78.*

Reimann, M., Schilke, O., & Thomas, J. S. (2009). Customer relationship management and firm performance: the mediating role of business strategy. *Journal of the Academy of Marketing Science, 38(3), 326-346.*

Rogers, D.S. & Tibben-Lemke, R. (2001). An examination of reverse logistics practices. *Journal of Business Logistics, 22 (2), 129-148.*

Sinkula, J. M., Baker, W. E., & Noordewier, T. (1997). A Framework for Market-Based Organizational Learning: Linking Values, Knowledge, and Behavior. *Journal of the Academy of Marketing Science, 25(4), 305-318.*

Spekman, R. E., Spear, J., & Kamauff, J. (2002). Supply chain competency: learning as a key component. *Supply Chain Management: An International Journal, 7(1), 41-55.*

Sterman, J.D. (2000). *Business dynamics: System Thinking and Modeling for a Complex World.* Irwin/McGraw Hill.

Swanborn, P. G. (2010). *Case Study Research- What, why and how?* SAGE Publications.

Thierry, M. , Salomon, M. , Van Nunen, J. & Van Wassenhove, L. (1995). Strategic Issues in Product Recovery Management. *California Management Review, 37 (2), 114-135.*

Van Aken, J. E. (1994). De bedrijfskunde als ontwerpwetenschap. *Bedrijfskune, 66 (1), 16-24.*

Yin, R.K. (1994). *Case Study Research.: Design and Methods. Sage:* London, UK.

An Innovative Design for Warehouses Considering a Different Material Flow Pattern

Ömer Öztürkoğlu[22]

Abstract

In this study, we propose a new aisle design for warehouses in which material flows through two different input and output (I/O) points located at the opposite sides of the warehouse. We basically construct a network of storage and I/O locations that represent this warehouse as a graph. We then evaluate the new aisle design for randomized and class-based storage policies with single-command operation. We also do experiments to estimate the performance of the proposed design under dual-command operation. We compare the expected travel distance to pick an item in the proposed design to that in a traditional design under several warehouse design and operating assumptions.

Keywords: Unit-load Warehousing, Distribution Center, Aisle Design, Input and Output Points, Material Flows

1. Introduction

In today`s competitive economic environment, customers have more choice but require less time than before to meet their needs or demand. This, of course, forces companies to find a way to response customers` demand quickly and efficiently in order to stay alive in the market. Constructing and managing a successful logistics systems and supply chain network is one of the essential part of providing cost efficient service and quick response to customers. Warehouses or distribution centers, hence, become very important player in a supply chain network and global logistics systems to provide high level of customer service.

Warehouses or distribution centers are places to store items until we receive an order from customers, and to transfer goods from suppliers to customers efficiently. Unit-load warehousing is a common type of warehousing activity in especially import warehouses, 3rd party transshipment warehouses and retail distribution centers in which unit loads, usually pallets, are carried at a time. It is also common to see unit-load operations in reserve storage areas in warehouses. The operations consisting of picking and storing pallets are the biggest cost components in warehouse operations cost (Tompkins, 2003). Additionally, as warehouses get larger, the labor cost associated with storing and picking operations gets higher because of increasing travel distances.

In traditional warehouse designs (Figure 1), storage racks are arranged parallel to each other. If there is any cross aisle, they are arranged with a right angle to picking aisles (Gue and Meller, 2009). Hence, the travel path is always rectilinear in traditional warehouses; travel along vertical picking aisles, then along horizontal cross aisles, or vice versa. To reduce the travel distance in warehouses, White (1972) proposed the idea of inserting radial aisles into warehouses. Gue and Meller (2009) took his idea further and proposed two different warehouse designs, Flying-V and Fishbone (Figure 2), for unit-load operations and compared them with traditional warehouse designs. They showed that Flying-V and Fishbone designs present 10% to 20% reductions in expected single-command travel distance regarding the size of the

[22] Yasar University, Turkey, +90 2324115349, omer.ozturkoglu@yasar.edu.tr

warehouse with randomized storage and a centrally located input and output (I/0) point. The reason of this improvement is that the travel path gets close to Euclidean travel, the shortest distance between two locations, in these designs, as it is rectilinear travel in traditional warehouses.

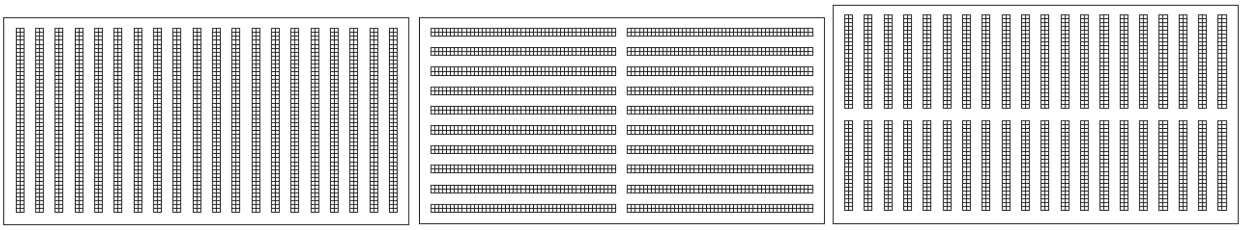
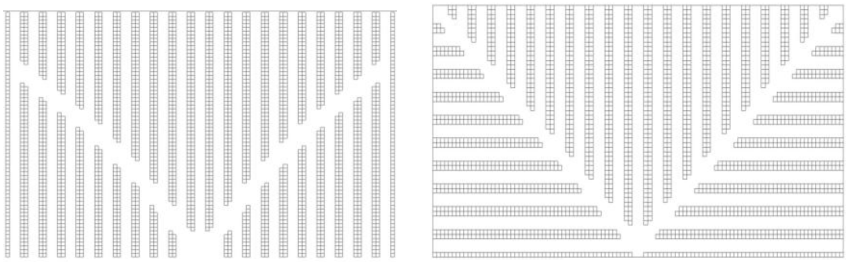


Figure 1. Traditional warehouse designs. Trad-A, Trad-B and Trad-C designs from the left to the right.



a) Flying-V b) Fishbone

Figure 2. Flying-V and Fishbone designs.

Pohl et al. (2009b) analyzed dual-command expected travel distance in the Fishbone design, and showed that it still offers improvement in expected travel distance over traditional designs. Pohl et al. (2009b) also proposed a modified Fishbone design for warehouses operated under dual-command operation. Pohl et al. (2009a) showed that the optimal arrangement of the middle horizontal cross aisle in traditional warehouses is slightly beyond the middle for dual-command operations. They also showed that Trad-B almost always outperforms Trad-A and Trad-C for dual-command operations. Pohl et al. (2010) investigated single- and dual-command operations in Flying-V, Fishbone and traditional warehouse designs under turnover-based storage policy. They showed that the Fishbone presents reduction in expected single-command travel distance under turnover-based storage, but the reduction is more under the randomized storage.

Öztürkoğlu et. Al. (2012) extended Gue and Meller (2009)`s idea and presented three optimal unit-load warehouse designs, Chevron, Leaf and Buttferfly, under single-command operation and randomized storage policy when there is a centrally located I/O point. They presented that, for example, the Chevron design offers about 17% reduction in the expected travel distance, but requires about 7% larger space, due to inserted cross aisle and angled aisles, compared to the Trad-A. They also showed that the relative improvement in travel distance decreases as the number of inserted cross aisle increases because of the loss space. Up to now, these studies only focused on warehouse designs with single I/0 point. Gue et al. (2012) considered Flying-V design for multiple I/0 points located at the bottom side of the warehouse, and showed that the improvement gets bigger as long as I/0 points are concentrated towards the center of the warehouse. Öztürkoğlu (2011), in his dissertation, also studied aisle design problem with multiple I/0 points considering several different flows. One of the most likely seen flows in industry has one I/0 point at the south (bottom) and one at the north (top) side of the warehouse (Figure 3). Öztürkoğlu (2011) proposed a design, Design C2, for this I/0 configuration (Figure 3), and showed that the Design C2 offers about 10% improvement in expected single-command travel distance under randomized storage if each I/0 point is equally utilized, but requires about 12% larger space.

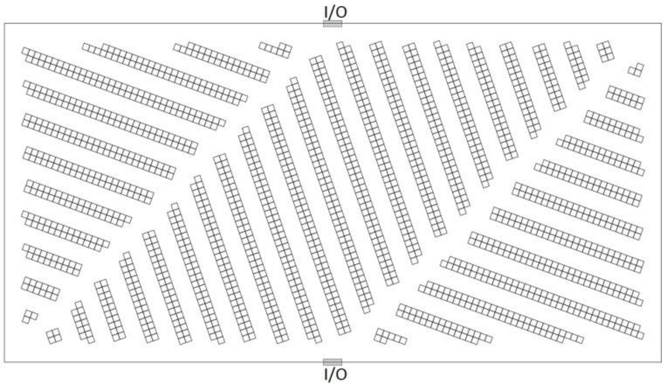


Figure 3. Design C2.

In this study, we also consider the I/0 configuration in Design C2 because of its popularity in industry. We propose a modified design of Design C2 to reduce the requirement of additional space. We then analyze the proposed design for single-command operation under randomized and class-based storage policies. Last, we investigate the performance of dual-command operation in the proposed design under randomized storage.

2. Assumptions and Model

In our proposed design, we modify the angles of picking aisles in Design C2 in order to increase the storage density and decrease the relative effect of enlarging space on expected travel distance. Hence, the angles of picking aisles in the proposed design are 180, 90 and 180 degrees from the rightmost region to the leftmost region in the warehouse (Figure 4). The cross aisles are oriented through the diagonals in a square half-warehouse. Hence, the half of the proposed design looks like Fishbone.

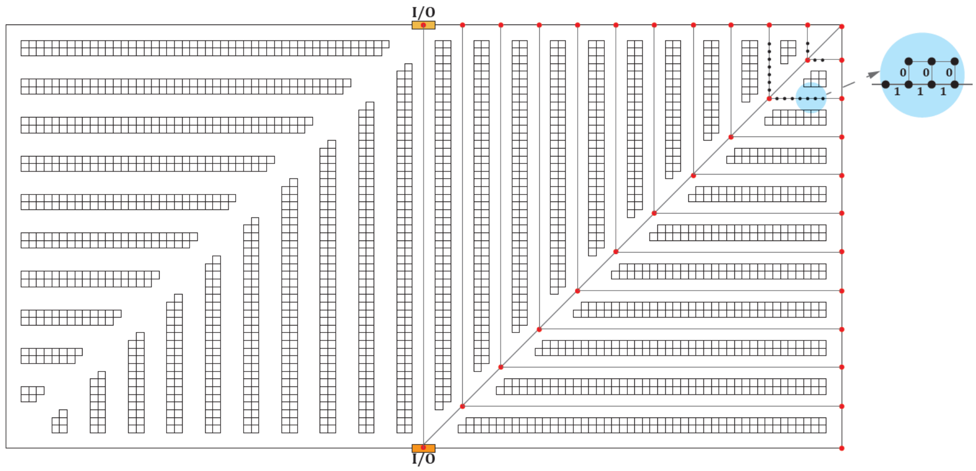


Figure 4. The modified Design-C2 and partial representation of the network of I/0 points, pallet locations and aisle intersections.

The main storage policies used to allocate pallets to the storage locations are randomized, dedicated and class-based. Randomized storage provides higher utilization in warehouses, and is the most popular policy in industry because of ease of use (Petersen, 1999). In dedicated storage, pallet locations are reserved for specific products according to their popularity. The advantage of this policy is to provide reduced searching time of locations and reduced distance to get most active products. Hence, on average, storage utilization is about 50% in this policy (Bartholdi and Hackman, 2008). Class-based storage is a mixed policy of randomized and dedicated. Products are divided into classes according to their turnover or share in the gross income, and each class consists of some set of dedicated pallet locations. In these classes, pallets are stored randomly. Because, storage utilization is important in the new aisle designs due to loss space, in this study, we focus on randomized and class-based storage. In randomized storage, the probabality of visiting any pallet location for picking or storing a pallet is the same. In class-based storage, we use the class and demand rates based on Weber (2002)`s discussion: 20% of the products have the 75% of the demand, and they are assigned to class A; 30% of the products have the 20% of the demand, and they are assigned to the class B; the rest 50% of the products with a 5% demand are in the class C. In order to assign locations to classes, we first calculate the total distance from each I/0 point to the each pallet location. For example, let d_i is the sum of the distance from the bottom I/0 point to the location i and the distance from the top I/0 point to the location i. This distance is used as a surrogate for the cost of a pallet location in terms of the closeness to the input and output points. Then, we rank locations on d_i from the least distance to the greatest distance. This method is called distance-based slotting. Francis et al. (1992) showed that distance-based slotting minimizes the expected single-command travel distance. Hence, using the class rates, we assign the most convenient locations to class A, then class B and the rest to class C. Additionally, to the best of our knowledge, the optimal strategy for the dual-command operation is still not known. Therefore, in our study, we only analyze expected dual-command travel distance under randomized storage.

We place two I/0 points at the center of the bottom and top sides of the warehouse. These I/0 points might the locations where workers get a pick list or where the stretch wrap machine is installed. We assume that they are also used for both receiving and shipping activities. We also assume that the half of the warehouse is square because Gue and Meller (2009) showed that the reductions in expected travel distance is maximum in this shape ratio.

Single- and dual-command operations are very common in unit-load warehousing. In single-command operation, only one pallet is carried in a trip. Hence, worker travel empty while a worker is either going for picking or coming back from storing activities. In order to reduce empty travel in single-command operation, some warehouses perform dual-command operation in which a worker first stores a pallet, then goes to another location to pick a pallet before he goes back to the I/0 point. If these two locations are arranged closely each other, then the empty travel distance, as well as the expected travel distance can be reduced. In our model, I/0 points are equally used for single-command operations. However, for dual-command operations, workers are directed to the closest I/0 point to their location assuming the warehouse is operated by an efficient warehouse management system.

Öztürkoğlu (2011) showed that the returning I/0 point does not affect the expected travel distance in single-coomand operation as long as I/0 points have the same probability to be chosen. Hence, as Öztürkoğlu (2011) noted that the expected single-command travel distance (E[SC-R]) under randomized storage with k I/0 points, n number of storage locations and the shortest distance between ith I/0 point jth storage location (d_{ij}) is

$$E[SC-R] = \frac{1}{kn}\sum_{i=1}^{k}\sum_{j=1}^{n} d_{ij} \, . \tag{1}$$

In our model, the expected single-command travel distance under class-based storage policy is

$$E[SC-ABC] = \frac{1}{k}\sum_{r=1}^{k}\left(\frac{\sum_{i=1}^{n_A} p_A d_{ir}}{n_A} + \frac{\sum_{j=1}^{n_B} p_B d_{jr}}{n_B} + \frac{\sum_{m=1}^{n_C} p_C d_{mr}}{n_C} \right). \tag{2}$$

n_A, n_B, n_C : total number of pallet locations in classes A, B and C, respectively.

p_A, p_B, p_C : the demand rates of pallet locations in classes A, B and C, respectively.

d_{ir}, d_{jr}, d_{mr} : the shortest travel distance between the rth I/0 point and the ith pallet location in class A, jth pallet location in class B, and mth pallet location in class C, respectively.

The dual-command expected travel distance (E[DC-R]) under randomized storage is

$$E[DC-R]=\sum_{i=1}^{n}\sum_{j=1}^{n}\min\{d_{1i},d_{2i},\ldots,d_{ki}\}+d_{ij}+\min\{d_{1j},d_{2j},\ldots,d_{kj}\}. \quad (3)$$

d_{ki}, d_{kj} : the shortest distance between kth I/0 point and ith, kth I/0 point and jth pallet locations, respectively.

d_{ij} : the shortest distance between ith and jth pallet locations (travel between distance).

In our model, the shortest distance between two locations is calculated using Dijkstra`s algorithm. The worst case running time for this algorithm is O(n^2) (Schrijver,2005). In calculating E[DC-R], we assume that a warehouse management system can assign the first pallet location to a worker located at the I/0 point closest to this location. Then, the returning I/0 point is the closest I/0 point to the second pallet location where a worker picks a pallet.

In order to investigate the loss space and calculate the shortest distance between locations, we build a discrete model of pallet locations and aisles for the proposed warehouse design. Therefore, we construct a network consisting of I/0 points, access points to pallet locations on the picking aisles and intersections of picking and cross aisles as nodes. These nodes are connected by appropriate edges with a non-negative length that is the distance between two connected nodes. The edge length for two consecutive pallet locations in the same rack is one pallet (unit) length. The edge length between access points that serve the opposite pallet locations in the same aisle is zero because we assume that these locations are served from the same point on the aisle. We also assume that the width of aisles are three pallets, pallet locations are square due to ease of representation. For representation, picking aisles with solid lines, access nodes to several storage locations and intersections with dots on the right half of the warehouse are depicted in Figure 4.

3. Results

In order to compare the single-command performance of the modified Design C2, we choose Trad-A as a base because it is the most compact and the efficient traditional design for single-command operations. The reason of this is that inserting an orthogonal cross aisle in a traditional design does not offer any improvement in single-command travel from I/0 points due to rectilinear travel (Roodbergen and de Koster, 2001.) In our analyze, we consider different warehouse sizes that are very common to see in industry. These are 19-, 21-, 23-, 25- and 27-aisle width warehouses. In order to provide the same number of pallet locations to the Trad-A, we expand the size of the modified Design C2 without changing its shape ratio (square half.) Because of the loss space in discrete aisle design due to angled cross aisles, the modified Design C2 requires approximately 10% larger space than the Trad-A in average. The size of the warehouses for both Trad-A and the modified Design C2 are shown in Table 1.

When we apply randomized storage policy to the both designs, the modified Design C2 offers almost 5.5% reductions in expected travel distance in average. When SKUs, or implicitly pallet locations, are assigned to classes as discussed before, the reduction in the expected single-command travel distance diminishes to 2%. Table 1 shows the detailed results. The improvement decreases in the class-based storage compared to that in than in the randomized storage because the furthest locations to the I/O points, where the travel path is very efficient in the Design C2, have a low demand rate. For example, in a 23-aisle width warehouse, the expected travel distances in classes A, B and C in the modified Design C2 are 357.9, 479.1, and 702.0, respectively. These are in the Trad-A 358.4, 511.3, and 750.1, respectively. The improvement in class A, where the demand to the locations in this class is the highest, is very slight. Even though the modified Design C2 offers reductions in classes B and C compared to the them in the Trad-A, their relative effect in the overall expected travel distance is slight because of the lower demand rates in these classes. Pohl et al. (2011) also showed very similar results that the improvement the non-traditional aisle designs offer under randomized storage is higher than in the turnover-based storage. In both randomized and class-based storage policies, as the warehouse size increases the improvement in the expected travel increases (see Figure 5.)

Table 1. The performances of the modified Design C2 and Trad-A are under randomized and class-based storage policies, and single-command operation when I/0 points are located both at the bottom and at the top of the warehouse.

	The modified Design C2					Trad-A			
# aisles	**Width - Height**	**# pallet locations**	**E[SC-R]**	**E[SC-ABC]**		**Width - Height**	**# pallet locations**	**E[SC-R]**	**E[SC-ABC]**
19	106 - 53	1872	475.9	336.2		100 - 50	1880	500.0	341.3
21	116 - 58	2280	521.0	367.7		110 - 55	2288	550.0	374.8
23	126 - 63	2727	566.2	399.4		120 - 60	2736	600.0	408.6
25	136 - 68	3214	611.3	431.8		130 - 65	3224	650.0	442.5
27	146 - 73	3742	656.4	464.0		140 - 70	3752	700.0	477.6

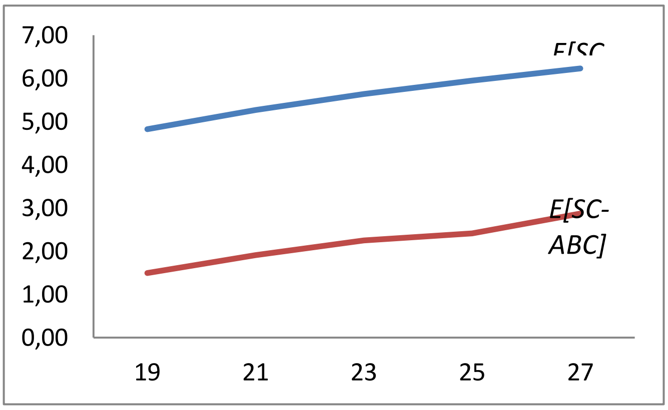


Figure 5. The improvement in the expected travel distances under randomized and class-based storage policies.

As seen in Figure 6, storage locations in each class in the Trad-A are equally distributed around the I/0 points because of the rectilinear distance and the symmetrically located I/0 points. Therefore, classes have rectangular shape. In the modified Design C2, classes have larger areas than they are in the Trad-A because of the loss spaces. They are also close to the rectangular shape, because of the symmetric design. Hence, managing classes in the modified Design C2 might be as easy as that in the Trad-A.

We also investigate the dual-command performance of the modified Design C2. Because evaluating dual-command expected travel distance for all pair of storage locations is computationally very expensive process, in this study we generate 10,000 random orders, in which there are one storing and one picking locations, and estimate the expected travel distance for this batch. In order to reduce the standard deviation, we also conduct 10 different experiments. Here, we take Trad-B as a base because it is as compact as the Trad-A, and it outperforms the Trad-A for dual-command operations (Pohl et al., 2009a.) In these experiments, we use the same seed numbers to generate random orders both for the modified Design C2 and Trad-B. Table 2 shows the average E[DC-R] of the ten experiments and the improvement in E[DC-R] that the modified design C2 offers over the Trad-A. Because the modified design C2 is specifically designed for single-command operation, it seems not to perform well for travel between distances between storage locations. However, because the two third of the E[DC-R] is single-command travel to and from I/0 points, this seems to compensate the loss in the travel-between distance.

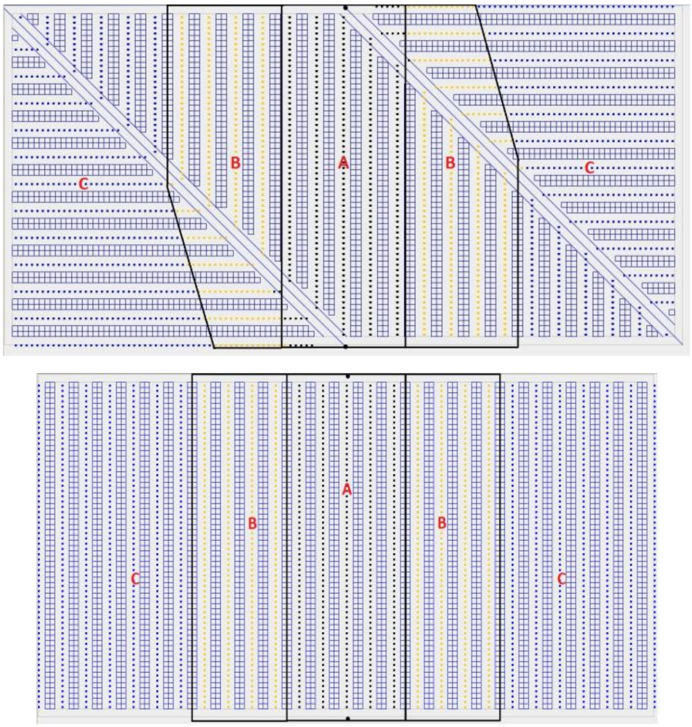


Figure 6. The representation of classes when class-based storage is applied under single-command operation for example modified Design C2 and Trad-A with centrally located I/0 points at the bottom and the top sides of the warehouse.

Table 2. The averages E[DC-R] of the modified Design C2 and Trad-B that are obtained in ten experiments.

The modified Design C2	Trad-A	Improvement (%)
1336.0	1326.9	-0.7
1460.5	1463.6	0.2
1590.7	1596.2	0.3
1715.5	1726.9	0.7
1842.2	1862.6	1.1

4. Conclusion

In this study we modify one of the designs, Design C2, Öztürkoğlu (2011) presented for unit-load warehouses in which materials flow through the midlle points of the northern and southern sides of the warehouse. Hence, receiving and shipping activities can be performed from both opposide sides of the warehouse. We call this proposed design "the modified Design C2", and this is more compact design than the Design C2 because of straightened horizontal and vertical picking aisles. We calculate the expected single-command travel distance to pick an item in the proposed design under randomized and class-based storage policies. We showed that the modified Design C2 presents about 5.5% improvement over the traditional design without any cross aisle under randomized storage. However, when the most demanded SKUs are assigned to most convenient locations according to the class-based storage, the improvement decreases to about 2%. Additionally, we showed that the improvement increases as the size of the warehouse increases. We also did experiments to estimate the dual-command expected travel distance under randomized storage. As shown that the modified Design C2 does not offer any advantage for dual-command operations over a traditional design with a vertical cross aisle when the loss space by angled cross aisles is taken into account. Therefore, we can also say that the modified Design C2 may not provide improvements in warehouses operated under multi-command operations due to low performance in travel between distance. Therefore, all these results present that new designs need to be investigated for both dual-command and multi-command operations. In future studies, other storage policies might be considered in the new aisle designs as well.

5. References

Bartholdi, J. and Hackman, S. 2008. Warehouse Distribution Science. *Georgia Tech*. Version 0.87.

Francis, R.L., McGinnis, Jr., L.F., White, J.A. 1992. Facility layout and location: an analytical approach, second edition. Prentice-*Hall*, Englewood Cliffs, NJ.

Gue, K., Meller, R. 2009. Aisle congurations for unit-load warehouses, *IIE Transactions*, 41(3), 171 - 182.

Gue, K., Ivanovic, G., Meller, R. 2012. A unit-load warehouse with multiple pickup and deposit points and non-traditional aisles, Transportation *Research Part E: Logistics and Transportation Review*, 48(4), 795-806.

Mallette, A., Francis, R. 1972. Generalized assignment approach to optimal facility layout, *AIIE Transactions*, 4(2), 144–147.

Öztürkoğlu, Ö., Gue, K., Meller, R. 2012. Optimal unit-load warehouse designs for single-command operations, *IIE Transactions*, 44(6), 459-475.

Öztürkoğlu, Ö. 2011. New Warehouse Designs: Angled Aisles and Their Effects on Travel Distance, *Ph.D. Dissertation*, Auburn University, Auburn, AL, USA.

Petersen, C. 1999. The impact of routing and storage policies on warehouse efficiency, *International Journal of Operations and Production Management*, 19(10), 1053-1064.

Pohl, L., Meller, R., Gue, K. 2009a. An analysis of dual-command operations in common warehouse designs, *Transportation Research Part E: Logistics and Transportation Review*, 45(3), 367–379.

Pohl, L., Meller, R. ve Gue, K. 2009b. Optimizing fishbone aisles for dual-command operations in a warehouse. *Naval Research Logistics*, 56(5), 389- 403.

Pohl, L., Meller, R., Gue, K. 2011. Turnover-based storage in non-traditional unit-load warehouse designs, *IIE Transactions*, 43(10), 703–720.

Roodbergen, K. J., de Koster, R. 2001. Routing order pickers in a warehouse with a middle aisle, *European Journal of Operational Research*, 133(1), 32-43.

Schrijver, A. (2005). On the History of Combinatorial Optimization (Till 1960), in “*Handbook of Discrete Optimization” (* Aardal, K., Nemhauser, G., and Weismantel, R., editors), Elsevier, Amsterdam, 1 – 68, 2005.

Tompkins, J., White, J., Bozer, Y., Frazelle, E., Tanchoco, J. 2003. Facilities Planning, *John Wiley & Sons*, NJ.

Weber, H. 2002. Supply Chain Management: Grundlagen, Strategien, Instrumente und Controlling. *Gabler Verlag*, 2008.

Sustainability Green Logistics by Process Management: A Case Study at DB Schenker Arkas

Onur Özveri[23], Senem Kılıç[24]

Abstract

DB Schenker Arkas created process measurement system and process maps under the concept of the Eco Program and determined all performance criterias. DB Schenker Arkas Performance criterias are all converted to the observations and those crtitical key points monitored by the support of advanced software programs. Step by step all main products; land traffic, sea transport, air cargo, Logistics etc. Success measured and monitored by advanced monitoring tools and kept in software programs. This makes easier to monitor and to take action if there is anything going on negative. Each product has its own performance criteria that shows current, past and future estimated statutes by the help of reports taken from software programs. For example In Land Traffic product each transportation km details kept in software programs and also reported, then all alternative and fuel saving eco root plan built up according to the monitoring values. Also consumption details like electricity consumption, reduction of wastes arising from the operation, alternative environmentally friendly transport modes, using alternative and recyled energy, use frequency etc. can be monitored by advanced software programs and are all in DB Schenker Arkas global sustainability green Logistics plan.

Keywords: Sustainability Green Logistics, process measurement

1.Introduction

There are a lot of factors to evaluate the performance of the supply chains such as customer service, quality, lead time, cost etc. But due to the environmental requirements (social responsibilities, Kyoto Protocol, government agencies etc.) an increasing attention has to be given to develop environmental strategies (Angheluta, Costea, 2011, 84). Logistics is one of the most dynamic scientific disciplines. It can be defined as the management of moving goods, people, information and other resources between the point of origin and the point of consumption. Fast technological development, rapidly growing goods consumption and new transport concepts lead to new environmental consciousness, with the aim of obtcdning and securing balanced global development. It is obvious that green Logistics play an important part in new Logistics approaches on a macro level in national economies and, on the other hand, on a micro level in production companies (Beskovnik, Twrdy, 2012, 25). Green Logistics is the management activities to pursue customer satisfaction and social development goals, connecting the main body of green supply and demand, overcoming space and time obstacles to achieve efficient and rapid movement of goods and services. Environmental impact of business activities has become an important issue in recent years due to growing public awareness of environmental conservation, increasing need for

[23] Assoc.Prof. Dr., Dokuz Eylül Üniversty, Faculty of Economics and Administrative Sciences, Department of Business Administration; Head, Quantitative Methods, Turkey, +90 232 4204180, onur.ozveri@deu.edu.tr

[24] DB Schenker Arkas, Business Management Systems and Customer Services Manager, Turkey, +90 232 4558787,
Senem.kilic@schenkerarkas.com.tr

sustainable development, and introduction of environmental legislations and regulations in developed countries. Companies are redesigning their Logistics practices to make the activities more energy efficient and environment friendly. Consequently, green Logistics (GL) have become an important consideration and a big challenge to supply chain management around the globe (Lau, 2011, 873-874) This stimulated different social groupings and organizations emphasise the introduction of 'greening' movement by implementation of emission control standards and their global application. The trend is therefore to switch firom classical Logistics to green Logistics. Green Logistics is a multi-level concept which includes both the green Logistics business activities and social activities for green Logistics management, standardize and control. Green Logistics is the performance of cycle economic in the Logistics industry, which status in the cycle economy can not be replaced and it is an important tool for the development of circular economy. Green Logistics is the Logistics to further enhance its consideration of environmental and resources issues, which is a necessary requirement for sustainable development (Jheng, Jhang, 2010, 116-117). The sensitivity of the states and the customers to the environment has been increasing gradually in a world where global rivalry is seen intensely. Therefore, the Logistics companies are in the position of presenting more environmentalist practices for all their functions. Moreover, in order to stay one step ahead of their rivals and, more importantly, to leave a cleaner world to the future generations, the Logistics companies have started to show sensitivity about the "Green Logistics." In this study, the concept of green Logistics is explained and process based green Logistics implementation model, applied in DB Schenker Arkas, one of the biggest Integrated Logistics Service suppliers in Turkey, is expressed.

2.Green Logistics

The concept of green Logistics hadn't been discussed in social and environmental respects until 1990's. Especially at the beginning of 1990's, in accordance with the environmental arrangements and the demands of the customers, Logistics companies firstly gave importance to the concept of environmentalist supply management. In the past, the Logistics companies would assume their environmentalist responsibilities in such subjects as the redesign of the processes, operations and waste management. But today, Logistics companies have integrated of all the operations conducted with their environmental responsibilities. When the environmental extent is in question for the Logistics companies, the decisions related to choosing the most environmentalist one among different supply chain models containing such subjects as transportation plans, storage points have started to be taken. Here, what is important is, if the Logistics companies can take right decisions regarding the environmental implementations and if they can apply these environmentalist implementations in a sustainable structure (Ubeda, Arcelus, Faulin, 2011: 44). The sensitivity to environmental pollution in Logistics sector has started to increase considerably, just as in the industrial implementations. Especially in European countries, the Logistics sector has also started to be included in the legal regulations regarding the environment. Such global companies as IBM, Hewlett-Packard, Xerox encourage their suppliers and distributors in the matter of green Logistics implementations. (Sheu, Chou, Hu, 2005: 288). Green Logistics is an approach which targets decreasing the usage of the sources and environmental pollution by using advanced Logistics technology planning and transportation, storage, packaging, handling, distribution systems. Green Logistics system is composed of six concepts; green transport, green storage, green supply and discharge systems, green packaging, green distribution and green knowledge management (Zhang, Zhao, 2012: 901). Green Logistics management aims at minimizing the environmental damages thanks to such operations as the decrease of emissions, noise and accidents in all of the Logistics operations (Dekker, Bloemhof, Mallidiss, 2011: 671).

The measurement and control of the emission values in Logistics Networks has been an important matter of subject in terms of presenting respect shown by today's Logistics companies to the environment. The impacts of the Logistics activities to the environmental pollution stay at important levels in terms both of human health and the quality of the ecosystem. Therefore, either the governments or the companies suppress the Logistics companies to be more environmentalist. Due to this reason, the Logistics companies have started to give more importance to green Logistics implementations. Green Logistics management is the approach of managing the implications of all processes at Logistics network in a way to take the environment into consideration. (Pishvaee, Torabi, Razmi, 2011: 624). Although it is important for the large scaled vehicles used in sea, land and air transport to provide fuel economy, it can also be provided by designing the storage areas in a better way and hereby enabling forklifts to make way less inside the storage. What is important in green Logistics management is the analysis of the environmental affects in every implementation and their being operable. Besides, it is a must for the environmental implementations to be sustainable. Today, not only the profitableness but also the sustainable environment implementations of the companies and the states have gained importance by the societies. Thanks to the Green Logistics implementations, Logistics companies can put the sustainable and respective environmental implementation into practice. (Murphy, Poist, 2000: 5).

3.Process Management

Process is the operation of converting some inputs by the help of human or machine into usable outputs. The process is the activities creating added value on the diverse inputs used for achieving the targeted output. It is the interconnected operation chain converting the inputs into the outputs or the results. The aim of each process is to meet the customer requirements and demands at once and correctly. (Canan, Besim, Vedat, 2001: 177). According to another definition, the process is the group of an activity or activities which take/s input, add/s value on it and provide/s output to internal or foreign customers (Born, 1998: 24). The process is the interconnected business operations set which contains certain inputs and produces certain outputs, and which are characterized by value added efforts (Carr, 1992: 32).

Process is an activities list which converts a certain input into a certain output for the customer, which can be described, measured and which creates interconnected value. Process is the interconnected business operations set which contains certain inputs and which produces certain outputs, which are value added and characterized by value added efforts. It is the total of the interacted people, equipment, materials, methods and environmental elements, which are combined in order to create a certain output. It is the combination of the activities which convert operation inputs into operation outputs. The processes are the composition of three main activities types. They are the value creating activities; in other words having importance for the customers; the activities enabling the work flow among the functional, departmental or organizational borders basically and the control activities. An organizational process is the work whose beginning and end is certain. In other words, it is the set of the sub-works and detailed works required to carry out a business. The processes, with the low end explanation, are the logical business totals which mean what a management does for their customers and which create the product or service of the management. The processes are the products of the consecutive situation changes; namely, the process is the activities series in which the inputs are turned into the outputs by changing the situation of one or more related creature/s. It is the sum of the activities created by taking one or some kind/s of inputs and producing an output which carries value for the customer. The process is the work flow in the logic chain. A process should have five main features below;

The process may take part in a certain function inside the operation or it can be inter-functional. Whether it contains physical, positional or informational transformation; a well-run process has such features (Champy, Hammer, 22002: 49),

- Definability: It is the feature of defining the basic elements of the process.
- Convertibility: The processes can change the input into a more valued output. In the physical conversion, the information is created by processed the input in knowledge conversion, while creating a concrete product in the end.
- Measurability: It is the feature of watching the process with performance criteria.
- Repeatability: It is the feature of meeting the requirement and expectations of the customers by the output created at the end of process, after processing the same or variable inputs.
- Feedback control: The input of the information, which comes out at the end of the process is called as the feedback. The feedback control prevents the process to get out of the control.
- Controllability: It is the feature in which the process responsible is always informed about the process performance and the corrective actions are made when necessary.
- Creating added value: It is the feature of the process to create positive effect on the quality of the output and the customer satisfaction using the output (Champy, Hammer, 22002: 49).

The functions of the process are in the position of suppliers and customers of one another. They are in the determiner position on the converted input during the process. The customers are the final decision makers about the quality of the process outputs. Human, machine, equipment, time, document, energy etc. used for the conversion of the inputs into outputs constitute the source. The features defined by the customer or on behalf of the customer about the product and services, the process outputs, namely customer requirements and demands are the most important sources for the company during the process management. Control is the follow and measure of the process in order to meet the expectations and conditions, observe the realization of the process according to the planned rule, principle and system. In order to provide process control, the criteria and methods should be defined and implemented. The most important control criteria, the indicators used for measuring the meeting level of customer requirement and expectations by the process; are the “process performance criteria.” (Smith, Fingar, 2003: 46).

The process hierarchy is the configuration of the processes gradually. What is important in this configuration is the scopes of the processes. The hierarchy scope is structured in a way to descend beginning as of the biggest process. In the process hierarchy, there are four levels; the main processes, sub-processes and process activities. Process Management means the designation of all processes of a company in order to understand and upgrade how the processes work today, defining, documentation, assigning owner, evaluating by following the process performance indicators regularly and making the small upgrades or radical designs when necessary. Management with Processes states a management conception and a management structure. In other words, management with processes means carrying out the management with the processes; by concentrating on the work with the processes. The implementation of this conception requires a structural conversion which is suitable for new management principles. For this conversion, it is necessary to pass the process management level, namely, to provide the effective management of the processes. Consequently, Process Management is a degree of transition to Management with Processes.

In an organization, parent processes, main processes and sub-processes are interactively related at the same time. It’s because, usually the output of a process is the input of another process. It is not enough only to define the interaction only at the parent process level for the effective management of the processes. It is required to define the interaction in way to involve both the main processes and sub-processes, too. The main processes and sub-processes of an organization are like a network in which quite complicated and interrelated processes take place. In order to define the interaction of the processes, it is necessary to define all of the parent processes, main processes and sub-processes of an organization and designation of the implementation of these processes in the organization. In this way, the processes affecting one another are defined. The inputs and outputs of the processes are related to the internal and foreign customers. For the definition of the conditions within the processes as the input, the customers play an important role. For the effective management of the processes, the interactions of the processes should be defined at the sub-process level. While making this determination, the inputs and outputs of the processes should be taken into account. It should also be defined that which process outputs are also an input for which processes. Thus, both inter-process transitions, interactions, the effects of the processes on one another and which processes can be affected by the possible mistakes during the processes, delays, and pauses and fail to reach to the defined targets can be determined (Margulious, 2002: 66).

4.DB Schenker Arkas Sustainable Green Logistics Implementation

DB Schenker, which was founded in Vienna in 1872, entered into the Turkish market firstly in 1889 and joined their forces with Arkas in 1995. With about 95.000 employers in over 2000 centers at the most important trade centers of the world, DB Schenker is one of the leading international integrated Logistics suppliers of the world, having provided extensive Logistics solutions and global supply chain management as well as air, sea, land and rail transport; and is connected to Deutsche Bahn AG Transport and Logistics Department. DB Schenker Arkas offers special Logistics solutions in accordance with the customer requirements with more than 380 specialist employees at 16 points and it is one of the biggest Integrated Logistics Service Suppliers of the country. It renders service throughout Turkey with the branch offices located in Istanbul, Izmir, Bursa, Ankara, Mersin and Gaziantep, with 5 Logistics centers located in Istanbul and Izmir and with sales offices located in Denizli, Kayseri and Konya.

DB Schenker Arkas meets up with transport suppliers every year regularly. During these activities, the performance parameters of the company and the current situation; the importance of carbon emission operations are emphasized. Additionally, the stakeholders are gathered and the conduction of environmental activities subject to the strategic targets is negotiated. Such studies as economic drive techniques, performance managements system studies (the suppliers), carbon footprint informing meetings, drive safety studies, work processes configuration projects, service processes etc. constitutes examples for these activities. On supplier days arranged annually and regularly, transport suppliers are met up. During the annual evaluation meetings made with the investors, the results of the operations carried out in environmental extents are referred. Diverse projects are conducted with the universities and in these projects, sustainable acquisitions are the basis. In the society surveys made annually, the results of our activities in environmental extent and in the field of social responsibility are examined with the related topic titles.

The fact that the sustainability of environmental management can be provided with the attendance of the employees is the main basis. For that, during highly participated activities, the sensitivity of DB Schenker Arkas to the environment and its sample stance in social responsibility field are emphasized. Moreover, a "green team", in which the employees of social responsibility projects are involved, is organized in order to provide the expansion of the sensitivity to the environment within the company. Visual and educational activities are conducted not only the employees but also their families. In the system, in which the opinions of the employees are evaluated via proposal/reward system, one of the assessment titles is about the environmental effect. The joint works carried out with oncology association, the projects conducted with SHÇEK, the bike tours arranged with the stakeholders, planting works, the joint projects conducted with TEMA (The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats), applied environmental educations given to the children of the employees constitute examples for the importance attached to the social responsibility subject in social field. Moreover, in such platforms as various panels, congress, seminar etc. knowledge sharing studies are carried out. The social activities numbers organized in this regard are 30, 21 and 35 between 2008-2010. The targets related to Green Logistics implementations of DB Schenker Arkas, every year realizes with the process model in Figure 1. Sustainable Green Logistics Model of DB Schenker Arkas is seen in Figure.2. As it is seen, the model is composed of two titles.

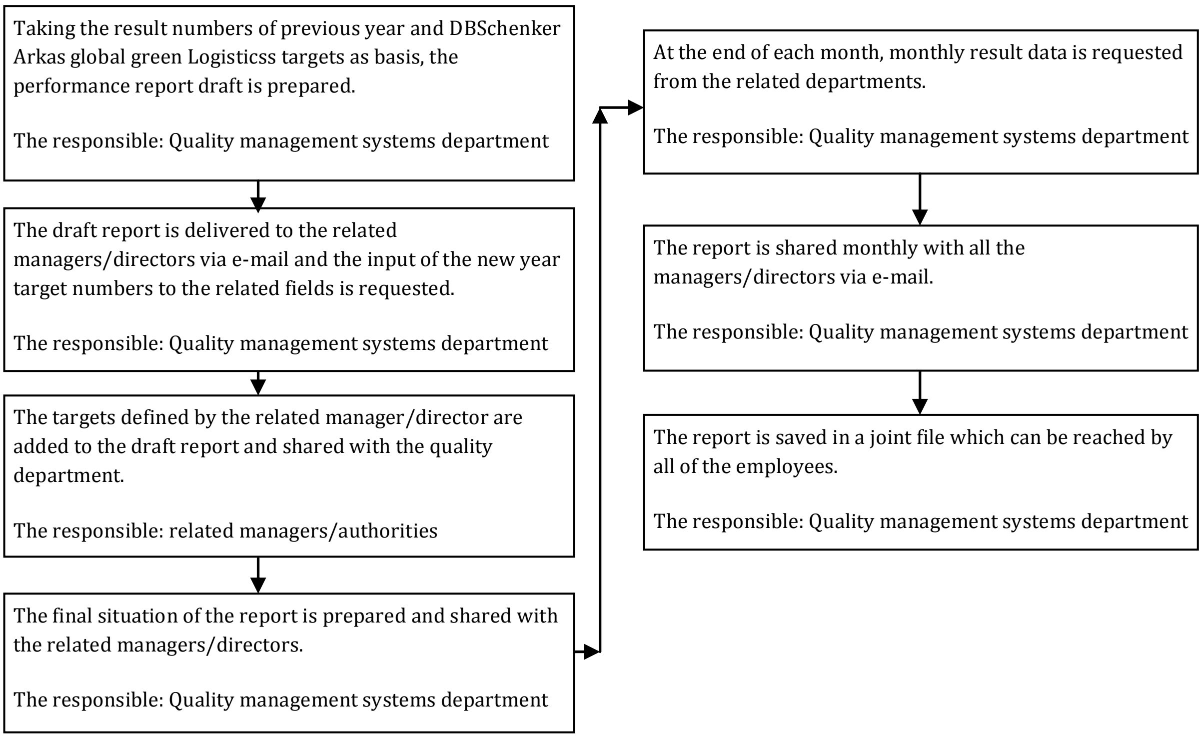


Figure 1. DB Schenker Arkas Green Logistics Target Setting Process

Carbon Emission Activities

DB Schenker Arkas has been conducting various activities within the organization since 2008, in accordance with the "Protection of the Natural Sources" which is included in the company strategy. DB Schenker Arkas, having been included in the "EcoWorld" action created by DBSchenker, aims at decreasing the carbon emission into the nature as a result of the carbon emission activities in the proportion of 20 % until 2020. For that, the items causing the carbon emissions are calculated on yearly basis and the carbon amount is gauged. In Logistics operations, the route is followed in a way to provide the most economic fuel usage for the current distance route movements. At the points where the alternative fuel usage is possible, the fuel which will harm the environment minimum is used.

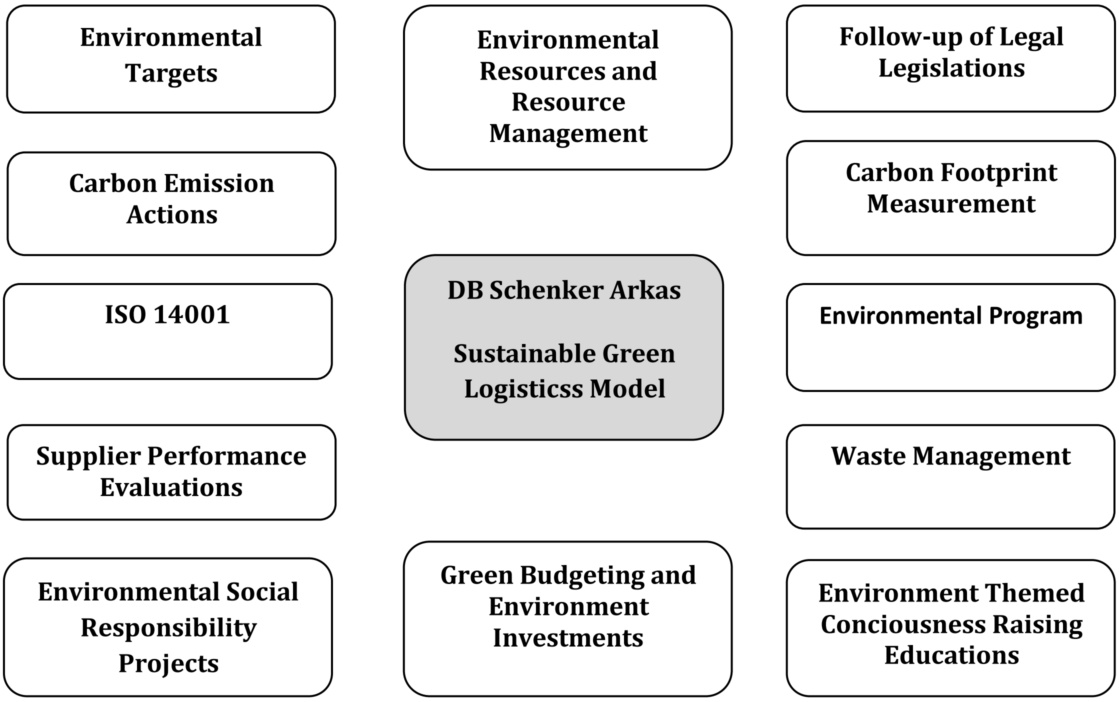


Figure 2. DB Schenker Arkas Sustainable Green Logistics Model

Besides, all of the drivers in their own fleets and also the most widely used supplier drivers are being given drive technique training. In these trainings, the expansion of effective fuel usage is targeted. In these trainings, the relation between the co2 emission and vehicle usage is explained with examples. Every year, the mass which is being trained is tried to be widened. The steps shown in Figure 3 illustrate the activity fields related to the measure program created with the aim of decreasing the carbon emission.

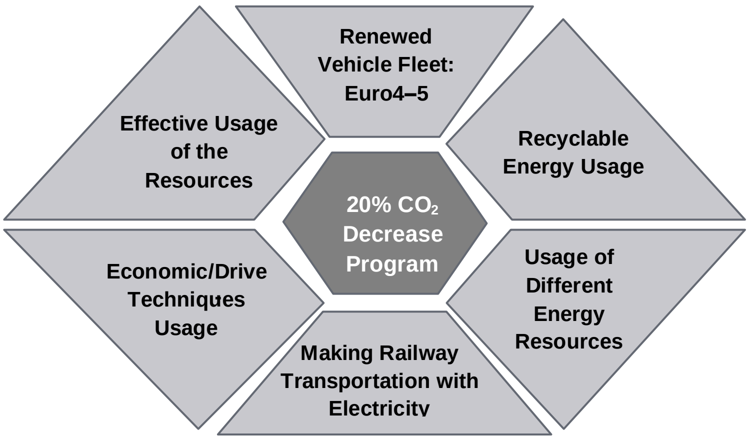


Figure 3. Carbon Emission Actions

ISO 14001 System

DB Schenker Arkas makes regular reporting to its affiliated organization regions for all operations it conducts. In the scope of IS0 14001:2004 documentation, DBSchenker annually makes an internal control by European organizations, and certification inspection by certification bodies once every three years. In the strategy meetings, at which the process performance indicators defined annually and controlled monthly are evaluated at the end of the year, in terms of seizing the targets defined. In the environmental business process management phase of the company, the main performance indicators which should be followed are monitored regularly by related functional manager and are recorded in cooperation with the quality department. All of the indicators in which the environmental affects take place are found within the same system. For the effort of reaching the targets belonging to these indicators, all the related units take charge coordinately and these targets are included in the performance targets in the bases of individual/unit/branch. During the follow-up of the environmental factors, all of the employees attend the performance assessment phase with diverse items.

Supplier Performance Assessment

Euro 4 and Euro 5 certificated vehicles belonging to approved suppliers and the numbers of DBSchenker Arkas self-owned Euro 4 and Euro 5 certificated vehicles are continuously been followed in accordance with year 2015 target, as it can be seen in figure 4. There isn't any legal responsibility in this matter and DBSchenker Arkas obeys the rule principally, taken by the DBSchenker group. DBSchenker Arkas shows its meticulousness regarding this matter by subsidizing the budget for this investment every year.

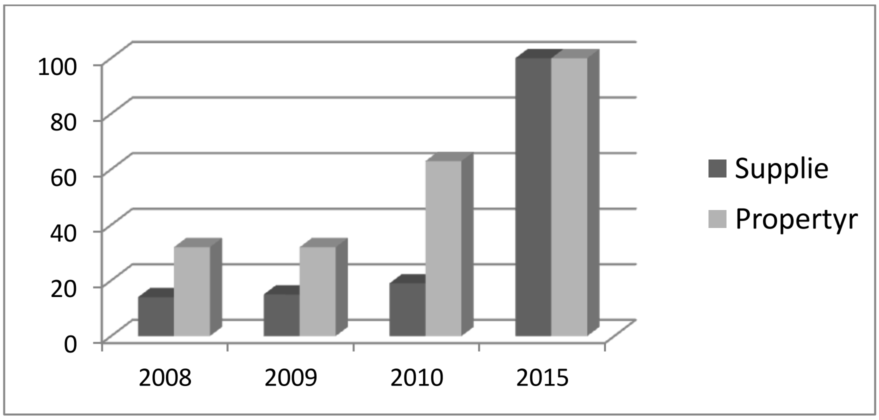


Figure 4. Euro 4 and Euro 5 Vehicle Conversion Rate

Environmental Targets

The targets defined in connection with the environmental policy in a way to contain all of the branches and storages of DB Schenker Arkas related to the environment are called as the "environmental targets" of DB Schenker Arkas organization. In the sum total targets report, which is evaluated in the scope of DB Schenker Arkas Process Performance Indicator Report and distributed to directors and managers monthly and added to the file in a way to enable the whole staff to reach, environment themed targets are also followed-up. Among these, such monthly, annually defined environmental targets as the decrease of waste amount on kilogram or tone basis, decrease of carbon dioxide emission, increase of the preference numbers of euro class vehicles in transportation, reduction of electricity consumption, making paper usage more conscious are included. For example, the target of reducing the electricity consumption 5% yearly, is included in the personal performance target of the personnel for the last 2 years.

Table 1. Environmental targets chart

Turkey Process Performance Indicator Report 2012					
Process Owner	Process Performance Indicator	Initial Value 2011	2012 Targe t Value	Existent Value	= Target - Existent Value +/- %
Quality and Environment	Risk analysis complication (5 WH & 2 offices)	7	7	7	0
	Risk close rate (5WH)	95%	90%	95%	5,00%
	Social responsibility project	5	4	1	-3

	Euro4 Euro5 vehicle transport number %5 increase	408	425	168	-257
	Supplier training – information meeting	2	2	0	-2

Environmental Program

Environmental Program is a program organized in compliance with the time interval given and the responsibilities in order to reach the defined environmental targets related to the environmental resources. An annual environmental program is prepared which regulates the measures for the realization of environmental targets, the realization period and the responsibilities. The scope of this program is expressed every year at DB Schenker Arkas Family Meeting and knowledge sharing is provided through DB Schenker Arkas Internet. The distribution of the knowledge to the personnel is provided with Schenker Arkas inter-corporately issued regulations, directions and procedures.

Awareness Raising Trainings on Environment

Information notes that are focused on raising sentiment about environment, awakening awareness about economy and providing the staff to spread the same conscious in the broad sense are put up on the communication boards and points that are continuously visible to all. In addition to the foregoing, training sessions at least once a year are organized on the Environmental Awareness Raising and Recycling.

DB Schenker Arkas annually gathers with the shipping suppliers regularly. In these activities, performance parameters of the company, the present situation and the importance of carbon emission activities are emphasized. Additionally, stakeholders are gathered with in various environments and maintenance of environmental activities as handled in the strategic objectives is discussed. Trainings on economic driving techniques, performance management system studies (suppliers), carbon footprint briefings, driving safety studies, work processes structuring projects, service processes and similar activities are the brief examples of such activities. Shipping suppliers are gathered with in the annual supplier days organized regularly. In the annual evaluation meetings organized with the investors, results of the performances conducted at the environmental level are evaluated. Various projects are conducted with the universities and in such projects sustainable yields are the basic fundamentals. Through annually organized social surveys, results of our activities at environmental dimensions and within the social responsibility field are examined along with the related subject titles.

Environmental Social Responsibility Projects

It is the basic principle that the sustainability of environmental management will be ensured by the participation of the employees. Therefore, in the activities with general attendance sentiment of DB Schenker Arkas on the environment and its model stand on the social responsibility are underlined. In addition, a “green team” has been established consisting of those included in the social responsibility projects and in order to spread of environmental sentiment within the company. Visual and educational activities are maintained targeting not only the employees but also the families of the employees.

One of the evaluation titles in the system in which the ideas of the employees are assessed by the prize/proposal system is on the environmental impact. Joint studies maintained with the Association of Oncology, projects maintained with SHÇEK (Social Services and Children Protection Agency), cycling tours organized with the stakeholders, forestation efforts, joint projects maintained with TEMA (the Turkish Foundation for Combating Erosion, Reforestation and the Protection of Natural Habitats) and applied environmental education given to the children of employees are examples for the importance given to the social responsibility issues in the social field. Information sharing activities are also maintained on some platforms such as various panels, congress and seminars etc. In this connection the number of the social activities maintained is 30, 21 and 35 respectively between 2008-2010.

DB Schenker Arkas aims to provide an affirmative impact on biological diversity by its program on reducing the amount of co2 emitted to the nature. It plays a spreading role in the social manner by a target of ensuring the awareness of protecting the environment in its social responsibility activities. In this context, an affirmative impact objective on the biological diversity is sustainable at environmental dimensions.

Follow Up of Environmental Legal Regulations and Updates

This is the follow up of all legally published regulations on environment that Schenker Arkas has to comply with while it maintains its activities and update of regulations and legislations within the company in compliance with the legal regulations if there are any changes from time to time.

Green Budgeting and Environmental Investments

By recycling for use the recyclable wastes that DB Schenker Arkas causes during its activities, some environmental (moral) and substantial gains are achieved. In addition to this, saplings which are planted for brand new married staff, for staff having a new born baby and for all customers in special days are described as environmental investments. Recyclable wastes that DB Schenker Arkas has been creating during its activities are recycled by some licensed recycling companies and a certain income is obtained; then this income is used to plan visits and organizations as an aid and support under the name of “social responsibility projects”.

Environmental Resources and Management of Resources

DB Schenker Arkas measures and controls all natural environmental resources such as electric, water, paper etc while it uses during its activities. An awareness raising activity is maintained on the employees in order to reduce the amount of all resources used in proportion to the previous year. Environmental targets with an objective of reducing usage in relation to the resources are shared with all managers and directors through monthly reports and they are also shared with the entire staff through these managers and directors. For example; having regular maintenances in administrative buildings been completed in order to provide thermal insulation.

Measure of Carbon Footprint

DB Schenker Arkas measures the amount of carbon emitted due to its activities and conducts its works to reduce emitted carbon amount. Some of these works are as follow:

a) By increasing the consumption of economic and environmental light bulbs, emission of harmful gases are prevented. Particularly the light bulbs used in warehouses are designed from economic and more environment friendly products.

b) Information Systems Department of the company purchases cutting edge and environmental friendly products in its all technologic equipments purchases. Usage of all products which are outdated, highly consuming electricity and increasing CO2 emission by harming the environment are prevented in the company.

c) Follow up and performance of regular maintenances and repairs of the leased vehicles and other property vehicles used fort he transportation needs of the company are provided.

d) Usage of new, cutting edge technology and environment friendly vehicles in Schenker Arkas is generalized.

Waste Management

Wastes and recycling process are followed by Waste Management Instructions including maintenance and management of various processes such as reducing the waste at the source, separating, collecting, temporarily warehousing, interim storing, recycling, carrying, destructing and controlling upon destruction according to the nature of the waste.

Conclusion:

There is little question that environmental issues have become an important consideration for many business decision makers in recent years, with some corporate executives having referred to the 1990s as the "decade of the environment." Many companies are designing their products to be more environmentally friendly, and many are using more environmentally friendly packaging materials (Murphy, Poist , 2000, 5). The ecological aspect and consciousness has increased drastically over the last two to three decades, especially in the developed economies. The green strategy is therefore becoming a key factor to better position of the company on the global market. This was confirmed also by the Eyefortransport survey in November 2007 (Summary and Analysis of Eyefortransports... 2007). It was found that 67% of the key company executives surveyed in Europe believed that the green strategy is an important element of their company's strategy. In regions with poorer and underdeveloped economies, 'green' thinking has still not been developed. This is undoubtedly true for the region of SE Europe. The main reason is limited financial funds, which are needed in the transport infrastructure and for equipment modernisation. However, it is an inevitable global trend to develop and adopt green Logistics management in every sphere of national industry, especially in the production and transport sectors (Dunning, Fortanier 2007; Garter, Rogers 2008; Kovács 2008). İn the early 199O's, green Logistics became a societal obligation in the developed regions and Logistics experts produced many studies, surveys and opinions. Tanja (1991) and Murphy, Poist, Braunschweig (1994) showed how environmental elements could be adopted by the Logistics sector.

In a series of workshops organized by the University of Hull involving academics and practitioners in supply chain management to investigate the issues and challenges of the next generation supply chains, environmental issues with cost effectiveness is always the major and most imminent concern identified (EPSRC, 2010). Generally speaking, Green Logistics refer to “attempts to measure and minimize the ecological impact of Logistics activities”. They include green purchasing, green material management and manufacturing, green distribution and marketing, as well as reverse Logistics. The overall objective is to reduce impact on the environment, lower production cost, and improve product value. A survey of 527 US enterprises by Min and Galle (2001) reveals that over 84 percent of the firms have participated in some form of green purchasing initiatives. Involvement in green purchasing is found to be related positively to firm size and attitude towards regulatory compliance. Similarly, a survey of 1,225 packaging personnel by the sustainable packaging coalition and packaging digest shows that 73 percent of the respondents report that their companies have increased an emphasis on packaging sustainability (Kalkowski, 2007). Another study reveals that 72 percent of the 235 transportation and Logistics professionals surveyed are planning to improve energy efficiency and 42 percent are planning to use vehicle re-routing to reduce mileage (O’Reilly, 2008).

Today, the implementations of the Logistics companies in global trade about being respectful to the environment have increased significantly. With the concept defined with the Green Logistics definition, the Logistics companies aim at being respectful to the environment in all of their operations. As well as being respectful to the environments, these implementations carry importance in terms of being sustainable. Logistics companies are in a great effort in order to make their green Logistics implementations sustainable. DB Schenker Arkas, implementing green Logistics applications at the highest level and making these applications sustainable with various functions, has been implementing sustainable Green Logistics Model in figure 2. Thanks to this model, it can manage the implementations respectful to the environment and provide sustainability.

As it can be seen in the process at figure.1, DB Schenker Arkas defines their targets together with their departments of green Logistics every year. In accordance with these defined targets, the implementations regarding twelve titles presented in the model at figure.2 are conducted. The implementation of the subjects under twelve titles during the planned year is executed within a program. At the end of the implementation year, the realization situations of the environmental targets and conformity to the program subjects are evaluated. The implementations under the title of carbon emission actions have started in 2008 and 20% decrease in carbon emission actions until 2020 is targeted. With the operations seen in figure.3, important steps have been taken regarding the carbon emission. Especially thanks to the educations given to the implementers in this program, the sustainability of the program is provided. With ISO 1400, international environmental standard, obeying to the rules regarding the environment is provided and thanks to the audits of this standard, the improvement and control of the system is enabled. DB Schenker Arkas has put targets directed at the numbers of euro4 and euro5 vehicles which are owned both by themselves and the suppliers. One of the important matters for the environmental implementations to be sustainable is to create consciousness. Therefore, DB Schenker Arkas has been giving consciousness trainings in such subjects as recycling, economic drive techniques etc. by the specialists to their own personnel and the suppliers. Thanks to these training, the personnel and the suppliers are provided with environmental consciousness raising both in Logistics implementations and in their personal lives. Thanks to these consciousness raising educations, the sustainability of the green implementations is provided since being respectful to the environments has become a culture. DB

Schenker Arkas has been trying to raise awareness of the society about the environment with the studies conducted with Oncology association bike tours, joint works with TEMA, environmental educations given to the children of the employees. Thanks to these social projects, sensitivity to the environment is provided within the society. The continuity of the green implementations is guaranteed by sharing budget items regarding the environment at the budget planning. All of the electricity, water, paper etc. natural, environmental sources used are being measured and controlled. Moreover, carbon amount generated as a result of the operations are gauged and targeted operations are conducted in order to decrease the carbon amount. With this applied green Logistics model conducted by DB Schenker Arkas, these implementations have been performed in a successful way until now.

REFERENCES

Angheluta, A., Costea, C., 2011, Sustaınable Go-Green Logıstıcs Solutıons For Istanbul

Metropolıs, Transport Problems, Volume 6 Issue 2: 59-70

Barzelay B., 1992, New Vision for Managing, *Breaking Through Bureaucracy*, California: 42.

Beskovnik.,B., Twrdy, e., 2012, Green Logıstıcs Strategy For South East Europe: To Improve

Intermodalıty And Establısh Green Transport Corrıdors, *Transport, 27(1): 25-33*

Born G., 1998, *Process Management To Quality Improvement : The Way To Design, Document And RE-Engineer Business Systems*, John Wiley & Sons, USA

Canan,Ç., Besim,A., Vedat,E.,2001*, Toplam Kalite Yönetimi ve Kalite Güvence Sistemi (ISO 9000-2000 Revizyonu)*, Beta İstanbul.

Carr D. K., 1992, *Breakpoint : Business Process Redesign* , Arlington, Va. : Coopers & Lybrand , USA

Champy J. and Hammer M., 2002, *The Emergence of Business Process Management*, A Report by Computer Sciences Corporation, Hampshire

Dekker,R., Bloemhof,J., Mallidiss,I., 2011, Operations Research for green Logistics – An overview of aspects, issues, contributions and challenges, *European Journal of Operational Research*: 219, 671–679

Dunning, J. H.; Fortanier, E, 2007. Multinational enterprises and the new development paradigm: consequences for host country development. *Multinational Business Review 15(1): 25-46.*

EPSRC, 2010, Next Generation Manufacture Supply Chains and Economy Research Collaboration (NEX-GEM), Engineering and Physical Sciences Research Council, http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef¼EP/F031858/1 (accessed 6 October 2010).

Garter, G. R.; Rogers, D. S., 2008. A framework of sustainable supply chain management: moving toward new theory. International Journal of Physical Distribution and Logistics Management 38(5): 360-387.

Kovács, G. 2008., Gorporate environmental responsibility in the supply chain. *Journal of Cleaner Production* 16(15): 1571-1578.

Jheng, L., Jhang, J., 2010, Research on Green Logistics System Based on Circular Economy, Asian Social Science, Vol. 6, No. 11:116-119.

Kalkowski, J. 2007, State of green packaging, *Packaging Digest*, December 1,

Lau, K., H., 2011, Benchmarking gren Logistics performance with a composite index, *Benchmarking: An International Journal,* Vol. 18 No. 6: 873-896

Margulious D. L., 2002, Workflow Meets BPM , *Info world*, Vol.24: 66

Min, H. and Galle, W.P. 2001, Green purchasing practices of US firms, *International Journal of Operations & Production Management, Vol. 21 No. 9: 1222-38.*

Murphy, P R.; Poist, R. R; Braunschweig, G. D. 1994, Management of environmental issues in Logistics: current status and future potential. *Transportation Journal 34(1): 48-56.*

Murphy, P.,R., Poist,R.,F., 2000, Green Logistics Strategies: An Analysis of Usage Patterns, *Transportation Journal,* Winter: 5-16.

O'Reilly, K. 2008, Green Transportation and Logistics, eyefortransport Report, July, http://businessassurance.com/downloads/2008/07/eye_for_transport_report.pdf (accessed6 October 2010

Pishvaee,M.,S., Torabi,S.,A., Razmi,J., 2012, Credibility-based fuzzy mathematical programming model for green Logistics design under uncertainty , *Computers & Industrial Engineering* , Vol:62: 624–632

Sheu,J.,B., Chou,Y.,H., Hu,C.,C., 2005, An integrated Logistics operational model for green-supply chain management, *Transportation Research* Part E 41: 287–313

Smith, Fingar, 2003, Business Process Management, The Third Wave: 47

Summary and Analysis of Eyefortransport's Worldwide Survey: Green Transportation & Logistics. 2007, http://www.greenLogisticsfonim.com/2008/free_report. pdf

Tanja, P. T. 1991, A decrease in energy use by Logistics: a realistic opportunity?, *in Proceedings of the European Conference of Ministers of Transport: Freight Transport and the Environment: 151-165.*

Ubeda,S., Arcelus,F.J., Faulin,J., 2011, Green Logistics at Eroski: A case study, *Int. J. Production Economics*, Vol:131: 44–51

Zhang, G., Zhao,Z., 2012, Green Packaging Management of Logistics Enterprises, *2012 International Conference on Applied Physics and Industrial Engineering*, Physics Procedia, Vol: 24: 900 – 905

The Emotional and Analytical Responses Generated from the Visual Perception of Brands Graphic Signature

Luiz Salomão Ribas Gomez [25], *Patricia Ceccato* [26]

Abstract

The design management plays a central role in branding, communicating the brand deepest values through elements there are perceived by the human senses. Among them is the graphic signature. Understanding the responses generated by the visual perception of this element of brand design is very important for both study areas. Through the achievement of a qualitative research that coordinates design management and branding with neuroscience theory, the present paper answers how the consumer brain responds to the visual perception of brands graphic signature. The method employed involves the bibliography search to theoretically justify the research. The data collected are described and interpreted taking into consideration the neuroscience literature about the rational and emotional brains. The reactive and analytical cerebral responses are briefly explained, in order to differentiate the consumer rapid (reactive or emotional) and slow (analytical or rational) cerebral responses originated from the visual perception of a brand graphic signature. Graphic signatures of brands with high emotional appeal trigger an automatic preconscious response from amygdala that, if positive, can assume the form of preference, and even result in an impulsively buying decision.

Keywords: *Design management, Graphic design, Graphic Signature, Brand management, Neuroscience*

1. Introduction

A brand could be defined as "a name, a word, a sign, a symbol, a drawing or a combination of them, intending to identify the goods and services of one seller or group of sellers and differentiate them from competitors' (Chertatony & Riley, 1997 cited in Batey, 2010: 26). But, in the last few years, the intangible values became more valuable than the tangible (Gobé, 2002: 18) and the "brands now carry deep currents of meaning in terms of context of use, socio-psychological nature of consumers and cultures to which they belong" (Batey, 2010: 15). Today, "a brand communicates with consumers at the level of senses and emotions, a brand stirs up for people, forging a deep and lasting connection" (Gobé, 2002: 19).

Currently, the brand is a factor of individual and cultural significance: what "is sold is not a product, but a vision, a 'concept', a lifestyle associated with the brand, which allows individuals to express their own individuality and worldviews: "Name, logo, design, slogan, sponsorship, store, everything must be mobilized, redefined with a new look, in order to refresh the image profile, to give a soul or a style to the brand" (Lipovetsky, 2007: 40). "All these contents are reduced to overlapping signs, culminating in the super-sign that is the brand: the only and true message".

In this context, the brand "focuses on the strongest aspect of the human character, the desire to transcend the material satisfaction and experience the emotional fulfillment" (Gobé, 2002: 19), encouraging the creation of emotional meaning associated to the brand, by the consumer. "Although the nature of these meanings evolves over time, a brand will continue to be a group of meanings. In fact, these

[25] UNIDCOM/IADE, Portugal; Universidade Federal de Santa Catarina, Brazil; +55 4899485555, salodesigner@gmail.com
[26] Universidade Federal de Santa Catarina, Brazil; +55 4896069474, patriciaceccato@hotmail.com

meanings must be constantly renewed, modified, polished, and, when necessary, replaced" (Batey, 2010: 31). This is the role of brand management.

Brand management – also called branding – is the 'corporate philosophy' which endows the offers with meanings: associations, attributes and benefits that allow the creation of emotional bonds between product and consumer. According to Kotler (cited in Tybout & Calkins, 2006), "branding is much more than naming an offer. It means making a promise to consumers about how to live an experience in a complete level of performance […] i.e. it means to 'live the brand'".

"Defining the meaning of a brand consists of a differentiation strategy in a market with too much information. In this context, the emotional factor is indispensable for the creation of meaning and knowledge in branding, which, in turn, is originated from the theories of management (marketing), communication (advertising) and shape (design)"(Gomez et al, 2011).

Design plays a central hole in branding, because it works on the creation of brand elements, and must "make many critical decisions regarding the use of names, colors, symbols and the like. This helps consumers to perceive a product consistently with the brand intentions" and meanings (Tybout & Calkins, 2010: 27). In this sense, "the more consumers 'experience' the brand by seeing, hear or think of it, the greater will be the probability of getting it registered strongly in their memory" (Keller & Machado, 2006: 43).

Branding is the creation of emotional ties between the brand and the consumer. Like in any relationship, the emotions are based on the information captured by our senses" (Lindstrom, 2007: 112). "So, anything that causes consumers to view a name, a symbol, a logo, a character, a package or a brand slogan can potentially increase the familiarity and the remembrance of that brand" (Keller & Machado, 2006: 43). The cited elements are part of the brand design, which is a step between the articulation of its concept and the creation of other contacts with consumers. Ideally, it should employ a wide variety of tracks or brand elements (Tybout & Calkins, 2010: 32). And "since the brain receives and processes images more easily than words, visual devices and symbols are important tools for building a brand and have proven to be easier to remember than words" (Batey, 2010: 253).

These visual elements are created through the visual programming or graphic design, "a set of theories and techniques that allows us to order the way we make visual communication" (Strunck, 2007: 53). Graphic design considers everything that comes to visually symbolize the brand as ways to communicate intangible values and convey symbolic meanings. It is responsible for developing the visual identity, which, according to Strunck (2007, p. 57), "is the set of graphic elements that communicates the visual personality of a brand".

In this way, it is great the importance of the visual identity in branding, as a way to communicate the meaning of the brand. According to Strunck (2007: 69), to communicate the visual identity of brands, there are basically four elements: "the main: logo and symbol, and the secondary: standard color (or colors) and standard alphabet". The combination of both main elements, the logo and the symbol, forms the graphic signature (Strunck, 2007: 80; Peon, 2011: 28-32). The importance of the graphic signature is justified because the other elements of the visual identity derive from it, and because it has the ability to visually convey the brand values. So, it becomes vital for branding to understand how the consumer responds to it.

The consumer's brain, generally, answers the visual perceptions basically by two manners: the first response is fast and occurs in a short period of time, being called "reactive", "emotional" or "automatic"; the second is a little bit more slow and occurs in a longer period of time, being called "analytical" or "rational" (Goleman, 2009; Rodrigues, 2011; Mozota et al, 2011; Cayuela et al, 2011). "There seem to be apparently two mental systems leading to decision: one that allows more extensive forms of reflection, but it consumes more mental resources, and a more automatic, but more inaccurate" (LeDoux cited in Rodrigues, 2001: 84).

Knowing that, this paper aims to answer how the consumer brain responds to the visual perception of a brand graphic signature. To accomplish that, the two above-mentioned mental systems are described from the point of view of branding, focusing on the responses that they produce facing the visual perception of the brand graphic signature. The aim of this study is not to develop a detailed investigation about the functioning of the human's nervous system, but specifically understand the cerebral responses generated from the visual perception.

Then, the objective of this paper is to differentiate the fast (reactive or emotional) and the slow (analytical or rational) brain responses originated from the visual perception of the brand graphic signature. To achieve that, the following specific objectives are configured: 1- to expose the results of the literature search conducted about design management and related subjects in their relationship with branding; 2- to briefly describe how behave the analytical and reactive mental systems; 3- to conclude interpreting how each one produces its response to the visual perception of the brand graphic signature.

From the viewpoint of the manner to approach the problem, this is a qualitative research. In this type of research, "the interpretation of the phenomena and the assignment of meaning are basic". Thus, "it is descriptive: researches tend to analyze the data inductively. The process and its meaning are the main foci of approach" (Silva & Menezes, 2005: 20).

The technical procedures involve the literature research, for the construction of theoretical fundamentals that make possible the description of the mental systems that produce the reactive and analytical brain responses. For the description of the emotional and rational mind, from the collection of bibliographic data, the comparative method is applied with the purpose of differentiating the reactive and analytical brain responses generated from the visual perception of a brand graphic signature. Intended for this, the collected data is interpreted in the light of the branding literature, determining the stage of interpretation: "the second stage of analysis and with it the research reaches the proper condition of scientificity" (Lopes, 1990: 131).

2. Design Management

Design "always involves an intention, a plan or a goal, particularly in analytical and creative phases, and a draw, model or sketch, at the implementation stage, to shape an idea" (Mozota *et al*, 2011: 16). "To design" and "the design", they both play a key role in shaping the world, and generate new products, systems and services in response to numerous market conditions and opportunities, working as a "mediator between the industrial and technological world and the consumer" (Mozota *et al*, 2011: 17).

Design also "supports the link between brand and strategy: 1- design and branding: design is a link in the chain of a brand or a way of expressing brand values to its different audiences; 2- design and corporate strategy: design is a tool to make visible a strategy" (Mozota *et al*, 2011: 17). In branding, design is "a discipline to solve problems related to the business and not just to create aesthetic appeal" (Phillips, 2008: 52). This term highlights the strategic role of design, which "only becomes effective when can solve the proposed problem. Therefore, it is necessary that the problem be clearly described. Moreover, the solution presented must be consistent with the business objectives" (Phillips, 2008: 40). "If we wish design to be considered a strategic issue within the company, we need to act strategically, in coordination with the other functions of the organization. This naturally influences the design solutions, as they are part of the strategy" (Phillips, 2008: 24, 36).

Design with focus on strategy can be called "design management". Gorb (1990 cited in Minuzzi, Pereira & Merino, 2003) defines it as the "operation of the design resources available in an organization to meet its objectives" and as an "effective distribution by managers of the design resources available to the company achieve its goals (1990 cited in Best, 2006: 12; Mozota *et al*, 2001: 92). Thus, "the important aspects of design management involve understanding the strategic objectives of an organization and how design can play a role, and effectively implement the ways and means, the tool and methods, teams and planning requirements, as well as passion and enthusiasm to achieve these goals as a result of success (Best, 2006: 12).

According to Tim Bachman (cited in Phillips, 2008: 114), "design management articulates implicit and explicit communications that reflect the company's values", thus, "it adds tangible and intangible values to the company": it adds a mark, a brand. "Design management contributes to define the profiles of consumers and the values to be added to products and services in order to increase the company's business" (Fricke cited in Phillips, 2008: 115). It "helps the designer creating the differences that are perceived by consumers as benefits and that impact on their behavior" (Mozota *et al*, 2001: 110) by transforming the company meaning and image in a powerful tool to communicate, motivate and inspire (Larsen cited in Phillips, 2008: 117). To attain this, "the establishment of the brand is the most used process. The differentiation and the brand management are part of design management (Mozota *et al*, 2011: 110). In accordance with Best (2006: 16), "within an organization, design management is present in the brand communication".

Mozota (2011: 125) explains that "the launch of a brand is one of the most effective ways to spread design across an organization. If the brand is well-developed and persuasive, promotes loyalty and encourage feedback from consumers", by transmitting the brand benefits, attributes and values, and increasing its meaning across all contact points experienced by the consumer. Design penetrates all components of brand value, mission, promise, positioning, expression and quality: "there is graphic design in the name and symbol of the brand; product design in the product performance; packaging design at the point of promotion; and environmental design in the store environment". All non-verbal elements of a brand – appearance, color, touch, smell, finishing and sound – can be projected by design (Mozota *et al*, 2001: 127).

Design "participates in the brand valorization making it alive in different bases: packaging, product, advertising, and in the long term, different markets. Brand features include credibility, legitimacy and affection" (Mozota *et al*, 2001: 135). In the relationship between branding and design management, "that means consistency in aesthetic and form, continued use of graphic codes and symbolic creation of new emotions" and meanings. Graphic design has the power to transmit these emotions and concepts through the visual elements that communicate the brand, regarding the form and the codes that compose the visual identity of the brand.

One of the most important element that compose the brand visual identity (and usually serves as a starting point for the creation of other elements) is the graphic signature, formed by the combination of the logo and the symbol. The graphic signature communicates the brand meaning and its values in order to identify the company and create an emotional appeal to consumers. In this sense, graphic signatures "have meanings and associations that change the consumer perception about the company" (Keller & Machado, 2006: 105). Any visual identity, and graphic signature, specifically, can be positioned in an arrow of two axis: graphical expression and emotional meaning" (Gobé, 2011 cited in Mozota *et al*, 2011: 128). To understand how these two axes generate responses by the human brain, it is necessary to understand the two mental systems that answer to the visual perception of the brand graphic signature. One is responsible to analyze the graphic expression of it, considering all elements of color and shape and making relationships with other knowledge; and the other to react emotionally to the meaning transmitted.

3. Emotional and Analytical Responses

The vision, more than any other sense, provides information about the world (Wheeler, 2009: 52). According to Aamodt & Wang (2009: 64), "the vision begins in the eye, which works the same way as a camera. A lens in the front of the eye focuses the light to a thin layer of neurons on the back, called retina". "The light energy reaches the eye through the cornea, enters through one opening, the pupil (an open area in the center of the iris), crosses the vitreous humor and reaches a light sensitive area, called retina (Rodrigues, 2011: 65).

The retina receives in the first instance visual information, then undergoes a process of photo transduction, a kind of encryption, because the retinal neurons are arranged as a sheet of pixels, each one detects the light intensity of a given region of the visual world. The light moves linearly: the light that hits the head of the person in front of me, will reach the basal part of my eye, and the feet the top, so the image appears inverted (Rodrigues, 2011: 64). The retina turns the world upside down, but it does not affect our vision because the brain is aware of this fact and interpret the information correctly (Aamodt & Wang, 2009: 64).

The retina contains visual receptors: cones and rods (Rodrigues, 2011: 65). In accordance with Aamod and Wang (2009: 64), "there are three different types of the so-called cone cells of retina, each one detects the green, red and blue colors. These neurons send signals increasingly stronger as the light intensity detected becomes stronger. According to the authors, "the other colors are formed by different levels of activity in the combination of these three cell types". A fourth type of cell called rod, detects the intensity of light in the darkness, but does not contribute to color vision (Aamodt & Wang, 2009: 65). In the words of Rodrigues (2011: 65), "these visual receptors convert light into nerve impulse that is carried by the axons. These axons together form a beam of nerve fibers – the optic nerve".

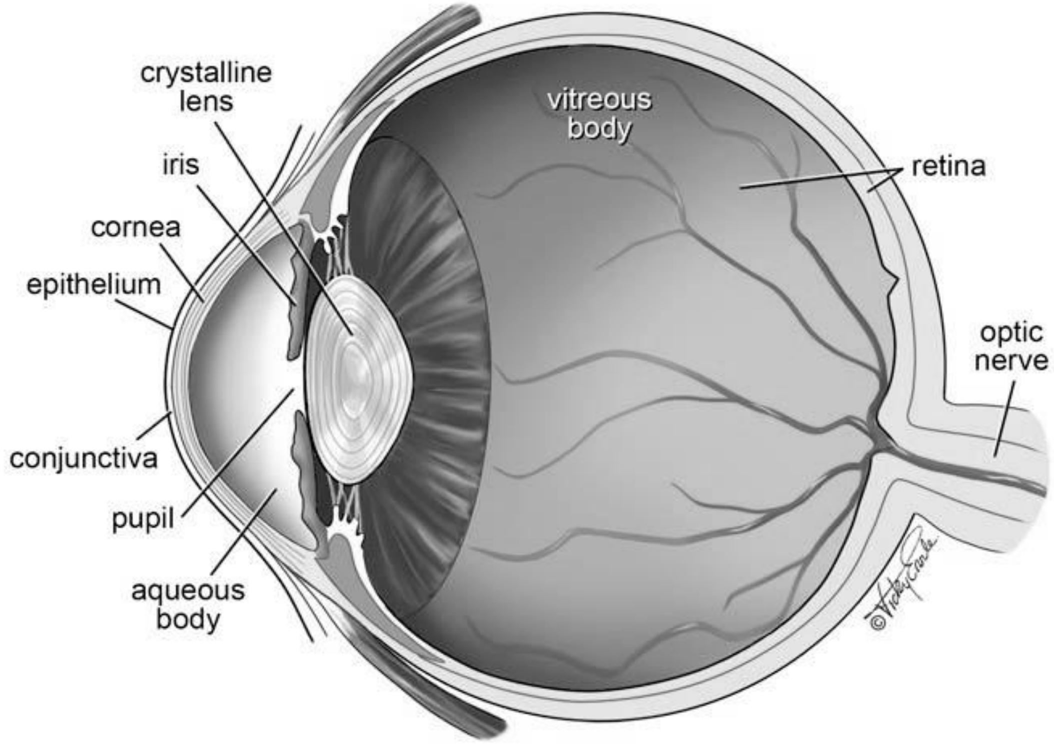


Figure 1. The vision [http://www.boydvision.ca/library/about-your-eyes.html accessed on 07/05/2012]

The optic nerve of each eye projects the nerve impulses to the brain. The optic nerves follow a pre-defined circuit in the brain: after the optic chiasm, the optic fibers are mostly projected for the dorsolateral geniculate nucleus of the thalamus, most part following to the cerebral cortex (primary and secondary visual cortex), which is located in the occipital lobes in the rear area of the brain. One other part goes directly to the amygdala [see Figure 2] (Rodrigues, 2011: 65). While the cerebral cortex must first determine the brightness of each part of the object that produced the visual image, calculate the depth in a scene and decide what objects are in it (rational analysis), the brain also has special forms to recognize objects that have particular importance (emotional reaction), such as people faces or the graphic signature of our favorite brand (Aamodt & Wang: 65-66).

According to Mozota (2011: 112), the consumer response to a visual perception "is determined by two distinct styles of information processing: the cognitive and the preferential", that can also be called analytical and emotional. The images "imply a cognitive treatment of them (a process of thought) and/or a treatment of emotional information (a process of feeling). Therefore, "the processing of information or is logical, rational, sequential, or is holistic and synthetic".

Rodrigues (2011: 84) also explains that "when we make decisions we can make it through a long process of deliberation on various options, considering the pros and cons before choosing the most logical solution. In this case, the decision-making seems to be a rational decision, an intentional process based on the language. However, many times, decision-making can be a different phenomenon, very intuitive, which involves simply choosing the option that we 'feel' is more correct. In the latter case, the decision appears to be based on something quite different from reflection, more visceral, more emotional, which arises spontaneously in the form of preference".

So, there are two mental systems that lead to a response to the visual perception, or to a decision based on it: one that allows more extensive forms of reflection, but however consumes more mental resources, and a more automatic, but more inaccurate. "Besides being anatomically distinct mental systems, the different processing speed is the feature that most distinguishes them" (LeDoux, 2000; Lieberman, 2007 cited in Rodrigues, 2011: 84).

"These two fundamentally different ways of knowing interact to construct our mental life. One, the rational mind, is the way of understanding that we typically have consciousness: most prominent in the field of attention, thoughtful, able to ponder and reflect. But beside this there is another knowledge system: impulsive and powerful, although sometimes illogical – the emotional mind. [...] These two minds, emotional and rational, most often work in perfect harmony, combining their two different ways of knowing to guide us through the world. Typically, there is a balance between the rational and emotional minds, in which emotion is fed while informs the operations of the rational mind, which refines and sometimes prohibits the contributions of emotion. However, the emotional and rational minds powers are semi-independent, reflecting, each one of them, the operation of distinct, but interconnected, circuits within the brain" (Goleman, 2009: 31).

In human brains, this emotional mind is related to the amygdala (from the greek word for 'nuts'), which is a group of structures in the form of almond perched on the top of the brainstem, near the lower edge of the limbic ring. There are two amigdalas, one on each side of the head. Joseph LeDoux, neuroscientist at the Center for Neural Science at the University of New York, explained through his research "how amigdala can take control of what we do while the thinking brain, the neocortex, is still striving to reach a decision" (Goleman, 2009: 36-37).

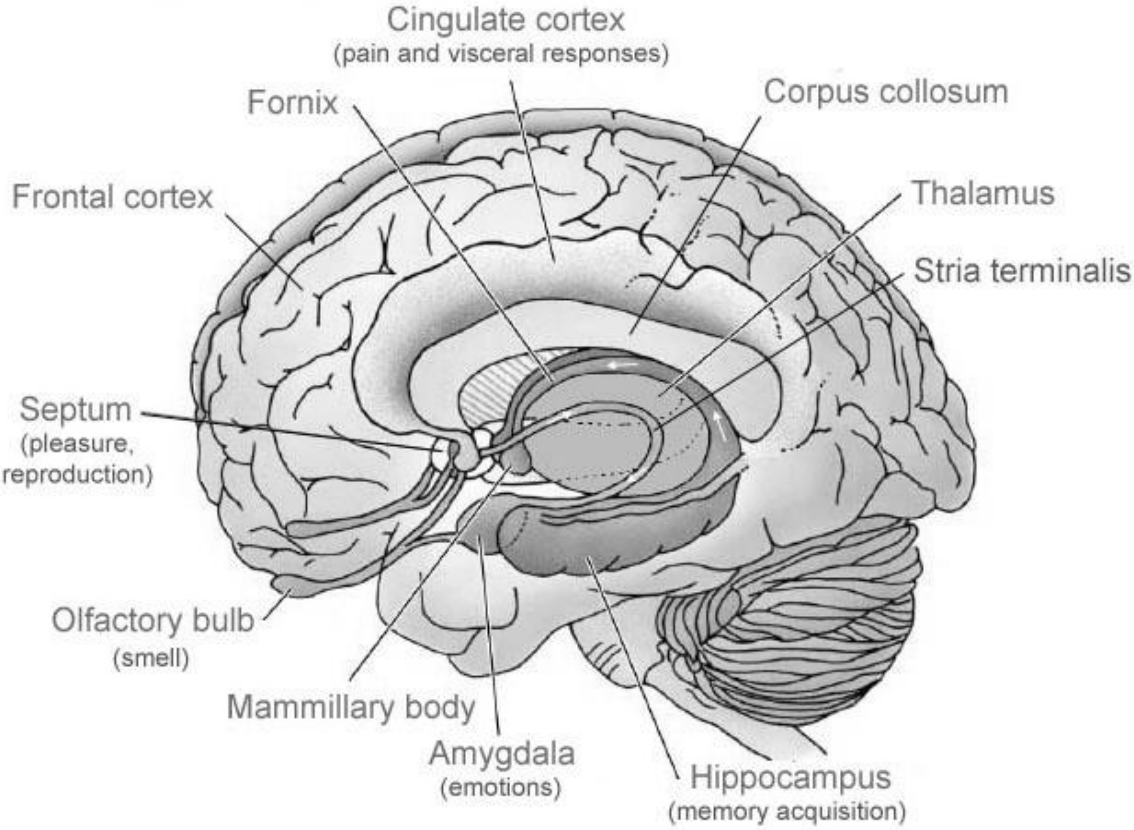


Figure 2. *Some Important Cerebral Structures [http://www.quora.com/Philosophy/Is-there-such-a-thing-as-the-subconscious accessed on 07/05/2012]*

The investigations of LeDoux (*apud* Goleman, 2009: 39) demonstrated that the sensory systems from the eyes and ears reach the brain passing first through the thalamus and then – by a simple synapse – through the amygdala; a second signal from the thalamus is sent to the neocortex, the thinking brain. "This branching allows the amygdala to begin to respond before the neocortex, which analyzes the information, making it pass through several levels of brain circuits, before understanding it completely and then formulating its own answer".

"A visual system flows first from the retina to thalamus, where it is translated into brain language. Most of the message then goes to the visual cortex, where it is analyzed and evaluated in terms of meaning and appropriate response; if that response is emotional, a signal goes to the amygdala, which triggers the emotional centers. But a small part of the signal goes directly from the thalamus

> *to the amygdala in a quicker transmission, allowing a faster response (although less accurate). Thereby, the amygdala can trigger an emotional response before the cortical centers have had time to fully understand what is happening" (Goleman, 2009: 40).*

This direct route has a huge advantage in terms of brain time, which is counted in milliseconds. The amygdala of a mouse is able to begin responding to a perception in only twelve milliseconds. The route thalamus-neocortex-amygdala takes approximately twice as long. According to Goleman (2009: 45) "equivalent measurements in regards to the human brain have still not been made, but it is believed that the relation will probably be the same".

According to the author, the route of emergency from eyes or ears to thalamus and amygdala is crucial: saves time in an emergency. And also offers an extremely fast way of linking the emotions, resulting in feeling before thinking. "No wonder we understand so little about our more violent emotions [...]: these emotions are triggered independently, and before, thought" (Goleman, 2009: 45). This demonstrates that visual stimuli are capable of activating a surprisingly large number of brain regions without coming into conscious awareness (Aamodt and Wang, 2009: 227).

Although the amygdala is known for its role in fear responses, it also quickly reacts to positive emotional stimuli, such as the logo of our favorite brand stamped on a product. "Altogether, the amygdala seems to be important to concentrate on events with emotional significance in the world around us". The neurons in amygdala respond to vision, hearing, or touch, and sometimes, these three senses at once. "Many of these neurons have preference for certain objects, especially gratifying objects", like a product stamped with the graphic signature of our favorite brand (Aamodt and Wang, 2009: 138).

When we see a product, "we realize not only what it is in the first milliseconds, but also decide whether we like it or not. The 'cognitive unconscious' presents to our awareness not only the identity of what we see, but also an opinion about it". In other words, our emotions have a mind of their own, able to provide 'views' independently of our rational mind (Goleman, 2009: 41).

However, "while the amigdala works triggering an anxiety and impulsive reaction, the area of the neocortical brain gives a more analytical and appropriate response to our emotional impulses. The neocortical response is slower than the emergency mechanism because it involves more circuits". Normally, the prefrontal areas regulate our emotional reactions from the beginning. "The highest projection of sensory information that leaves the thalamus doesn't go to amygdala, but to the neocortex, and its many centers responsible for recording and deciphering what is being perceived". This information, and our response, is coordinated by the prefrontal lobes, the center of planned and organized actions in view of a goal" (Goleman, 2009: 46-47).

"Thus, in a certain sense, we have two brains, two minds, and two different types of intelligence: rational and emotional" (Goleman, 2009: 50), that Rodrigues (2011: 84) called deliberative and automatic: "the automatic system produces fast reactions, but inaccurate assessments for the decision; while the deliberative system produces thinner decisions, but with higher cost of time and mental energy. The final product of this automatic system will be the emotional response, involuntary and adaptive (Ledoux, 1994; Damásio, 1994 cited in Rodrigues, 2011: 84).

Then, we may prefer/choose a brand, i.e. decide, on a non-conscious way (not rational). All these studies suggest the existence of an emotional/affective automatic and preconscious processing (Rodrigues, 2011: 90). Although the meaning of the expression 'automatic' is up for debate, most of researchers use this term to indicate the processing that occurs below the threshold of consciousness (Ledoux, 2000 cited in Rodrigues, 2011: 88).

This information is valuable to branding. "The decision between buying or not is primarily a physical-chemical, biological process that occurs inside the brain, and not outside" (Camargo, 2010: 164). What means that the majority of brands should have a graphic signature with strong emotional appeal that may trigger an emotional preconscious response, which can reflect in preference, and even in an impulsive buying decision. It is necessary to be attentive to the graphic expression of the graphic signature, its colors and shape, to generate the right interpretation of its design: the right understand of the brand concept. But it is also important to be aesthetically pleasant to the consumer, and generate an emotional positive response, which, even though unconscious, acts under the threshold of consciousness as a state of mind, influencing our decisions (Goleman, 2009). According to Goleman (2009), a feeling that overflows our mind in a moment, continuous to act in our subconscious per hours.

4. Contributions

Knowing that the human brain responds to the visual perceptions in two different ways: the first one is fast, emotional and automatic, generated by the amygdala, and can be called reactive, automatic or emotional; the second is slower, conscious and rational, generated by the neocortex and can be called analytical or rational (Goleman, 2009; Rodrigues, 2011; Mozota et al, 2011; Cayuela et al, 2011), at the time of the design and evaluation of a graphic signature, the designer must take into account these two mental systems that will result in different types of response from consumers.

While the second produces a slow response, considering the analyzable aspects of the graphic signature and achieving a logical understanding of what it means and represent (the brand, the company that produced the product); the first one produces a much faster response, based only on emotion, which, if positive, takes the form of preference and is transformed in a state of mind (Goleman, 2009) that may influence, unconsciously, the analytical response, may resulting in an impulsive decision-making.

Even if the decision comes from a rational analysis – for example: "the products of the brand this graphic signature represents have good quality and price" – a preference originated by the amygdala earlier, below the level of consciousness - for example "I don't know why, but I really like this product -, influences the satisfaction with the decision made". In branding, it means that graphic signatures that stimulate a positive emotional response by the amygdala, are more likely to be positively evaluated, even when the rational aspects are not positive – "it is too expensive, but I deserve it".

The problem is that it is not known yet how much the amygdala response influences the rational analysis, and which is the effect of this influence. A research is being developed at the Federal University of Santa Catarina, Brazil, to investigate the differences between this two cerebral responses, the emotional and the rational, and attest the degree of influence that the first has over the second.

It was developed a tablet app to diagnose the emotional and analytical appeal of different brands graphic signatures, to find out whether the consumers evaluate it positively by the reactive/emotional mental system, showing the graphic signature for visualization for a short period of time: 12 milliseconds (so it can't be analyzed rationally); and by the analytical/rational system, exposing the graphic signature for a longer period of time (2 seconds), for assessment. It was possible to note if the brands graphic signatures had a positive evaluation when detected quickly and slowly by the visual system of consumers.

The creation of a tool was necessary since, although the analytical and rational assessment produce a conscious response, the emotional assessment originated by the amygdala is automatic and unconscious, cannot being verbally informed by the consumers, since they do not have awareness of this response (Rodrigues, 2011: 88; Aamodt & Wang, 2009: 227).

The tablet app exhibited twenty graphic signatures of different brands in the two above-mentioned speeds. The app was applied to 400 (four hundred) people, all students of the under graduation programs of the Federal University of Santa Catarina. Each person first visualized each graphic signature separately, and after each had to press the button "yes" or "not" to respond the answer: "Do you like the graphic signature?", so after viewing each one for 12 milliseconds, as after seeing it for 2 seconds.

It was possible to observe that the majority of people changed some of their responses in the second visualization of the graphic signature (the slower), but in general mode, the percentage of "likes" and "not likes" in the first and second assessment of each graphic signature did not vary much. The percentage of "likes" and "not likes" at both times of visualization, summing all the graphic signatures, changed from 51,20% and 48,80% to 53,39% and 46,61%.

The analysis of this result is not concluded, and the research is still in development, but it is possible to temporarily conclude that the emotional response, even if different and independent of the rational, can influence this in a high level. Although the majority of people changed the evaluation of some graphic signatures, quantitatively, taking into account all the participants, this change was not too expressive, in percentage. It has to be highlighted that the observations made in this paper are precipitated. The data collected will be analyzed in greater depth, and just after that it will be possible to draw definitive conclusions about the research in process.

5. Conclusion

Neuroscience has been providing numerous contributions to the brand management, regarding the improvement of the knowledge about the nervous system and its implications in the desires, emotions and decisions of consumers. The comprehension of the rational and emotional minds and their implications in choosing a brand or a product based on the visual perception of the graphic signature stamped on it, is of great importance for design management, responsible for managing the visual elements of a brand, as well as for branding.

Graphic design has always been concerned about the functional values of communication, since its goal is to solve a problem through the communication of information. However, as regards the design management in branding, only to communicate information and promote understanding is not sufficient. It is also necessary to transmit an emotional appeal, so the brand, rather than permit the identification of its name, can build an emotional relationship with consumers, which, if positive, may assume the form of preference, even influencing the buying decision. In the long term, it may even conquer the consumer's loyalty.

This paper is intended to expose the knowledge obtained from neuroscience about the human rational and emotional minds, and alert designers and brand managers that one must be attentive to the consumer emotional response, as well as the analytical, at the time of evaluation of a graphic signature or other brand visual element. It is important to underline that the emotional reaction, for being unconscious, cannot be told by consumers through questionnaires, interviews and focus-groups. Thus, seeking for new methods to evaluate visual identities is an urgent task. Furthermore, this paper recommends the designer to always be in dialogue with other areas of knowledge, because many of them have important contributions to make to his work, such as the case of neuroscience.

5. References

Aamodt, Sandra; Wang, Sam. 2009. *Cérebro: Manual do utilizador.* Lisboa: Pergaminho.

Batey, Mark. 2010. *O Significado da Marca: Como as marcas ganham vida na mente dos consumidores.* Rio de Janeiro: Best Buniness.

Best, Kathryn. 2006. *Design Management: Managing design strategy, process and implementation.* Lausanne: AVA Publishing.

Camargo, Pedro. 2010. *Comportamento do Consumidor: A biologia, anatomia e fisiologia do consumo.* Ribeirão Preto: Novo Conceito.

Cayuela, Oscar Malfitano; Requena, Ramiro Arteaga; Romano, Sofia Edith; Scinica, Elsa Beatriz. 2011. *Neuromarketing: Para recobrar a confiança com os clientes.* Rio de Janeiro: Qualitymark.

Gobé, Marc. 2002. *A Emoção das Marcas.* Rio de Janeiro: Campus.

Goleman, Daniel. 2009. *Inteligência Emocional.* Camarate: SIG.

Gomez, Luiz S. R. Olhats, Magali. Floriano, Juliana. Vieira, Milton L. H. 2011. *O DNA da Marca de Moda: O processo.* Porto: Vila Econômica.

Keller, Kevin Lane; Machado, Marcos. 2006. *Gestão Estratégica de Marcas.* São Paulo: Pearson Prentice Hall do Brasil.

Lindstrom, Martin. 2007. *BrandSense: A marca multissensorial.* Porto Alegre: Bookman.

Lipovetsky, Gilles. 2007. *A Felicidade Paradoxal: Ensaio dobre a sociedade de hiperconsumo.* Lisboa: Edições 70.

Lopes, Maria Vassalo Immacolata. 1990. *Pesquisa em Comunicação.* São Paulo: Loyola.

Minuzzi, Reinilda; Pereira, Alice; Merino, Eugenio. 2003. *Teoria e Prática na Gestão do Design.* In: 2º Congresso Internacional de Pesquisa em Design. Rio de Janeiro: AEND-BR.

Mozota, Brigitte B. Costa, Filipe Campelo X. Klopsch, Cássia. 2011. *Gestão do Design: Usando o design para construir valor de marca e inovação corporativa.* Porto Alegre: Bookman.

Peón, Maria Luísa. 2011. *Sistemas de Identidade Visual.* Rio de Janeiro: 2AB.

Rodrigues, Fernando. 2011. *Influencia do Neuromarketing nos Processos de Tomada de Decisão.* Viseu: PsicoSoma.

Silva, Édna Lúcia; Menezes, Estera Muszkat. 2005. *Metodologia da Pesquisa e Elaboração de Dissertação.* Florianópolis: UFSC.

Strunck, Gilberto Luiz Texeira Leite. 2007. *Como Criar Identidades Visuais para Marcas de Sucesso: Um Guia sobre o Marketing das Marcas e como Representar Graficamente seus Valores.* Rio de Janeiro: Rio Books.

Tybout, Alice M. Calkins, Tim. 2006. *Branding.* São Paulo: Atlas.

Wheeler, Alina. 2009. *Disigning Brand Identity.* Hoboken: John Wiley & Sons.

Global E-Laws for E-Promoting, E-Branding and E-Marketing of Innovative Technologies

Priya Vinjamuri[27]

Abstract

Globalization and advent of innovative technological advancements has blurred the borders in trade. The strategies for effective, efficient and competitive trade are fast emerging and evolving. The buzz words today are "global economies", "global climatic changes", "global strategies" and "global trade". The need of the day is a "global law" to promote and provide for measures of regulation of e-technologies being innovated and used through e-marketing strategies.

The paper is an attempt at identifying the lacunae in the regulations and rules for implementing laws in the cyber/electronic world in the context of convergence of media. The laws for cybercrimes have made headway but much needs to be decided on the regulations and policies globally in an era of diversified national economies with the developing world differentiated from the developed and equitable responsibility is being opted to equal responsibility by the former.

Introduction

The number of guidelines, rules, regulations and policies to adapt to and follow while operating in the e-commerce world is not only magnanimous in scale but also variant. The laws of the internet are not yet globally formulated promoting the nature's principle of the ***"Big fish eat up the small fish"*** thereby making it immensely difficult to compete with the global market.

This is not an assumption but a reality when one has to address the concerns of the information technology laws especially with the advent of advances in cloud computing and network security. The illustration to this effect is the variation in the Cyber and Information Technology laws of the US, India and Hong Kong for instance which are stringent, in a state of constant amendments and non-existent respectively.

The laws of the electronic world, such as the Cyber laws & IT Act, as mentioned earlier do not have international dimensions and are in infancy if formulated and the global economic and primarily the creation of the technologically advanced giants with biased rules for functional use of the world users. The various national and international Acts and Regulations governing the Bio-medical sciences, stem cell research and therapy, the Patent's Act and the regulations governing the patenting of processes are a indicative testimony to this effect.

Online promoting, branding, marketing and selling are all dependent on the e-commerce laws, primarily having the flavor and essence of the commercial laws of transaction, including, Law of Contracts, the Company Law, Laws of Investment and Security, Law of Foreign Transactions and the Export-Import laws besides related statues depending on the functionality of the internet or online business as illustrated the case of many online trading firms, for instance, E-Bay. The policies on e-contracts, e-transactions and e-agreements so to say are not holistic and all-encompassing for the practice of fair trade.

Online promotion and marketing of products, online trading firms and business ought to be flexible so as to incorporate the frequent changes in the laws and adjust to the amendments to the global laws. The online business requires an understanding of not only the technological regulations and laws but also the commercial transaction and mercantile laws.

[27] Technology and Legal Analyst, Faculty of Law, COLS, UPES, Dehradun, INDIA

As Warren Keegan rightly puts it, *"a company that fails to go global is in the danger of losing its domestic business to competitors with lower costs, greater experience, better products and, in a nutshell, more value for its customer."* [28]

Inflation, global economy and networking technological advancements make the e-laws versatile and in a constant fluid state. Profitability of a shopping cart company, the parlance for any online company, is subject to the adaptability to the change and incorporation of the e-survival tactics with a thorough understanding of the principles of law governing any commercial transaction.

Gordon Moore predicted that *"every 18 months chip processing power would double while the costs to purchase would stay the same"*

The simple e-law or rather, the e-principle is held to be true in the context of the impact of cost to company and the business on the internet and e-commerce online stores. The cost of the e-business therefore increases as the cost of computers being constant, absorbing the maintenance costs, the real cost of running the business is actually falling given the economy of inflation, thereby making the online e-business accessible, affordable, profitable being technologically advanced, owing to the increased speed of functioning of the systems and their ease of access. The e-business gives a boost to e-sales as the buyers online are open to a quicker and reliable technology based buying market.

It is no exaggeration that **"E-commerce has been created by the buying and selling power of e-business"** and therefore, the virtual corporations and online businesses must utilize the available speed of technology.

The second most crucial aspect of e-business is the value of a network, usually measured by its utility that can perhaps be roughly estimated based on the extent of use of the network. The adaptability and constant up-gradation to faster networks is very important for an e-business with the increased number of users, products and awareness through e-promotion thereby making it extremely important to keep in tune with the increased demand of the rush of the internet users thus necessitating the requirement of a functional and implementable online supply chain management system so as to enhance the e-brand image and the face value of the e-company, reflecting on the significant growth and profitability of the business.

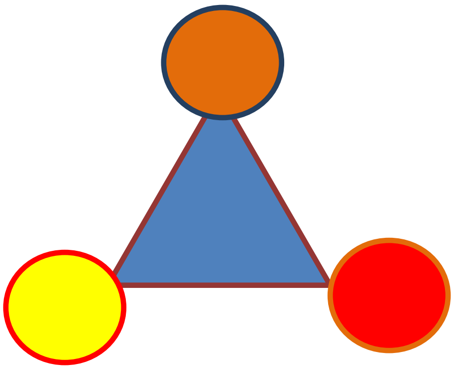
The third most important law of the e-commerce world is the 20-80 Rule applicable worldwide to a variety of e-products on e-sale. The Rule says **"20% of the population actually tries a variation of products online during its introduction and the remaining 80% follow behind after a true product is created."** This philosophy or rather the behavior of e-customers necessitates a thorough research of the e-business and substantial risk assessment and analysis of the e-market need, purpose and reason. Strategies adapted and implemented by other virtual players have to be keenly observed and understood.

GLOBAL E-COMMERCE REGULATIONS

E-commerce, simply, the selling of goods over the internet is subject to regulations and legislations which are not only complex but extremely transient and versatile. Promotional e-mails, online newsletters, sale of e-goods, marketing of e-goods and promotion of e-goods is a recent trend in virtual business and this as are any transactions is subject to the local laws of the land of production and also the laws of the land of consumption.

Trade restrictions, particularly import controls, are a very important problem which an international market faces. The issue is even is transaction is done online, delivery requires custom clearances for goods and thus prohibited and restricted goods to international destinations should be identified by the e-marketer failing which as unintended and unassuming criminal charge may be levied.

The emerging competitive environment depicted in the Figure 1.0 shows the competition faced by the local, national and international firms in an emerging competitive environment which has a direct and indirect impact on the laws governing the trade



LEGEND:

COMPETITION FACING LOCAL/NATIONAL/INTERNATIONAL FIRMS

NATIONAL PLAYERS

LOCAL PLAYERS

FOREIGN PLAYERS

E-commerce is understood to mean the *production, distribution, marketing, sale or delivery of goods and services by electronic means.* The Asia Pacific Economic Co-operation ("**APEC**") has adopted a wider definition of e-commerce to include *all business activity conducted using a combination of electronic communications and information processing technology*. The United Nations Economic and Social Commission for Asia and the Pacific ("**UNESCAP**") has also defined e-commerce as '*the process of using electronic methods and procedures to conduct all forms of business activity*. Over the past few years, global trade has expanded due to the explosive growth of electronic commerce.

Projections indicate that the volume of e-commerce will be approximately US$ 2 to 3 trillion in 2003-2005. While e-commerce is still at a nascent stage in India, certain estimates indicate that the total transaction volume of e-commerce in India is expected to grow rapidly to Rs. 195,000 crore by 2005.

Though at the outset, the prospect of conducting e-commerce may seem uncomplicated and economical, there are a variety of legal factors that an e-commerce business must seriously consider and keep in mind before commencing its activities. The importance of dealing with these complex legal issues has already been highlighted in light of the **recent "Napster.com" and "ToysRUs"** cases.

While governments across the globe have been grappling with these issues, it seems a long way before any concrete solutions may be reached. The set of issues that arise may be bifurcated into "**CORE**" legal issues that are relevant to all forms of businesses and "**OTHER**" legal issues, whose relevance may depend upon each particular industry.

The dot-com bubble is long behind us, but online commerce is finally red-hot again. In the late 1990s, the conventional wisdom was that the transformation from "bricks to clicks" for retailers would happen almost instantly. Yet over the past ten years, it's become clear that the shift to the Web was not a two- to three- year *revolution*, but a 15-20 year *evolution*.

According **to com Score**, non-travel/auto/gas/food e-commerce sales represented just 7.1% of total retail sales in the US in Q2 2010. But, significantly, online sales have grown at an annualized rate of 9.7% since 2006 (vs. the 2.3% annualized *decline* in total retail sales over that same period, which includes the Great Recession). Leading online retailers, like **Amazon.com**, are growing even faster—30% per year for the past several years. This growth in e-commerce should only accelerate.

Companies like **Zappos, Bessemer portfolio company Quidsi** (operator of Diapers.com and Soap.com**), Vente Privee, Netflix** and others are creating new online-retail categories and pulling offline dollars onto the Web. But a lot has changed since the heady—and money-losing—days of eToys and Pets.com. Today's successful e-commerce sites don't just throw products up on a Web site and spend tens of millions of dollars on traditional brand advertising to promote them. The rules of the game today are much more complex and, in many ways, scientific: They involve astute use of targeted, direct-response advertising, for instance, and careful calculations about the lifetime value of each customer. Those leading the e-commerce pack today also display a laser-like focus on customer service, including offering fast and/or free product delivery. (Consider Zappos, which ships customers their shoes overnight.)

The crucial and tricky aspect of the e-laws in e-promoting would be the territorial rules of the land, giving a geographical indication to the dependency on the laws of land of origin, land of promotion and land of final consumer.

An understanding of the intricate web of which e-product may be e-promoted over the internet, which e-product may be e-branded or e-purchased using a variety of browsers becomes a crucial security concern for the networking industry. For a fine example, e-marketing or e-promotion of alcoholic beverages is strictly prohibited in the middle-east, e-promotion of lingerie and nude photographs is banned in some conservative nations and e-branding of non-European products is not permissible in the European nations. The reason for imposition of such restrictions is as varied and variant as the culture and local laws prevalent.

The e-laws and regulations globally are not restricted to computers or their use but to the other electronic devices inclusive of telephones, fax machines, modems, software and related devices. These are supplemented by the distance selling regulations and provisions of service regulations.

The other most crucial aspect of the impact of globalization on business is that it necessitates continuous productivity improvement because of the survival of the fittest environment. In a globalized business environment, Indian firms face global competition even in the domestic market. Foreign firms may compete in the Indian market by goods manufactured by them in India or imported from abroad. If the Indian firms are not able to compete with them on the basis of price, quality, features, etc. which determine the product choice by consumers, their chances of survival are very bleak. This necessitates stringent local laws in favor of the national market thereby not satisfying the customer needs if imposed especially in era of globalization and free trade policies.

In light of the global value chain of product components, as depicted in ***Figure 2.0*** below, adapted from the UNCTAD, World Investment Report, 2002,the concerns of technology transfer through the procurement and e-advertising may be said to be in an infancy.

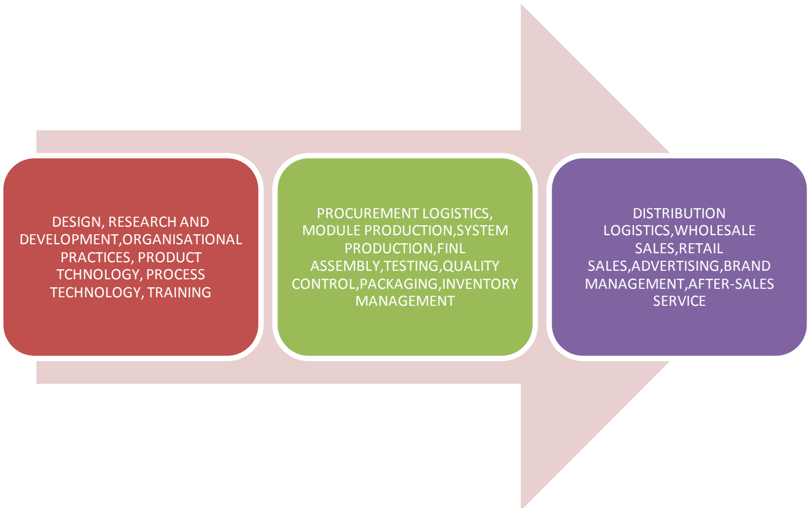


FIGURE: 2.0 -The Global Value Chain of Product Companies

(Adapted from UNCTAD, World Investment Report, 2002)

The global laws for establishing the connect between managing the electronic or online business, the virtual world and managing the e-business has become a crucial and essential ingredient of the various aspects of work place etiquette and ethics irrespective of the nature of the firm being a start-up or a public enterprise or a multi-national corporation. The most important aspect of any business being finance and grants is another area of concern requiring a fine understanding of the nuances of financial management and its legal implementation in the e-world of business for the concerns of tax, payroll, commercial transactions, and contractual agreements besides the human resource aspects of workplace health, safety, skills and employment incentives. The virtual business world also needs to comply with the workplace concerns of environmental efficiency and protection.

An understanding of the preference of virtual branding, promoting and advertising leading to marketing on the internet is very important to understand the paradigm shift in the business trends from physical to virtual.

The implication of the relation between the laws promoting e-trade and the strategic management of the virtual market necessitates a global platform for international virtual trade and transactions.

CHALLENGES IN E-TRADING OF INNOVATIVE TECHNOLOGIES

The advent of innovative technologies has blurred the borders in internationals trade with the globalization of economies. International trade calls for effective, efficient and economical strategies in the utilization of technologies that are fast emerging and the regulation of the use of these is very crucial yet cumbersome.

The challenges of e-business include the concerns of uniform laws formulated for the purpose of standardization of world economy and uniformity in the GDP of nations, concerns of climatic changes owing to e-waste disposal and the intellectual property issues in the digital era of creation and the concerns of technology licensing and patents for the various software processes, products and middle ware created for faster and reliable business.

The biggest challenge in the implementation of global e-laws is primarily the formulation of new regulations, rules and policies of universal applicability followed by the prudent use of existent laws of trade that can be adapted by the virtual trade industry. The various Acts, Regulations and Policies that are drafted are wanting in the applicability and enforcement in the changing global scenario, more so in the light of the entire gamut of e-transactions. The aspects illustrative of such lacunae may be in the laws governing

1. Offer and Acceptance
2. Click-Wrap Contracts
3. Online Identity

The Information Technology Act, 2000 ("**IT Act**") deals with contractual aspects of use of electronic records, such as attribution, acknowledgement, time and place of dispatch and receipt. Being an enabling Act, it is to be read in conjunction with the Contracts Act (the Indian Contracts Act, 1872) and its basic provisions of offer, acceptance and consideration within the definition of its various sections while applying to e-contracts.

The issues or challenges would arise on various aspects, which include serious queries such as

1. How do we know on the acceptance of the offer ?
2. The transmission of message is en-route, and does not establish a direct line of communication, and hence, how to ascertain the exact time of communication?
3. How to determine the rights of the parties?
4. Does a person who has not read the terms of the contract or who has is not being able to negotiate, as in the case of click-wrap contracts, be bound by the terms and conditions of the contract? (As in the case of the Subscriber's Contracts available online.)
5. How does one legally address, on a global platform transactions on the internet, particularly consumer related, that often occur between parties who have no pre-existing relationship arising out of concerns pertaining to a person's identity in terms of capacity, authority and legitimacy to enter a contract? (Digital Signatures is perhaps the closest we can get in terms of a viable solution, the regulatory framework of which is governed by the provisions of the IT Act.)

6. How do we handle the different legislations regulating the digital signatures in terms of Authentication aspects on a global e-regulatory system?

The next big concern is the Security over the internet, especially to promote e-commerce that is safe and devoid of unauthorized intrusion internally and externally from hackers, viruses, Trojan horses and internal technical staff, which may partly be addressed through different modes of encryption, firewalls, access codes, passwords, virus scans and biometrics. The enforcement of these requires an e-legal policy, well documented and made mandatory for all the users and stakeholders.

An example to illustrate the case is that in 2011, a person decided to sue Nike because the Nike's website was hacked and the contents of the domain were re-directed through the person's web servers in the U.K., bogging them down and costing the web hosting company time and money.

Internet does eliminate the need for physical contact but, it does not do away with the fact that any form of contract or transaction would have to be authenticated. Different authentication technologies have evolved over a period of time to ensure the identity of the parties entering into online transactions. However, there are some issues that need to be considered by companies, especially those in the e-marketing and e-commerce business. Some of the technologies that need to be implemented include

Use of digital signatures as authentication tools: The Indian IT Act stipulates that the digital signatures should be used for the purposes of authenticating an electronic contract. The digital signature must follow the Public Key infrastructure ("**PKI**"). This acts as a limitation on the use of any other technology for authentication purposes. If Indian e-commerce companies use some other form of authentication technology, it could be said that there has been no authentication at all.

Innovating and evolving inter-operable technology standards: Laws of different countries provide different authentication standards, sometimes specifying a clear technology bias. These different authentication standards need to be inter-operable so as to facilitate cross-border transactions. This would need a high degree of co- operation between countries and the technology providers. For example, an e-commerce company that uses PKI authentication technology for online contracts with Indian consumers may use different / other forms of technology while entering into online contracts with consumers in other countries. In such a case, these contracts with foreign consumers may not be recognized in India as the authentication technology used is not PKI. However, such contracts may be enforceable in the foreign jurisdiction depending upon the laws of the foreign country.

Ensuring privacy of the users: Use of innovative technologies and lack of secure systems makes it easy to obtainpersonal and confidential information about individuals and organizations. For instance, in July 2001, a dozen privacy groups filed a complaint in the US about the privacy issues in Microsoft's Windows OS. Some features of the Operating System store personal information such as passwords and credit card data so that users are not required to constantly re-enter this information as they surf through websites. Another illustration to the effect is the risk of extinction faced by the Web Cookie under a proposed European commission directive, which may actually not take off if the initiative of the Interactive Advertising Bureau of UK lobbying effort "Save our Cookies" takes off as statistics reveal that British companies could lose approximately US$ 272.1 million if the directive were passed.

Privacy concerns have also been raised regarding the Internet Corporation for Assigned Names and Numbers ("**ICANN**") "Whois" database, which is a publicly searchable resource used to determine the identity of domain name registrants. The database includes the name of the individual or company that registered a given domain name, as well as the owner's address, the dates on which the domain was created, when it expires and when it was last updated. Privacy groups criticized the company for selling information about its registrants, arguing that many of them are individuals who never agreed to having their information sold as a commodity when they signed up for the service.

The major privacy concerns on the internet that need immediate address and redress include

1. dissemination of sensitive and confidential medical, financial and personal records of individuals and organizations
2. sending spam (unsolicited) e-mails;
3. tracking activities of consumers by using web cookies;
4. Un-reasonable check and scrutiny on an employee's activities, including their email correspondence

Moreover, when an e-commerce company caters to consumers in foreign jurisdictions, the foreign jurisdictions may have laws that could make the e-commerce company liable for violating the foreign consumer's privacy rights. For example, Company A in India, that receives some personal data from a consumer in the European Union, and disseminates the information to companies in the US, may be liable for invasion of privacy rights of the consumer.

One of the foremost considerations that any company intending to commence ecommerce activities should bear in mind is the protection of its intellectual assets. The Internet is a boundless and unregulated medium and therefore the protection of intellectual property rights ("**IPRs**") is a challenge and a growing concern amongst most e-businesses. While there exist laws in India that protect IPRs in the physical world, the efficacy of these laws to safeguard these rights in e-commerce is uncertain. Some of the significant issues that arise with respect protecting IPRs in e-commerce are:

a. Determining the subject matter of protection

b. Ascertaining novelty *I* originality

c. Enforcing IPRs

d. Preventing unauthorized hyperlinking and meta tagging

e. Protection against unfair competition

The laws against cyber-squatting, have been made very stringent as in the recent ".info" top-level domain that was opened for registration and the WIPO (World Intellectual Property Organization) had to handle two cases for dispute settlement. Further, another US Company, NeuLevel Inc. who had been restrained from distributing the ".biz" domain names, has now been allowed to do so as the plaintiffs declined to post a bond that would have prevented the company from handling out new domain names. Moreover, the ICANN recently confirmed that it had finalized a contract with Museum Domain Management Association whereby ".museum" has also been included as a generic top-level domain in the global domain name system.

The other major concern in e-commerce and the formulation of global e-laws is the jurisdiction of the corporate structure thereby requiring determination of the extent of any liability that may arise against the website. According to the traditional rules of private international law, the jurisdiction of a nation only extends to individuals who are within the country or to the transactions and events that occur within the natural borders of the nation.

The e-marketing strategies are dependent on the economic strength of a nation, the factors for implementation of laws and regulations for higher profitably by the strong nations thereby rendering the chances of e-marketing highly non-profitable or extremely difficult in the developing nations. The grievance is being addressed by most of these under privileged lands by accepting to provide cheap training and labor for the outsourced e-business projects in all the service sectors including telecommunications, information technology, legal and medical field through telemedicine practices besides other online businesses to meet the never ending demands of employment escalating proportionally with population growth. The second world nations to meet the local demands of social pressures, monetary benefits and a dire need for any kind of employment are ever ready to consent to the strategy of the first world super powers thereby knowingly consenting to higher profitability. Perhaps, as an after-thought, this could be one of the reasons why richer nations become richer and poorer one poorer.

The second biggest challenge is the rules for implementation of cyber or electronic laws in the context of media convergence where by the borders between the telecasting, telecommunications and internet are merging. The regulations for these convergent e-communications are in infancy and differ from nation to nation, thus creating a barrier for global e-trade and e-transaction. Cyber laws, transmission laws, spectral laws and broadcasting laws world-wide have to be re-structured so as to create and impose global e-laws for media convergence to promote global e-trade.

The third identifiable challenge to e-marketing and e-promoting is the security levels of individual nations, the personal laws that are restrictive in nature being globally variable and the reach of the internet to remote and rural sectors. In the high density rural populations of the world, with special focus on the developing lands, the accessibility to internet and thereby e-trade and e-transactions are highly infeasible and therefore, the e-trade is not profitable in these sectors. The implementation of e-marketing strategies in these nations would therefore be highly non-profitable and organizations have to balance the demand-supply curve in these sectors.

The fourth challenge is the technology licensing issues in e-transactions. The intellectual property that needs ample protection is the processes and products of software design and development. These source codes have to be protected and are subject to grant of patent. The specification and drafting of software patents is again variable as the permission for process patent is not universal wherein the grant for product is. This paves way for new concerns of network protection and anonymity as e-trading especially, in situations that require submission of online attendance.

The final challenge to global e-laws is a common platform for formulation of the laws that do not compromise with the statues of the individual lands and yet provide for the freedom of e-trade to all nations on the same level of laws implementation.

CONCLUSION

The global e-laws for e-branding, e-promoting and e-marketing in the world market are not existent, and if present are not uniform in their implementation. The lacunae in the regulations and rules have to be firstly analyzed and then enforced. The lacunae as identified above create room for implantation of the laws globally thereby promoting safe and protected transactions. Much has to be researched upon and deliberated effort for the global laws decided on the regulations and policies globally in an era of diversified national economies with the developing world differentiated from the developed and equitable responsibility is being opted to equal responsibility by the former.

REFERENCES:

1. International Business-Text and Cases- *Francis Cherunilam- 4Ed*
2. Bessemer top 10 e-commerce rules
3. *ProCD* v. *Zeidenberg*, available at http://www.law.emory.edu/7circuit/june96/96-1139.html
4. "Europe Goes After the Cookie", October 31, 2001 at www.unwired.com
5. Article 19 (1)(a) and Article 21 of the Constitution. Refer to *Unni Krishnan, J.P.* v. *State of AP* (1993) 1 SCC 645,
6. *Kharak Singh* v. *State of U.P* AIR 1963 SC 1295, *Gobind* v. *State of Madhya Pradesh* (1975) SCC (Cri) 468.
7. *People's Union of Civil Liberties* v. *the Union of India* (1997) 1 SCC 318.
8. Section 69 and Section 72 of the Information Technology Act, 2000.
9. "Hosts" and web page creators can delete files within a matter of hours or days after their posting.
10. India has not signed this treaty. Pursuant to this treaty, the US Government has enacted that Digital
11. Millenium Copyright Act to afford protection to digital copyrights
12. Article 11, WIPO Copyright Treaty, 1996.
13. California Software Incorporated v. Reliability Research, Inc., 631 F. Supp. 1356 (C.D. Cal. 1986) cited from Julian S. Millstein et al *Doing Business on the Internet: Forms and Analysis (1999)*.
14. The Due Process Clause of the 14th Amendment of the Constitution of the United States as referred to in
15. "A Separate Jurisdiction for Cyberspace?" by Juliet M. Oberding and Terje Norderhaug
16. http://www.ascusc.org/jcmc/vol2/issue1/juris.html.
17. International Shoe Co. v. Washington, 326 U.S. 310 (1945) cited from"A Separate Jurisdiction for Cyberspace?" by Juliet M. Oberding and Terje Norderhaug.
18. http://www.ascusc.org/jcmc/vol2/issue1/juris.html.
19. *Calder* v. *Jones*, 465 U.S. 783 (1984) cited from"A Separate Jurisdiction for Cyberspace?" by Juliet M Oberding and Terje Norderhaug.
20. http://www.ascusc.org/jcmc/vol2/issue1/juris.html. However, Indian courts have yet not taken any particular stance regarding the "minimum contacts" theory.
21. *CompuServe, Inc.* vs. *Pattterson*, 89 F.3d 1257, 1259-1260 (6th Cir. 1996) cited from Julian S. Millstein et al *Doing Business on the Internet: Forms and Analysis (1999)*.
22. Washington23 Washington Post Co. v TotalNews, 97 Civ. 1190 cited from Richard D. Harroch, Esq. *Start-up and Emerging Companies: Planning, Financing, and Operating the Successful Business* (Vol 2 Revised Ed.)
23. New York Times Co. v Sulllivan, 376 US 254 (1964) cited from Richard D. Harroch, Esq. *Start-up and Emerging Companies: Planning, Financing, and Operating the Successful Business* (Vol 2 Revised Ed.).

24. Warren J. Keegan, Global Marketing Management, Prentice-Hall of India, New Delhi, 1995, p.3)
25. "The Work Programme on Electronic Commerce; Background Note by the Secretariat", Council for Trade-Related Aspects of Intellectual Property Rights, WTO.

26. "A. Didar Singh, "Electronic Commerce: Issues for the South" Trade-related Agenda, Development andEquity, Working Paper, South Centre, October 1999, p. 4.
27. "A. Didar Singh, "Electronic Commerce: Issues for the South" Trade-related Agenda, Development and Equity, Working Paper, South Centre, October 1999, p. 4.

28. See http://ecommerce.wipo.int/primer/section1.html#27 as visited on October 18, 2001. The estimates weretaken from OECD (1995, 1997, 2001-2), ITU (1998) and Forrester Research, Inc. (2003-5).

29. Current e-commerce transaction volume estimated to be between Rs. 15,000 to Rs. 20,000 crore (FY 2000): "E-commerce Opportunities for India Inc." NASSCOM-BCG Report on E-commerce (June 2001), p.7. BCG defines e-commerce to include all electronic transactions including EDI.

30. See http://www.wired.com/news/politics/0,1283,37286,00.html (as visited on October 22, 2001

31. See: http://www.it.mycareer.com.au/breaking/2001/10/22/FFX18I063TC.html (as visited on November 5,2001).

32. See: http://news.zdnet.co.uk/story/0,,t269-s2098080,00.html (as visited on November 5, 2001).
33. See: http://www.washtech.com/news/regulation/13217-1.html (as visited on November 5, 2001) "Private International Law", Cheshire and North, 11th Ed. pg. 188

Supply Chain Continuous Improvement Supported by Inter-organizational Learning

Quan Zhu[29]*, Harold Krikke*[30]*, and Marjolein C. J. Caniëls*[31]

Abstract

In today's uncertain and turbulent markets, classic approaches to supply chain (re-)design fall short to deal with changes. A dynamic view of supply chain continuous improvement (SCCI) has become a significant issue for companies to maintain their competitive advantage. To realize SCCI, solutions and tools need to be indentified to guide practice. Of them, inter-organizational learning seems to play an essential role. Thus, in this paper, we propose a framework to illustrate how inter-organizational learning supports SCCI. We show why supply chains should be more modular, but modularity alone is not enough to help companies achieve competitive advantage in a long run, due to the emergence of the Red Queen effect. The Triple-A supply chain can alleviate the Red Queen effect, and inter-organizational learning serves as a mediator to connect strategies of modularity and the Triple-A supply chain with SCCI. Finally, several concerns on how to foster inter-organizational learning are discussed.

Key words: Change, Supply chain continuous improvement, Inter-organizational learning

1. Introduction

On March 11th, 2011, a magnitude 9.0 earthquake rocked the main island of Honshu, Japan. Exploding nuclear power plant buildings, demolished cities and personal accounts of the tragedy stunned people around the world. The earthquake also heavily disrupted global manufacturing supply chains, from suppliers to manufacturers. Serious lost was found not only in Japanese companies (e.g. Sony lost $ 273 million from March to May, due to its shut-down plants), but also in multinational firms (e.g. HP lost $ 700 million from March to May, due to the shortage of components from suppliers) (Brennan, 2011).

In today's uncertain and turbulent markets, natural disasters, accidents, and intentional disruptions from outside and global sourcing, ever-shrinking product life cycle and green issues from inside, all have resulted in serious disruptions to supply chain activities. Thanks to their stability, classic approaches to supply chain (re-)design fall short to deal with modern market changes. In cooperate with the changes dynamically, supply chain continuous improvement (SCCI) has become an issue of significance for many companies to tackle with uncertainty. One positive solution is that supply chain (systems) today become more modular, universal systems replace the propriety supply chain systems currently in place. However, although it provides plug and play capabilities, modularity alone is not enough. For example, Dell's strategy to Assemble to Order helps the company achieve competitive advantage until the fourth quarter of 2006, when Dell lost its title of the largest PC manufacturer to rival HP. To this end, we argue that a more strategic solution should be utilized. To support the implementation of a strategic solution, organizations need to learn, and moreover they need to learn collaboratively in response to the changing business environment (Caniëls and Romijn, 2008).

Continuous improvement (CI) is a philosophy that Deming described simply as consisting of 'improvement initiatives that increase successes and reduce failures' (Juergensen, 2000). Indeed, McAdam

[29] Open University, the Netherlands, +31 (0)45 5762791, quan.zhu@ou.nl
[30] Open University and Tilburg University, the Netherlands, +31 (0)13 4662315, Krikke@uvt.nl
[31] Open University, the Netherlands, +31 (0)45 5762724, mcc@ou.nl

et al. (2000) argue that development of a CI culture by companies is strongly associated with the development within companies of an innovation culture, and learning is central to innovation and improvement (Hyland et al., 2003). This goes in line with the idea in using the balanced scorecard to measure supply chain performance: innovation and learning perspective is used to measure supply chain improvement performance (Brewer and Speh, 2000). According to Spekman et al. (2002), supply chain serves as a vehicle for gathering knowledge and learning. Vise versa, (inter-)organizational learning has a positive influence on customer orientation and relationship commitment in the global supply chain (Hult et al., 2000).

The purpose of this study is to gain insights into how SCCI can be more successful through inter-organizational learning. Scholars (Baldwin and Clark, 1997; Schilling, 2000; Mikkola, 2003; Krikke et al., 2004; Umeda et al., 2008) have certified that modularity is a solution for SCCI. However, due to the emergence of the Red Queen effect -- focal firm's innovative actions to gain advantage in the marketplace will be eroded by its rival's competitive moves (Derfus et al., 2008), modularity alone is not enough to help companies achieve competitive advantage in a long run. The current study argues that the Triple-A (agile, adaptable, and aligned) supply chain (Lee, 2004) can alleviate the Red Queen effect and inter-organizational learning serves as a mediator to connect strategies of modularity and the Triple-A supply chain with the performance of SCCI. The research framework is summarized in Figure 1 and will be discussed in details in the following sections.

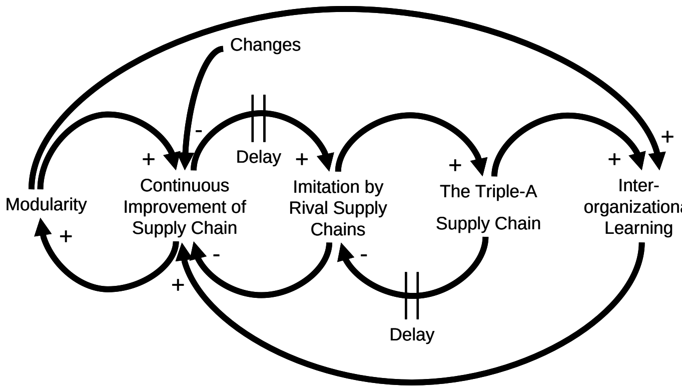


Figure 1. Research framework

The paper is structured in the following way. In section 2, we will illuminate how inter-organizational learning supports SCCI through a literature review. First, we will discuss classic approaches to supply chain (re-)design in 2.1. Then, we will introduce modularity and the rising problem of the Red Queen effect in 2.2. To solve the problem, we will recommend the Triple-A supply chain in 2.3. Last, we will address the supportive role of inter-organizational learning and the way to implement it in 2.4. And in conclusion, we form our research framework and recommend future research in section 3. References are listed in section 4.

2. Literature review

2.1 Classic approaches to supply chain (re-)design

Supply chain (re-)design decisions need to be matched with customer demand. A counter example occurred on Webvan, an online grocer promising cheaper, more convenient methods of shopping. It became the standard bearer for dot-bombs by burning through $1 billion in investor capital in a little over a year before going bankrupt in 2001 (Rizzo, 2001). What Webvan overlooked or miscalculated was that a marketing strategy of offering low prices needs to be matched with an operations strategy that actually achieves low costs (Boyer & Hult, 2005). According to Porter (1980), a company's failure to make a choice between cost leadership and differentiation essentially implies that the company is 'stuck in the middle'. Porter's dichotomy thinking is -- from a supply chain strategy perspective -- reflected in Marshall Fisher's framework that commodities were to be produced by efficient supply chains, and innovative products by responsive supply chains (Fisher, 1997).

There is disagreement between scholars regarding the black and white approaches of Porter (1980) and Fisher (1997). Kay (1993) and Miller (1992) have cited empirical examples of successful companies like Toyota and Benetton, which have adopted more than one generic strategy. Both these companies used the generic strategies of differentiation and low cost simultaneously, which was the key to the success of these companies. Following the same logic, Mason-Jones et al. (2000) point out that the supply chain must excel at the market winner metrics and be highly competitive at the market qualifier metrics, i.e. the minimum standard for entry into the marketplace (Figure 2). Basing on this idea, they propose a framework of 'leagile' supply chain: lean supply chains remove all non-value-adding activities, thereby avoiding unnecessary cost, whilst agile supply chains focus on responding to volatile downstream demand. 'Leagile' supply chains combine best of both worlds (Figure 3). However, where to position the decoupling point depends on many factors and foremost it is subject to change of demand uncertainty. For example, when we consider the whole life cycle of a product, the decoupling point should be first put close to lean processes side in the introduction phase, leaving more resources for agile processes to deal with the demand uncertainty. When the demand becomes concrete and the profit margin begins to shrink, the decoupling point should be moved towards agile processes side, leaving more efforts for lean processes to cut costs. In this case, a prototype of SCCI from demand side begins to emerge.

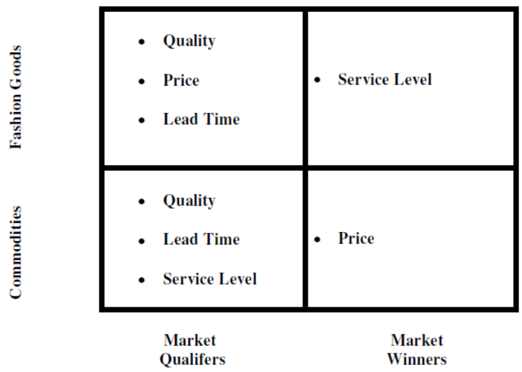


Figure 2. An example of using the classification matrix based on market winners and market qualifiers (Mason-Jones et al., 2000)

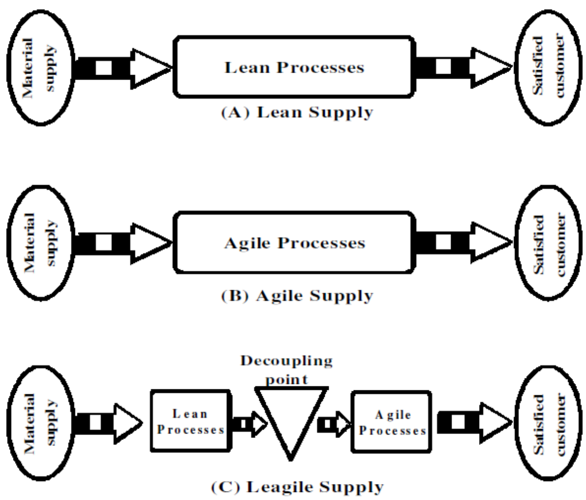


Figure 3. Block diagrams representing lean, agile, and leagile supply (Mason-Jones et al., 2000)

Another important issue for supply chain (re-)design is supply uncertainty. Lee (2002) summarizes the differences between stable supply process and evolving supply process (Figure 4). Free exchanges of information (starting with the product development stage and continuing with the mature and end-of-life phases of the product life cycle), early design collaboration and supplier hubs have been found to be highly effective in reducing the risks of supplier failure. Supply uncertainty also changes by time. Lee uses Dell as an example to illustrate supply chain strategies for innovative products with stable supply processes. But considering the case of Japan Earthquake, we can hardly say that Dell's supply processes are still stable nowadays. A company, like Dell, should anticipate and make backup plans for change in supply uncertainty. Thus, the need for SCCI also appears from supply side.

Stable	Evolving
Less breakdowns	Vulnerable to breakdowns
Stable and higher yields	Variable and lower yields
Less quality problems	Potential quality problems
More supply sources	Limited supply sources
Reliable suppliers	Unreliable suppliers
Less process changes	More process changes
Less capacity constraint	Potential capacity constrained
Easier to changeover	Difficult to changeover
Flexible	Inflexible
Dependable lead time	Variable lead time

Figure 4. Supply characteristics (Lee, 2002)

In sum, as the forms of changes and their severity begin to increase, companies now are forcing to think in a more dynamic view of SCCI rather than the static view of supply chain (re-)design. So how can companies on the supply chain cope with changes and facilitate SCCI? One possible answer is modularity.

2.2 Modularity and the Red Queen effect

According to Baldwin and Clark (1997), modularity is an approach for organizing efficiently the design and production of complex products and processes. Complex tasks are decomposed into simpler elements so that they can be managed independently and yet operate together as a whole. Modularity exponentially increases the number of possible configurations achievable from a given set of inputs, greatly increasing the flexibility of a system (Schilling, 2000). A motivation behind modularity is to gain flexibility and cost savings through economies of scale (Mikkola, 2003). Modularity fulfills the demand of both lean and agile processes. That's why it is widely used in SCCI to reduce demand uncertainty.

Modularity also serves as a useful tool to deal with supply uncertainty. According to Krikke et al. (2004), modularity goes hand in hand with greening the entire supply chain, as it's easier to reuse and upgrade. It will make the reverse supply chain a competitive vendor as good as new supply rather than a dumping channel to cascade markets, adding a valuable source of supply. Meanwhile, considering the whole life cycle of a product, components that undergo the same life cycle processes should be grouped into one module for improving, e.g. disassemblability, maintainability, upgradability, reusability, and recyclability, thus merging the supply base of certain components (Umeda et al., 2008).

However, modularity can be gradually copied by competitors, leading to the Red Queen effect (Derfus et al., 2008). The Red Queen effect is based on the conversation between the Red Queen and Alice in Lewis Carroll's *Through the Looking Glass*. In that story, Alice realizes that although she is running as fast as she can, she is not getting anywhere, relative to her surroundings. The Red Queen responds: "Here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!" (Carroll, 1960: 345). Applied to a business context, the Red Queen effect can be seen as a contest in which each firm's performance depends on the firm's matching or exceeding the actions of rivals. In these contests, performance increases gained by one firm as a result of innovative actions tend to lead to a performance decrease in other firms. The only way rival firms in such competitive races can maintain their performance relative to others is by taking actions of their own. Each firm is forced by the others in an industry to participate in continuous and escalating actions and development that are such that all the firms end up racing as fast as they can just to stand still relative to competitors. In the words of system thinking, it belongs to 'Limits to Growth' (Senge, 1990) (Figure 5). The process of firm actions and firm performance feeds on itself to produce a period of accelerating growth. However, rival actions and rival speed of actions slow down this growth by negatively influence focal firm performance, ending up to a balancing process. The focal firm would not achieve a competitive advantage in a long run through certain actions. For example, Dell's strategy to Assemble to Order, outsource to regional locations and squeeze supplier's prices has been caught up by time because it has brought un-intentional benefits to its rivals who use the same components (suppliers). In our case, modularity is also this sort of firm action, though the imitation of rival firms may show some extent of delay. Thus, the Red Queen effect will negatively influence the quality of modularity, also ending up to a balancing process. So what is the proper firm action that cannot be easily imitated, so that the Red Queen effect can be relieved and further facilitate SCCI? We recommend the answer of the Triple-A supply chain (Lee, 2004) below.

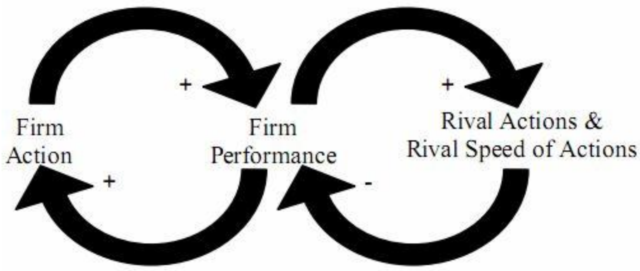


Figure 5. The Red Queen effect in the words of system thinking

2.3 The Triple-A supply chain

The Triple-A stands for agility, adaptability, and alignment. Agility refers to the ability of a supply chain to react quickly to unexpected or rapid shifts in supply and demand. Adaptability refers to a willingness to reshape supply chains when necessary, without ties to legacy issues or the way the chain has been operated previously. And alignment refers to ensuring that the interests of all participants in a supply chain are consistent (Lee, 2004).

Nowadays, markets are becoming customer-oriented. The reconceptualization of the marketing mix by Bruner (1988) addresses many of the weaknesses of the four P's (product, price, place, promotion) with the four C's (concept, cost, channel and communication), which shows a transfer from product-dominant marketing to customer-dominant marketing. Moreover, Vargo and Lusch (2008) propose their idea of service-dominant logic, stating that all economies are service economies and a service-centered view is inherently customer oriented and relational. Therefore, the decoupling point should move towards lean processes side and leave more resources to agile processes so that companies can gain more agility to better fulfill customers demand and cope with short-term changes on supply chain. Meanwhile, quick data exchange in supply and demand and the collaboration of product development are also important to agility. Zara, for example, utilizes a quick response strategy to increase agility. According to Ferdows et al. (2004), Zara's strategy builds on three principles: close the communication loop, stick to a rhythm across the entire chain and leverage capital assets to increase supply chain flexibility. The first principle maintains information flow through supply chain partners. The second principle allies the efforts through the whole supply chain. And the third principle guarantees more resources investing to agile processes. As a result, though facing considerable market uncertainty of the apparel industry, Zara still achieved a net margin of 10.5% in 2001, higher than its competitors (Beneton's was 7%, H&M's was 9.5%, and Gap's was near zero).

Comparing to the near-permanent shifting power to customer side, sudden changes in the market further test supply chains resilience. First of all, it may cause the disruption from supply side. A famous example is from Philips in New Mexico, where a fire at the local plant site caused a production breakdown worldwide at various manufacturing sites. Ericsson lost $400 million in sales, because it employed the Philips as a single source. Ericsson's production was disrupted for months, when the Philips plant shut down after the fire. By contrast, Nokia, another major customer of the plant, almost immediately began switching its chip orders to other Philips plants, as well as to other Japanese and American suppliers. Thanks to its adaptability, Nokia suffered little during the crisis and even stole market shares from

Ericsson (Chopra and Sohdi, 2004). In spite of crisis and disasters interrupting supply, supply chains also face sudden changes from demand side. Those changes usually occur because of economic progress, political and social change, demographic trends, and technological advances. Unless companies adapt their supply chains, they won't stay competitive for very long (Lee, 2004). For example, to reduce the impact of economics and political factors, Li & Fung, the largest trading company in Hong Kong for durable goods, established a supply network of over 4,000 suppliers throughout Asia. When the Indonesia Rupiah devalued by more than 50% in 1997, many Indonesian suppliers were unable to deliver their orders to their U.S. customers because they were unable to pay for imported materials. In this case, Li & Fung adapted quickly by shifting some production to other suppliers in Asia and by providing financial assistance to those affected Indonesian suppliers to ensure business continuity. With an adaptive supply network, Li & Fung was able to serve their customers in a cost-effective and time-efficient manner (Tang and Tomlin, 2008). Thus, adaptable supply chains rely heavily on information transfer to identify shifts in the market, and then take appropriate actions such as moving facilities, changing suppliers and outsourcing (Ketchen Jr. and Hult, 2007).

Obviously, both agility and adaptability rely on the well maintenance of supply chain relationship, since information sharing and collaboration should be based on a solid relationship. However, most chain participants faced with taking an action that benefits their firm versus one that benefits the chain will choose the former (Narayanan and Raman, 2004). As a result, incentives must be organized in such a way that all parties' interests are aligned. First, focal companies must know which kind of suppliers or customer companies should be closely connected. From resource-base view, Steinle and Schiele (2008) propose that suppliers or customer companies can be firm-addressable resources if they are sufficiently bound to a firm. Suppliers or customer companies are seen as firm-addressable resources, which can contribute to a sustainable competitive advantage, if they fulfill the following criteria: (1) they offer a valuable product to the final customer; (2) they are rare, that is, there are only a few comparable suppliers or customer companies; (3) their product is not easy to substitute and (4) it is difficult for third parties to imitate the buyer-supplier relationship. Second, those chosen suppliers and customer companies should also consider focal companies as a necessary link on the supply chain. This may happen if those chosen suppliers and customer companies inherently rely on the focal companies (on technology, transaction volume, and market information, etc.) or focal companies' alignment motivates those chosen suppliers and customer companies to follow. In the latter case, focal companies should redefine partnership terms to share risks, costs and rewards for improving supply chain performance and relocate incentives so that players maximize overall chain performance while also maximizing their returns from the partnership (Lee, 2004).

As a consequence, the Triple-A supply chain elevates supply chain management from a function that supports strategy to a key element of strategy, which can achieve a sustainable competitive advantage. That's why we consider the Triple-A supply chain as the proper firm action to alleviate the Red Queen effect and further support SCCI. So the next question should be: do we have certain tool(s) to help the implementation of the Triple-A supply chain in practice? We find the answer of (inter-)organizational learning.

2.4 (Inter-)organizational learning

There are several definitions of organizational learning. Senge (1990) defines organizational learning as 'a continuous testing of experience and its transformation into knowledge available to the whole organization and relevant to their mission', while Argyris and Schön (1978) see organizational learning as a phenomenon that emerges when organizations acquire information (knowledge, understanding, know-how, techniques and procedures) of any kind by any means and Cyert and March (1963: 123) define organizational learning as 'a process by which organizations as collectives learn through interaction with their environments'. The latter two definitions imply the importance of the business environment for organizational learning, thereby including the interaction with business partners. This interaction facilitates knowledge and information sharing and collaboration, making relationship-specific investments in return for benefits that can only be reaped by working together (Dyer and Singh, 1998). This logic can be better illustrated by Mikkola (2003) 's framework (Figure 6). In his framework, product architecture contributes to modularity and agility; component outsourcing contributes to adaptability; and supplier-buyer interdependence contributes to alignment. So it makes clear that modularity and the Triple-A supply chain smooth the progress of knowledge sharing, and knowledge sharing facilitates inter-firm learning. After learning by doing/failure, the focal company achieve better performance and further spurs certain strategies.

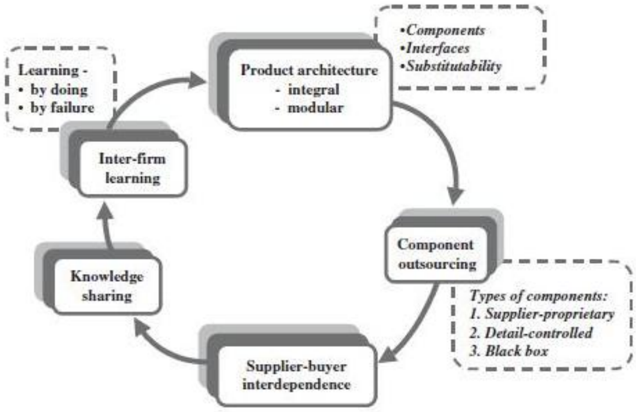


Figure 6. Modularization, outsourcing, and inter-firm learning (Mikkola, 2003)

Further, we find a holistic link among SCCI, modularity, the Triple-A supply chain and inter-organizational learning from Brewer and Speh (2000). In their study, they use a balanced scorecard to measure supply chain performance. As one of the four perspectives of a supply chain management framework, SCCI is specified as four goals: product/process innovation, partnership management, information flows and threats and substitutes, which reflect the idea of modularity, alignment, agility and adaptability, respectively. To achieve these four goals, innovation and learning perspective should be taken in forming a balanced scorecard. In detail, four measures are used to evaluate the four goals: product finalization point, product category commitment ratio, number of shared data sets/total data sets and performance trajectories of competing technologies. All the measures come from inter-organizational practice, which shows the necessity of inter-organizational learning in connecting certain strategies with performance measures.

So how can companies on the supply chains foster inter-organizational learning? First of all, focal firms must understand the difference between tacit (implicit) and codified (explicit) knowledge (Polanyi, 1966). Tacit knowledge is informal and uncodified and can only be absorbed and shared by means of intensive, direct communication, observation and learning by doing (Becerra et al., 2008). In this case, the donor's motivation to teach is critical to tacit knowledge transfer (Ko et al., 2005). As soon as knowledge (e.g. product designs, manufacturing processes and industry trends) is codified, i.e. transformed into some systematic form that can be communicated at low costs, it is made explicit and available for use (Cowan & Foray, 1997). Hence, it is essential for supply chain partners to codify their knowledge as much as possible, which serves as the foundation of agility and adaptability. In practice, the process of codification includes three aspects: model building, language creation and the writing of messages (Cowan & Foray, 1997). Consider a tennis player who wishes to communicate how to serve through writing a book. He must first break up the action of serving a ball into smaller ideas that can be spoken (the modelling phase) in a language that others can understand (the messaging phase). However, in the course of the process, his modelling activity may lead him to 'discover' some micro-movements which cannot be described with available language. Thus, he has to develop some creativity at the language level modifying the language in light of his model (the language creation phase).

Furthermore, interdependency and trust are the most significant elements for successful inter-organizational learning. According to Maloni and Benton (2000), expert power and referent power have a significant positive influence upon the buyer-supplier relationships. While coercive and legal power have harmful effects. Thus, interdependent relations governed by trust encourage the transfer of proprietary know-how (Helper and Levine, 1992). If a focal firm has certain kind(s) of power, this power asymmetry can still have positive effects on information sharing, as long as the power position is not abused (Caniëls and Gelderman, 2005). Mayer et al. (1995) posit that trustworthiness is comprised of three factors: ability, benevolence and integrity. Ability is a group of skills, competencies and characteristics that allow a party to have influence within some domain. For supply chain partners, this subsumes both the formal and informal influence they are perceived to have through the chain, as well as their perceived competence and skills (Mayer & Davis, 1999). Benevolence is the extent to which a trustee is believed to want to do good to the trustor, aside from an egocentric profit motive. Benevolence-based trust is based on the expectation of the other party even when the opportunity is available, or at least will not knowingly hurt the other's interests. This is consistent with the notion of the expectation of fairness and non-maliciousness in a relationship (Muthusamy, 2005). Integrity is defined as the trustor's perception that trustee adheres to a set of principles that the trustor finds acceptable. This subsumes not only that a supply chain partner espouses values that the focal company sees as positive, but also that the supply chain partner acts in a way that is consistent with the espoused values (Mayer & Davis, 1999).

Last but not least, efficient inter-organizational learning needs learning orientation as a premise. Learning orientation refers to organization-wide activity of creating and using knowledge to enhance competitive advantages (Calantone et al., 2002). This includes gaining and sharing information about customer needs, market changes, and competitor actions, as well as development of new technologies to create new products that are superior to those of competitors (Mone et al., 1998). The three components of learning orientation are commitment to learning, shared vision, and open-mindedness (Sinkula et al., 1997). Commitment to learning, or the degree to which an organization values and promotes learning, is likely to foster a learning climate (Sinkula et al., 1997). It is related to Senge's (1990) discussion of learning principles (i.e., whether the value placed on the learning activity can be viewed as axiomatic). The committed organization considers learning as an important investment that is crucial for survival (Calantone et al., 2002). Most importantly, commitment to learning is associated with a long-term strategic orientation. If managers does not encourage the development of knowledge, employees will not be motivated to pursue learning activities (Calantone et al., 2002). Shared vision refers to an organization-wide focus on learning, which influences the direction of learning (Sinkula et al., 1997). Verona (1999) stresses that without a shared vision, learning by members of an organization is less likely to be meaningful. In other words, even if they are motivated to learn, it is difficult to know what to learn (Calantone et al., 2002). Brown & Eisenhardt (1995) note that various department differ their ways of obtaining and interpreting knowledge. Therefore, individuals from different functional areas perceive innovation in varied ways. Similar problem also happens among different management levels and divisions. Without commitment to and agreement with the direction the organization is taking, less motivation to learn is likely (Senge, 1990). Open-mindedness is the willingness to critically evaluate the organization's operational routine and to accept new ideas (Sinkula et al., 1997). Success and failures of the past support the formation of mental models about how the marketplace works. As time passes, these models may no longer hold true but may still operate unless an organization has the open-mindedness to question them (Senge, 1990). Open-mindedness encourages a willingness to question current thinking and practice, receptiveness to emerging possibilities, the sharing of ideas, and the consideration of differing perspectives (Cegarra-Navarro & Sánchez-Polo, 2011). Therefore, the creation of an open-mindedness culture is more likely to result in the question long-held practices and beliefs (Sinkula et al., 1997).

3. Conclusion and Future Research

Consequently, a whole picture of Figure 1 becomes clear: different types of changes trigger continuous improvement of supply chain. Modularity is a useful tool to facilitate SCCI, which will reversely encourage companies to invest more in modularity. However, modularity can be gradually copied by competitors (after they observe the improvement of focal company's supply chain), leading to the Red Queen effect, an effect negatively affecting the quality of continuous improvement. Rivals' imitation motivates managers to think out more long-term solutions and a proper one is the Triple-A supply chain. But the effect of the Triple-A supply chain is slow, so unwise decisions may be made to invest in modularity, not in this long-term solution. At the same time, both modularity and the Triple-A supply chain can facilitate inter-organizational learning, which can further support continuous improvement of supply chain. Thus, inter-organizational learning serves as a mediator to connect strategies of modularity and the Triple-A supply chain to the performance of SCCI.

From the perspective of (inter-)organizational learning, we can explain Figure 1 via first order and second order learning. According to Argyris and Schön (1978), in first order learning, organizations modify their actions according to the difference between expected and real outcomes. In our case, modularity belongs to first order learning. First order learning can solve technical problems in the production process, but it cannot help companies achieve sustainable competitive advantage. In our case, it is illustrated by the rising problem of the Red Queen effect. By contrast, in second order learning, or reflexive learning, organizations question the values, assumptions and policies that led to the actions in the first place. When actions and routines are adapted and changed, then second order (reflexive) learning has taken place. Second order learning opens possibilities for continuous improvement. In our case, the

Triple-A supply chain belongs to second order learning. Both modularity (first order learning) and the Triple-A supply chain (second order learning) finally buttress SCCI through inter-organizational learning.

For future research, we first form a correlation framework (Figure 7) according to our research framework. A questionnaire has been designed and will be used to test the validity of our correlation framework. The upcoming results will shed light on supply chain management as well as inter-organizational learning, encouraging further research in this interdisciplinary field. It will also enlighten decision makers to achieve competitive advantage via SCCI with inter-organizational learning.

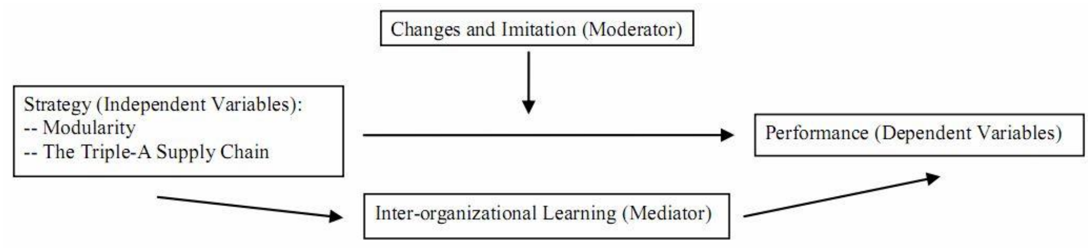


Figure 7. Correlation framework

4. References

Argyris, C. & Schön, D. 1978. *Organisational learning: A theory of action perspective*. Reading, MA: Addison Wesley.

Baldwin, C. Y. & Clark, K. B. 1997. Managing in an age of modularity. *Harvard Business Review*, 75(5): 84-93.

Becerra, M., Lunnan, R., & Huemer, L. 2008. Trustworthiness , risk , and the transfer of tacit and explicit knowledge between alliance partners. *Journal of Management Studies*, *45*(4): 691-713.

Boyer, K. K., & Hult, G. T. 2005. Extending the supply chain: Integrating operations and marketing in the online grocery industry. *Journal of Operations Management*, 23(6): 642-661.

Brennan, P. 2011. Lessons learned from the Japan Earthquake. *Disaster Recovery Journal*, Summer: 22-26.

Brewer, P. C. & Speh, T. W. 2000. Using the balanced scorecard to measure supply chain performance. *Journal of Business Logistics*, 21(1): 75-93.

Brown, S. L., & Eisenhardt, K. M. 1995. Product development: Past research, present findings, and future directions. *The Academy of Management Review*, *20*(2): 343-378.

Bruner, G. C. 1988. The marketing mix: Time for reconceptualization. *Journal of Marketing Education*, 11(2): 29-33.

Calantone, R. J., Cavusgil, S. T., & Zhao, Y. 2002. Learning orientation , firm innovation capability , and firm performance. *Industrial Marketing Management*, *31*(6): 515-524.

Caniëls, M. C. J. & Gelderman, C. J. 2005. Purchasing strategies in the Kraljic matrix – A power and dependence perspective. *Journal of Purchasing and Supply Management*, 11(2-3): 141-155.

Caniëls, M. C. J. & Romijn, H. A. 2008. Supply chain development: Insights from strategic niche management. *The Learning Organization*, 15(4): 336-353.

Carroll, L. 1960. *The annotated Alice: Alice's adventures in wonderland and through the looking-glass*. New York, NY: New American Library.

Cegarra-Navarro, J.-G., & Sánchez-Polo, M. T. 2011. Influence of the open-mindedness culture on organizational memory: An empirical investigation of Spanish SMEs. *The International Journal of Human Resource Management*, *22*(1): 1-18.

Chopra, S. & Sodhi, M. S. 2004. Managing risk to avoid supply-chain breakdown. *MIT Sloan Management Review*, 46(1): 53-61.

Cowan, R. & Foray, D. 1997. The economics of codification and the diffusion of knowledge. *Industrial and Corporate Change*, 63(3): 595-622.

Cyert, R. M. & March, J. G. 1963. *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice Hall.

Derfus, P. J., Maggitti, P. G., Grimm C. M. & Smith, K. G. 2008. The Red Queen effect: Competitive actions and firm performance. *The Academy of Management Journal*, 51(1): 61-80.

Dyer, J. H. & Singh, H. 1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *The Academy of Management Review*, 23(4): 660-679.

Ferdows, K., Lewis, M. A. & Machuca, J. A. D. 2004. Rapid-fire fulfillment. *Harvard Business Review*, 82(11): 104-110.

Fisher, M. L. 1997. What is the right supply chain for your product? *Harvard Business Review*, 75(2): 105-116.

Helper, S. & Levine, D. I. 1992. Long-term supplier relations and product-market structure. *The Journal of Law, Economics & Organization*, 8(3): 561-581.

Hult, G. T. M., Nicholes Jr., E. L., Giunipero, L. C., & Hurley, R. F. 2000. Global organizational learning in the supply chain: A low versus high learning study. *Journal of International Marketing*, 8(3): 61-83.

Hyland, P. W., Soosay, C. & Sloan, T. R. 2003. Continuous improvement and learning in the supply chain. *International Journal of Physical Distribution & Logistics Management*, 33(4): 316-335.

Juergensen, T. 2000. *Continuous improvement: Mindsets, capability, process, tools and results*. Indianapolis, IN: The Juergensen Consulting Group, Inc..

Kay, J. 1993. *Foundations of corporate success*. Oxford, UK: Oxford University Press.

Kertchen Jr., D. J. & Hult, G. T. M. 2007. Bridging organization theory and supply chain management: The case of best value supply chains. *Journal of Operations Management*, 25(2): 573-580.

Ko, D. G., Kirsch, L. J., & King, W. R. 2005. Antecedents of knowledge transfer from consultants to clients in enterprise system implementations. *MIS Quarterly*, *29*(1): 59-85.

Krikke, H., le Blanc, I. & van de Velde, S. 2004. Product modularity and the design of closed-loop supply chains. *California Management Review*, 46(2): 23-39.

Lee, H. L. 2002. Aligning supply chain strategies with product uncertainties. *California Management Review*, 44(3): 105-119.

Lee, H. L. 2004. The Triple-A supply chain. *Harvard Business Review*, 82(10): 102-112.

Maloni, M. & Benton, W. C. 2000. Power influences in the supply chain. *Journal of Business Logistics*, 21(1): 49-73.

Mason-Jones, R., Naylor, B. & Towill, D. R. 2000. Lean, agile or leagile? Matching your supply chain to the marketplace. *International Journal of Production Research*, 38(17): 4061-4070.

Mayer, R. C., & Davis, J. H. 1999. The effect of the performance appraisal system on trust for management: A field quasi-experiment. *Journal of Applied Psychology*, *84*(1): 123-136.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. 1995. An integrative model of organizational trust. *The Academy of Management Review*, *20*(3): 709-734.

McAdam, R., Stevenson, P. & Armstrong, G. 2000. Innovative change management in SMEs: Beyond continuous improvement. *Logistics Information Management* , 13(3): 138-149.

Mikkola, J. H. 2003. Modularity, component outsourcing, and inter-firm learning. *R&D Management*, 33(4): 439-454.

Miller, D. 1992. The generic strategy gap. *Journal of Business Strategy*, 13(1): 37-42.

Miller, K. 1991. A framework for integrated risk management in international business. *Journal of International Business Studies*, 23(2): 311-331.

Mone, M. A., Mckinley, W., Barker, V. L., & Mone, M. A. 1998. Organizational decline and innovation: A contingency framework. *The Academy of Management Review*, *23*(1): 115-132.

Muthusamy, S. K. 2005. Learning and knowledge transfer in strategic alliances: A social exchange view. *Organization Studies*, *26*(3): 415-441.

Narayanan, V. G. & Raman, A. 2004. Aligning incentives in supply chains. *Harvard Business Review*, 83(11): 94-102.

Polanyi, M. 1966. *The tacit dimension*. London, UK: Routledge and Kegan Paul.

Porter, M. E. 1980. *Competitive strategy*. New York, NY: Free Press.

Rizzo, T. 2001. The death of Webvan. *Internet World*, 7(15): 4-5.

Schilling, M. A. 2000. Towards a general modular systems theory and its application to inter-firm product modularity. *The Academy of Management Review*, 25(2): 312–334.

Senge, P. 1990. *The fifth discipline*. New York, NY: Doubleday.

Sinkula, J. M., Baker, W. E., & Noordewier, T. 1997. A framework for market-based organizational learning: Linking values , knowledge , and behavior. *Journal of the Academy of Marketing Science*, *25*(4): 305-318.

Spekman, R. E., Spear, J. & Kamauff, J. 2002. Supply chain competency: Learning as a key component. *Supply Chain Management: An International Journal*, 7(1): 41-55.

Steinle, C. & Schiele, H. 2008. Limits to global sourcing? Strategic consequences of dependency on international suppliers: Cluster theory, resource-based view and case studies. *Journal of Purchasing & Supply Management*, 14(1): 3-14.

Tang, C. & Tomlin, B. 2008. The power of flexibility for mitigating supply chain risks. *International Journal of Production Economics*, 116(1): 12-27.

Umeda, Y., Fukushige, S., Tonoike, K., & Kondoh, S. 2008. Product modularity for life cycle design. *CIRP Annals – Manufacturing Technology*, 57(1): 13-16.

Vargo, S. L., & Lusch, R. F. 2008. Service-dominant logic: Continuing the evolution. *Journal of the Academy of Marking Science*, 36(1): 1-10.

Verona, G. 1999. A resource-based view of product development. *The Academy of Management Review*, *24*(1): 132-142.

Logistics of Telemedicine and Online Clinical Care as an Innovative Health Care Strategy

Sandeep Dhulipudi[32]

Abstract

The logistics of innovative health strategies have taken a new turn and emerging into a new and independent field in the management sphere. Hospital administration management hitherto confined to infrastructure has extended its arms into areas of clinical research, medical and health care, telemedicine and diagnostics.

The effectiveness and efficiency of telemedicine and the implementation strategies of outsourcing medial prescriptions, medical history and clinical data can be strategically implemented in developing nations such as India so as to render a legally efficient policy keeping in view the cost-benefit analysis.

The paper is an attempt to identify the strategic and innovative logistic application of telemedicine and clinical care applications in vogue and their effective use in the Indian context.

INTRODUCTION

The understanding and scope of telemedicine as an emerging and innovative area of medical science enhancing its capacity as a service provider is stupendous and the growth fast and exponential. The entire gamut of telemedicine may be comprehended as an extension of the principles of healthcare and hospital management in the virtual world. The principle of telemedicine is applicable to the administration of clinical and diagnostic care from across borders thereby limiting the concerns of availability, accessibility and affordability in the new age world.

According to World Health Organization, telemedicine is defined as, *"The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities".*

A broader definition of telemedicine is *"the use of telecommunication technology to deliver healthcare services and health education to sites that are distant to the host site or educator".*

Telemedicine can also be defined as *"the transfer of electronic medical data (i.e. high resolution images, sounds, live video and patient records) from one location to another. This transfer of medical data may utilize a variety of telecommunications technologies, including, but not limited to ordinary telephone lines (POTS), ISDN,AM, the internet and the satellites".*

The literal meaning of telemedicine encompasses and envisages "healthcare at a distance."

Telemedicine may thus represent healthcare practiced in real-time using a video link for example, asynchronously, perhaps by email.

[32] Resident Physician, Apollo Hospitals, Dehradun & Dr. Priya Vinjamuri, Faculty of Law, COLS, UPES, Dehradun

TELEMEDICINE GLOBALLY

Telemedicine is globally recent and emerging field in health and management sciences arising out of the effective fusion of Information and Communication Technologies (ICT) with medical science.

Worldwide strategic implementation of the principles and practice of telemedicine would provide healthcare delivery in various sectors and forms to remote areas of the world. Integration of the medical science to communication technology has been a not too young two decade old concept in the name of medical transcription, a predominantly outsourced industry capitalized by the developed nations in the guise of catering to the economically available work force in more populous and less employed nations of the world.

Telemedicine includes not just the lucrative and economically viable medical transcription of the west making use of the needs of the developing worlds, but focuses on the enormous potential the integration of the medical sciences and technology to management offers.

Globally, the application of telemedicine may be categorized depending on the kind of the telemedicine process, its unique feature being its integration and applicability into other areas of hospital management and administration.

The global telemedicine process is predominantly technology driven on the asynchronous mode of acquiring medical data and subsequently transferring it to the doctor or specified recipient, for assessment offline. The emerging concept of technology driven real time or synchronous telemedicine requires the presence of both the parties simultaneously through highly efficient communication systems, the latest being tele-robotic surgery. The technologies may be applied to any of the modes of tele-pathology, tele-cardilogy, tele-radiology, tele-surgery and tele- ophthalmology to cite a few.

The basic principles of telemedicine applicable globally are fast emerging with the present telemedicine market at a growth rate of 76% and a market capital of approximately USD 100 million.

LOGISTICS OF INNOVATIVE HEALTH CARE STRATEGIES

The telemedicine implementation is a challenge especially, when the requirement is to cater to the remote and rural areas of the world where the communication system is perhaps poor of existent.

The connectivity is a crucial logistic concern even if world-class medical and clinical care is available and cutting edge technology is in the waiting. The second major logistic concern which needs innovative brain storming is the strategy of mapping the two or perhaps multiple ends of communication for an efficient, effective and economical service. The various nodes shall be identified based on the purpose of the telemedicine and are predominantly for imparting medical education, medical and clinical care and health management.

The Point-To-Point Communication Protocol (PPP) is a data link protocol commonly used to establish a direct connection between two nodes over terrestrial and satellite link and the Point- To-Multipoint Communication Protocol (PMP) is communication which is accomplished via a specific and distinct type of multipoint connection, providing multiple paths from a single location to multiple locations

Globally, the application of telemedicine is in the four broad areas of tele-healthcare including tele-consultation and tele follow up, tele-education through regulated and un-regulated distance education processes by using the information and communication technologies for flexible and accessible learning, disaster management for providing medical care for victims of natural disaster through satellite connectivity and customized telemedicine and tele- home health care for elderly or underserved, home bound patients with chronic illness allowing monitoring and treatment through economical and time efficient methodologies.

The global application of telemedicine promotes efficient medical care in the major areas of

1. Easier accessibility to patients
2. Cost effectiveness
3. Time efficiency
4. Integration of communication, information technology and health science increasing the scope for research and development

The implementation of telemedicine caters to the three main social aspects of sustained sustainability through

1. Addressing needs of grass root levels
2. Ease of health care and management by the government
3. Social responsibility of the government

IMPLEMENTATION OF TELEMEDICINE IN INDIA-COST EFFECTIVITY AND GRASS ROOT LEVEL CARE –A LUCRATIVE SOCIAL INITIATIVE IN DEVELOPING NATIONS

The challenges of healthcare delivery to rural and remote areas besides several other applications in education, training and management in health sector may be met with partially if not completely by the innovative and strategic implementation of telemedicine.

The application of telemedicine may be as simple as two health professionals discussing medical problems of a patient and seeking advice over a simple telephone to as complex as transmission of electronic medical records of clinical information, diagnostic tests such as E.C.G., radiological images etc. and carrying out real time interactive medical video conference with the help of IT based hardware and software, video-conferencing using broadband telecommunication media provided by satellite and terrestrial network.

The Indian population is of about 1.1 + billion spread in 28 States & 5 union territories of which vast Population (80%) is spread in inaccessible & remote areas (border areas),remote islands and around 627,000 villages. Statistics reveal that about 80% of the super-specialty clinics and medical professionals live in big cities challenging the ease and feasibility of providing health care to the inaccessible majority. The Indian healthcare system is predominantly government managed through a three-tier hierarchical system of Primary, Secondary and tertiary healthcare with ~ 23000 Primary Healthcare Centers (PHCs), 3000 Community Healthcare Centers (CHCs) and 670 District Hospitals (DHs) as the major governmental healthcare delivery system besides the high-end, highly sophisticated private institutions serving the population. Agencies like the ISRO, Department of Information technology, the Indian Railways, state governments besides private networks like the Apollo Group, AHF, AIIMS ESCORTS cater to the need of the day in the field of telemedicine.

The ISRO along with other agencies has launched many programs to promote and spread awareness on the potential capacity and thrust on telemedicine through special space based rural development programs with thrust on telemedicine since the 1990's spearheading the telemedicine movement towards continuous development and improvisation. The special program of ISRO initiated in t 2001 was focused on providing tele-healthcare to the un-served and under-served, a major social responsibility initiative by setting up facilities in distant and rural parts of the country to supplement the general health care infrastructure and fill the gaps through the technological advancement that telemedicine offers through the satellite network in terms of ease of access, quick installation, flexibility, extensive and consistent geographic coverage doing away with the challenges of geographical and environmental barriers and most importantly, efficient support to broadcast and multipoint communications for medical education consultation and quick medical care through high network flexibility, reliability and security it offers.

Telemedicine had helped in the Indian context in providing technology and connectiviry in remote and rural hospitals, continuing medical education through distance mode training, installation of mobile units for telemedicine besides the integration of telemedicine with the village resource centers in the rural areas. The primary focus of the telemedicine program had been the disaster management support that allowed providing immediate medical help to victims of any kind of a disaster as the satellite network helped provide the information on any untoward incident in a very short period of time. Applying telemedicine to the principles of geospatial science promotes the quicker accessibility through connectivity by setting up information kiosks for multiple services.

Indian government in the implementation of telemedicine had adopted a unique approach of proof of concept through demonstrative pilot projects by the technology department in several states, development of national standards and guidelines with Efforts to optimize the clinical requirements for evolving a suitable e-heath technology and to minimize the costs to bring in affordability and maximize the reach.

The telemedicine had received proactive encouragement through new models of innovative insurance schemes, integration of healthcare administrators, planners, technologists and entrepreneurs and bringing all the stake holders to a common platform.

TRENDS, CHALLENGES & SUGGESTIONS FOR EFFECTIVE IMPLEMENTATION

The implementation of the telemedicine concepts has challenges manifest in the technological and logistics of implementation. The biggest challenge still remains the laws for regulation of the practice in India as also the global perspective.

The biggest challenge in a developing nation like India is the inhibition and resistance to adopt and adapt new and unknown technologies. However, the training and educating users have to create interest in utilizing the tele-med and e-Health tools which can be efficiently and effectively employed.

The other methodology that is challenging despite the advanced ICT is the mobile health care system foe reaching the doorsteps of the rural populace.

Telemedicine in India as in any nation, developed or developing has evolved from the point to point approach to point to multipoint and further to multipoint to multipoint and finally in the stage of tele-education, thus broadening the scope of application. The other aspect is the mobile telemedicine technology devised to overcome the prohibitive costs of large number of terminals and reaching out to the rural areas.

Some of the prominent private organizations to implement effective telemedicine are Sankara Nethralaya and Aravind Eye Hospital and the Apollo Group. The PPP in India was implemented at The SGPIMS, Lucknow by providing PPP to medical colleges in Orissa via satellite link and District Hospitals of Rae Bareli via fiber optic cable. The PMP has a longer way to tread with it being implemented in two district hospitals of Uttaranchal likes to the SGPGIMS via ISDN links.

The main objective of telemedicine is to cross the geographical barriers and provide healthcare facilities to rural and remote areas (health for all) so it is beneficial for the population living in isolated communities and reduce the isolation of rural practice by upgrading their knowledge.

The practice of telemedicine – through transmission of digitized data, audio, video and images – is getting popular all over the world as it provides hitherto unavailable access to tertiary level specialist healthcare even in geographically remotest areas without displacement of the patient, physician or the equipment. It is not only cost-effective to the patient but cost-beneficial to the society also. More and more doctors and patients are resorting to the use of telemedicine due to its advantages of convenience and cost-saving.

The practice of telemedicine, however, has brought with it several complicated issues. These issues involve not only healthcare workers and consumers but the society, technologists and the lawmakers. The primary issue in the implementation of telemedicine is the Physician/Patient Acceptance. Physicians and patients have unique technological resources available to improve the patient-physician relationship. It has been found that patients have no difficulty in accepting telemedicine program. The survey conducted by SGPGIMS tele-follow up program for the patients of Orissa state revealed that 99% patients were satisfied with using telemedicine technology. In almost all the cases the patients are more than happy and satisfied as they don't have to travel 1500 km to show their diagnostic reports to their doctors. In tele-consultation they were also happy that they get the specialist consultation and their cases have been seen by some expert doctors.

However, some resistance is seen amongst doctors. Doctors in government sector tend to look upon telemedicine as an additional duty or workload. Therefore, there is need to weave telemedicine into the routine duties of the doctors. The private doctors sometime fear that telemedicine is likely to reduce their practice. They need to realize that this technology enhances their reach and exposure and is only likely to increase their practice further.

It is myth that to establish a telemedicine platform is an expensive. The basic system needs hardware, software and telecommunication link. In all the areas there is a significant reduction in the prices. Most of these costs are well within the reach of most of the hospitals, and can be recovered by nominal charge to the patients and students in case of tele-education which would be much less than the physically traveling.

Although information technology has reached in all corner of the country but the accessibility of people living in remote and rural area to the nearest health center (PHCs, CHCs or district hospital) may not be easy due to poor infrastructure of road and transport. It may be possible that the available telemedicine system in thee health centers may not function becaue of the interruption in power supply.

Some healthcare professionals have doubts about the quality of images transmitted for tele-consultation and tele-diagnosis. In tele-radiology, tele-pathology, tele-dermatology the quality of image (color, resolution, field of view, etc) should be international standards to avoid any wrong interpretation and mis-diagnosis. The delay in transmission of data may be of critical importance in tele-mentoring and robotic surgery and have to be reduced to the minimum.

There should be a format to calculate the investment and recurring cost of the telemedicine system. The insurance companies have to decide whether the cost of tele-healthcare should be reimburse or not.

Telemedicine is a new emerging field there is lack of training facilities with regards to application of IT in the field of medicine. Most of the healthcare and IT professionals are not familiar with the terms commonly used in telemedicine such as HIS, EMR, PACS, etc. Telemedicine is also not the part of course curriculum of medical schools.

Telemedicine technology has been proved and established and its advantages and benefits are well known but still many healthcare professionals are reluctant to engage in such practices due to unresolved legal and ethical concerns. In case of a cross-border tele-consultation the queston of the application of the litigation laws of the national to which they apply is a challenge as it is not yet clear if it would be those of the country in which the patient is living or those of the remote physician.

There are many issues that should be considered regarding the security, privacy and confidentiality of patient data, in telemedicine consultations in terms of the patients' rights of confidentiality of their personal data protected and thereby to ensure security of the data and restrict its availability to only those for whom it is intended and who are authorized and entitled to view it. The strategy and rules that prohibit the misuse and even abuse of electronic records in the form of unauthorized interception and/ or disclosure would be a huge challenge in the implementation.

CONCLUSION

The challenges of the implementation of telemedicine are manifold and the most efficient procedure for apt and feasible use of the integrated technologies of medical science and information and communication would be the strategic and secure use of the resources available to provide the remote health care service and education.

The imposition and formulation of stringent laws and regulations for the reliable and accountable practice of telemedicine is the need of the hour.

Innovation Profile of Turkish Logistics Sector: What Can Be Done For Value-Added Chain?

Serhat Burmaoğlu[33] *and Cem Erbektaş*[34]

Abstract

Especially in the time that includes the last part of the 19th century and a large part of the 20th century, the efficiency and productivity of the supply-chain started to become increasingly important. Within the context of the supply-chain philosophy, production firms have been making efforts to increase customer satisfaction, especially through redesigning distribution processes. Due to the structures that cause, via supply-chain approaches, to take competition out of the hands of the firm and have an impact on all the firms in the chain, the fact that innovation is performed by all firms in their own fields will bring an important value to the chain. Along with the fact that the production sector has put forward the value-chain approach by motivating other firms, included in the chain while conducting innovations in their own processes and products, the issue of innovation in the logistics sector has also started to be deemed important. Therefore, this study aims to demonstrate the innovation profile of logistics sector according to CIS-2010, which is conducted by Turkstat. Logistics sector is truncated from the main data by using NACE Rev.2 classification and H subgroup that includes (49-53) subgroups is taken into consideration. Finally, in the truncated group there are 536 logistics firms, which are used in the analysis. By doing so, the present situation of logistics firms can be demonstrated and future implications may be discussed.

Keywords: *logistics innovation, service innovation, service sector, logistics, value chain*

1. INTRODUCTION

In recent years and along with globalization, international trade has been rapidly improving and firms buy products from the far end of the world and they sell them to the other end of the world. Logistics, which is an indispensable part of the supply chain and which constitutes a time and distance bridge in the supply chain, has become and important activity (Klink and Visse, 2004) and has evolved into factor that provides an advantage of competitiveness from a passive cost reducing function (Chapman et al. 2003).

The sophisticated and vague state that is created by the rapid developments in almost every field has caused the firms to require innovation for their strategic guidance. Today, in order to be competitive, firms have to either make innovations or use or imitate the successful innovations made by other firms. Innovation is an important issue for logistics firms as well. The innovativeness of the logistics firms has directly affected the other supply chain actors and has been one of the factors that brought the world of business to where it is today (Grawe, 2009).Logistics innovation, shorten distances, can provide visibility of the product, can provide solutions to environmental pollution. By logistics innovation, organizations can realize greater production, increased efficiencies, and technological competencies (Chapman et al. 2003).Logistics innovation can increase effectiveness and efficiency of the supply chain. So that, value chain of a firm is developed by logistics innovation.

The effect of all the sectors of logistics makes it important for nations economies. Turkey has an important advantage in logistics with its close location to large economies, large markets, countries that have oil reserves, its population potential, and increasingly growing economy. A proper use of this advantage will strengthen Turkey's economy. Innovations that will be made by logistics firms will enable manufacturing firms to increase their service quality and productivity and too compete in the international market.

[33] Turkish Military Academy, Ankara, Turkey, +90 312 4175190/4447, sburmaoglu@kho.edu.tr
[34] Turkish Military Academy, Ankara, Turkey, +90 312 4175190/4447, cemerbektas@gmail.com

The purpose of this study is to determine the innovation profile of Turkish logistics firms by using the data of Community Innovation Survey 2010 which was prepared by Turkish Statistics Institution. Thus, by examining the current innovation situation of the firms, it will be possible to discuss the future effects.

2. LITERATURE

Innovation is considered to be one of the most important means of competitiveness, development and growth. According to the Oslo Manual (2005) definition of innovation is:

> "The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations"

According to this general definition innovation can be done in every field and industry. The view that innovation could only be achieved through radical technological inventions has long been prevalent (Camacho and Rodriguez, 2008). Today, however, less concrete steps are considered as innovations as well (Toivonen and Tuominen, 2009).

Along with globalization, competition has become more evident and it has become important for firms to gain an advantage of performance and sustainable competitiveness over others. It has become difficult to differ in product quality and price, making it important to produce new goods (Schilling and Hill, 1998).

While a new or significantly improved good or service is defined as product innovation, process innovation includes a new or significantly improved method of production or delivery as well as significant changes in techniques, equipment and/or software. Marketing innovation stands for a new method of marketing which includes significant changes in designing or packaging, deployment, promotion and pricing of goods while organizational innovation is defined as a new method of organization of firms in their operations in trade, organization of their work places or their external relationships. These types of innovation widely used in all sectors in the economy.

Mainly these sectors are divided as manufacturing and service sectors and logistics sector is a subsector of the service sector. National economies and the business world have become service-based rather than manufacture-based and services now have the biggest share in countries' Gross Domestic Production (GDP) (Ostrom ve diğ. ,2010).

The existence of innovation in the service sector has long been discussed. Service innovation used to be viewed as the imitator or facilitator of manufacture sector's innovation (Toivonen and Tuominen, 2009). However, it is widely acknowledged that in today's circumstances of competitiveness, service firms make innovation opportunities (Camacho and Rodriguez, 2008). According to the literature research of Aas and Pedersen (2010), service innovation could change a firm's internal operation processes, improve its internal sufficiency, change its relationships with its partnerships, and affect customer satisfaction and the firm's power of competitiveness.

Studies show that service firms particularly make organizational innovation (Tether, 2005), that they do not follow R&D (research and development) (Hipp and Grupp, 2005), and that one of the most important reasons of innovation is to improve the quality of service, to enter into new markets (or the growing share in the market) and to broaden the range of services (Tether, 2005).

In recent years, logistics sector has gained importance with its contribution to economy, employment and other sectors. Logistics management, according to the definition made by the Council of Supply Chain Management Professionals (CSCMP, 2012) is:

> "Part of the supply chain management that plans, implements and controls the efficient and 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 customers' requirements."

Along with globalization, the requirement for logistics has increased due to the increase in distances, in the volume and quantity of the goods, the need to accelerate the production network and to relate the processes, the requirement for more often and smaller deliveries as a result of the just-in-time concept, the improvements in information and communication technologies, and to the shorter production cycle time and delivery time.

Since the logistics sector is a part of the service sector, logistics innovation is a part of service innovation. According to Flint et al. (2005), logistics innovation is the logistics services which are new and useful to a certain community. Logistics innovation is the result of understanding the customer requirements by managers which are met or are insufficiently met of these requirements by providing new services.

The important factors affecting the logistics innovations are financial factors, usable information, organizational structure, customer tendencies, competitiveness, employee guidance, environmental vagueness, government support and technology.

3.ANALYSIS

Turkey vas the 39th country in the logistical performance index 2010, which was conducted in 2007 for the first time on 135 countries (Connecting to Compete, 2010). The logistics sector studies in Turkey started in 1980s, and it was accelerated in 1990s and many investments have been made and many firms have been established both nationally and internationally since 2000 (Tutar et al.,2009)

In geographical terms, Turkey is a bridge between the east and the west, as well as a junction of three continents. The recent increase of the Asian countries' shares in the global economy, its close location to developed European countries and Middle East countries that have rich natural resources and the fact that it is a strategic passage provides Turkey with a logistics advantage.

Turkey's foreign trade volume, which has been growing since 1980 as a result of adopting export based development strategies and which reached 376 billion dollars in 2011 (TUİK,2012) has enabled Turkish logistics sector to take important steps (Gürdal, 2006). The contribution of logistics sector to Gross Domestic Product of 1294 billion TL was 172.4 billion TL in 2011, while its contribution to employment to the data of 2011 was 44.000 employess (NACE Rev.2)

In order to the logistics firms to make use of the advantages that Turkey has in logistical terms they need to improve their method of providing services and they need to become competitive in national and international fields. One of the most important means of this is innovation. Gaining innovative skills by logistics firms will be a propulsive power for both the economy of the country and other sectors.

The data of the Community Innovation Survey 2010 of the Turkish Statistics Institution, which covers the 2008-2010, is used in our study. Innovation Surveys are carried out in European countries in coordination whit EUROSTAT and according to Oslo Manuals. It covers 536 logistics firms which are in the logistics sector and are 49-53 employment groups according to NACE rev.2.

Although in literature there are several types of innovation Oslo Manual (2005) mentions four kinds of innovations which are product innovation, process innovation, marketing innovation and organizational innovation.

Table 1 covers the situation of innovations in logistics sector in terms of production, process, organizational and marketing innovation according to 2008-2010 Community Innovation Survey 2010 data.

Table 1: Types of Innovation

TYPE OF INNOVATION	f	(%)
Product innovation	106	19,8
New/improved goods	29	5,4
New/improved services	99	18,5
Process innovation	141	26,3
New/improved methods of manufacturing	96	17,9
New/improved logistics, delivery or distribution methods	90	16,8
New /improved supporting activities	105	19,6
Organizational innovation	133	24,8
New business practices for organizing procedures	84	15,7

New methods of organizing work responsibilities and decision making	117	21,8
Marketing innovation	119	22,2
New media or techniques for product promotion	75	13,8
New methods of pricing goods or services	80	14,9

It is understood from the table that 141 (26%) firms made process innovation, 133 (24.8%) made organizational innovation, 119 (22.2 %) firms made marketing innovation, 106 (19.8%) firms product innovation. The aims of product and process innovations of firms are demonstrated in Table 2.

Table 2: The Aims of Product and Process Innovation

AIMS	HIGH		MEDIUM		LOW		NOT USED	
	f	%	f	%	f	%	f	%
Increase range of goods or services	85	15,9	34	6,3	13	2,4	404	75,4
Replace outdated products or processes	61	11,4	39	7,3	17	3,2	419	78,2
Enter new markets or increase market share	104	19,4	31	5,8	11	2,1	390	72,8
Improve quality of goods or services	128	23,9	23	4,3	8	1,5	377	70,8
Improve *flexibility* for producing goods/services	64	12,5	44	8,2	22	4,1	403	75,2
Increase *capacity* for producing goods/services	98	18,3	34	6,3	11	2,1	393	73,3
Reduce labor costs per unit output	74	13,8	42	7,8	13	2,4	407	75,9
Reduce material and energy costs	69	12,9	37	6,9	17	3,2	413	77,1
Reduce environmental impacts	61	11,4	34	6,3	20	3,7	421	78,5
Improve health/safety of your employees	71	13,2	41	7,6	11	2,1	413	77,1

The firms that did not make a choice are shown as "not effective" in Table 2. The purpose of 128 firms is to increase quality of goods or services, the purpose of 104 firms is to create a new market or to increase the market share, and purpose of the 98 firms is to increase the capacity of goods or services.

Table 3 covers the purpose for innovation of the firms which made organizational innovation.

Table 3: The Aims of Organizational Innovation

AIMS	HIGH		MEDIUM		LOW		NOT USED	
	f	%	f	%	f	%	f	%
Reduce time to respond to customer/ supplier needs	55	10,3	42	7,8	16	3	423	79
Improve ability to develop new products or processes	44	8,2	44	8,2	19	3,5	429	80
Improve quality of your	64	11,9	46	8,6	14	2,6	412	76,8

goods/ services								
Reduce costs per unit output	31	5,8	44	8,2	25	4,7	436	81,3
Improve communication or information sharing	37	6,9	48	9	18	3,4	423	78,9

According to Table 3, 64 firms consider the purpose of increasing the quality of goods or services as very effective and 55 firms consider the purpose of shortening the time to meet the customer and supplier requirements as very effective. Table 4 covers the purpose of the firms which made marketing innovation.

Table 4: The Aims of Marketing Innovation

AIMS	HIGH		MEDIUM		LOW		NOT USED	
	f	%	f	%	f	%	f	%
Increase or maintain market share	94	17,5	15	2,8	3	0,6	424	79,1
Introduce products to new customer groups	71	13,2	24	4,5	6	1,1	435	81,1
Introduce products to new markets	61	11,4	23	4,3	9	1,7	443	82,6

According to Table 4, 94 firms considered it important to make marketing innovations whit the purpose of preserving the market share and 71 firms had the purpose of introducing the goods to new customer groups.

Table 5 demonstrates the factors that inhibit the production and process innovation activities.

Table 5: Obstacles of Innovation

OBSTACLES	HIGH		MEDIUM		LOW		NOT USED	
	f	%	f	%	f	%	f	%
Cost factors								
Lack of funds within your enterprise or group	100	18,7	102	19	65	12,1	269	50,2
Lack of finance from sources outside your enterprise	75	14	93	17,4	70	13,1	298	55,6
Higher cost of innovation	148	27,6	104	19,4	44	8,2	240	44,8
Knowledge factors								
Lack of qualified personnel	52	9,7	102	19	70	13,1	312	58,2
Lack of information on technology	34	6,3	84	15,7	78	14,6	340	63,4
Lack of information on markets	34	6,3	64	11,9	70	13,1	368	68,7
Difficulty in finding cooperation partners	43	8	65	12,1	53	9,9	375	70
Market factors								
Market dominated by established enterprises	77	14,4	89	16,6	58	10,8	312	58,2

Uncertain demand for innovative goods or services	57	10,6	118	22	55	10,3	306	57,1

It is clear in Table 5 that the obstacles related cost is the leading factors. 148 firms chose the inhibition that costs of innovation are too high and 100 firms choose the fact that the investing group did not have enough resources as the main reason.

Regarding the knowledge related inhibitions that prevent innovation, 52 firms viewed the reason that they did not have sufficient qualified personnel, 43 firms chose the reason that it was difficult to find a partner to cooperate in an innovation. It can be said that information related factors were viewed as effective.

It was considered as an important reason by 77 firms that settled firms firms prevail in the market and 57 firms deemed the inhibition that the demand for new goods or services is vague as important.

4. CONCLUSION

In general, it is clear that the rate of innovation of Turkish logistics firms is low. According to the data of the Survey, the rates of process innovation (26%) and organizational innovation (24.8%) are higher than other types of innovations. It can be said that this is the result of the characteristics of services. This supports Tether's (2005) statement that service firms particularly make organizational innovations.

When the purposes for innovations are examined in relation with innovation types, it can be seen that the purposes of increasing the quality of goods or services, creating a new market or increasing the market share. The capacity of producing goods or services are chosen with higher rate than other purposes. These results are in line with Tether's (2003) study in which he evaluated the European Community Innovation Survey 1997 and support Carman and Langeard (1980) in the view that, strategically, service firms need to redesign the market share, geographical enlargement and current service innovatively.

In understanding that cost related factors are viewed as the most important obstacles against implementing innovations for logistics firms. Firms are not able to make innovations due to high costs and difficulty in finding financial resources. The obstacles that settled firms prevail in the market and that there is lack of qualified personnel are also important factor affecting innovations.

As a result, it is understood that Turkish logistics firms do not make sufficient innovation and, in line with literature, that they particularly make innovations in terms of organizational and process. In order for logistics firms to become more conscious about innovation; governments, business chambers and universities could work in coordination. Regarding the lack of financial resources, governments could provide logistics firms with funds and incentives. Firms could be facilitated about current financial resources and the process of providing these resources could be facilitated.

REFERENCES

Aas, T.H. and P. E. Pedersen. "The Impact of Service Innovation on Firm-Level Financial Performance", *The Service Industries Journal*, 2010, 1–20.

Camacho, J. A and M. Rodriguez. "Patterns of Innovation in The Service Sector: Some Insights From The Spanish Innovation Survey", *Economics of Innovation and New Technology*, 17(5), July, 2008, 459–471.

Connecting to Compete. *Trade Logistics in the Global Economy*, *The Logistics Performance Index and Its Indicators*, 2010.

CSCMP, Council of Supply Chain Management Professionals, 11 July 2012, <cscmp.org/digital/glossary/glossary.asp>

Flint, D.J., E. Larsson, B. Gammelgaard and J.T. Mentzer. "Logistics Innovation: A Customer Value-Oriented Social Process", *Journal of Business Logistics*, 26, 1, 2005, 113–147.

Grawe, Scott J. "Logistics Innovation: A Literature-based Conceptual Framework", *The International Journal of Logistics Management*, 20, 2009.

Gürdal, Sahavet. *Türkiye Lojistik Sektörü Altyapı Analizi*, İstanbul, İstanbul Ticaret Odası, 2006-14, , 2006.

Hipp, C. and H. Grupp. “Innovation in the Service Sector: The Demand For Service-Specific Innovation Measurement Concepts and Typologies”, *Research Policy*, 34, 2005, 517–535.

Klink, A.V. and E.J.Visse. Innovation in Dutch Horticulture: Fresh Ideas in Fresh Logistics, *Tijdschrift Voor Economische en Sociale Geografie*, 95, 3, 240-346, July 2004.

Oslo Manual *The Measurement of Scientific and Technological Activities, Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data* 3rd Ed., Paris, France: Organization for Economic Co-operation and Development (OECD), 2005.

OSTROM, Amy et al.. “Moving Forward and Making a Difference: Research Priorities for the Science of Service”, Journal of Service Researce, 2010.

Schilling, M. A. and C. W. L., Hill. “Managing the New Product Development Process: Strategic Imperatives”, *Academy of Management Executive*, 12, 1998, 67–82.

Tether, Bruce S. “The Sources and Aims of Innovation in Services: Variety Between and Within Sectors”, *Econ. Innov. New Techn*., 2003, December, 12(6), 481–505.

Tether, Bruce. “Do Services Innovate (Differently)? Insights from the European Innobarometer Survey”, *Industry and Innovation*, 12, No. 2, June 2005, 153-184.

Toivonen, M. and ve T. Tuominen. ”Emergence of Innovations in Services”, *The Service Industries Journal*, 29, 7, July 2009, 887–902.

Tseng, C., H. Kuo and S. Chou. “Configuration of Innovation and Performance in the Service Industry: Evidence from the Taiwanese Hotel Industry”, *The Service Industries Journal*, 28, 7, September 2008, 1015–1028.

Tutar, Erdinç et al. ”Türkiye’de Lojistik Sektörünün Gelişmişlik Düzeyinin Seçilmiş AB Ülkeleri (Romanya ve Macaristan) ile Karşılaştırmalı bir Analizi, *KMU İİBF Dergisi* ,11,17, 2009.

TÜİK. Türkiye ve Dünya Dış Ticareti 1950-1993, 2010. 16 Mart 2012 <kutuphane.tuik.gov.tr/pdf/0013718.pdf>

Wagner, Stephan M. “Innovation Management in the German Transportation Industry”, *Journal of Business Logistics*, 29, 2, 2008, 215-231.

Modeling the Humanitarian Logistics to Create a Value through Disaster Relief Operations

Turhan Bilgili[35]

Abstract

Humanitarian logistics has much in common with corporate logistics, but yet the best practices from the business world, or from other humanitarian organizations in many cases, have not crossed over with the disaster relief operations. It is paradoxical that an industry which has extreme requirements in terms of timeliness, affordability and value-added processes but inadequate to respond victims of random-based phenomena. The ability to deliver the appropriate supplies in the appropriate amount in optimal condition, where and when they are needed, is a prerequisite for an effective emergency operation, as always. The response in an emergency logistics may be divided into providing for limited needs, such as providing critical medical items, communications equipment, repair items for water supply, sanitation, electrical power, etc., and moving bulk commodities, such as food and shelter or even people themselves. It is also important to bear in mind that there are a number of other factors that pose constraints on logistics, such as pre-existing logistics infrastructure, political factors, the absolute number of humanitarian actors, the damage caused by the disaster, and sometimes the security of the environment. This paper is intended to give logistics professionals an understanding of how disaster relief systems are synchronized with logistics in a robust model.

Keywords: *Humanitarian logistics, Disaster, Supply Chain, Emergency*

1. Introduction

Disaster yet has no unique definition but a classification in nature. However, a disaster is a generated phenomenon and an unwanted, unintended event or process causing damage to life, property and destroys the economic, social and cultural life of people both resulting in an event of substantial extent and causing significant physical damage or destruction, loss of life, or drastic change to the environment (Quarantelli E.L., 1998; Buckle, 2005); a disaster can be allegedly defined as any tragic event stemming from events such as earthquakes, floods, catastrophic accidents, fires, explosions or financial outbursts yielding regional crisis In that sense, the degree of disasters can be a multiple function of hazard and vulnerability. Since each disaster is unique—its effects not only have to do with the type of natural or man-made phenomenon—there are common features, and identifying them can help improve the management of humanitarian assistance and the use of resources in case of emergency.

On the other hand, emergencies and disasters as a sum of hazard and risk impose exceptional demands on the logistical and organizational skills of the affected geography and population as well as in that country. In responding to a natural disaster, the delivery of logistics is paramount. This challenge is undergone with particular intensity in logistics industry and processes, where deficiencies in the flow of supplies may have ominous consequences. The problem does not merely lie in the supply and procurement of emergency goods and equipment but also the management of those supplies already at hand or in the pipeline. Supplies may be piling up at the central level while acute shortages are painfully

[35] Middle East Logistics Institute for Training – MELI, Almajdouie Group, Dammam/Kingdom of Saudi Arabia, +90 505 5937750, turhanbilgili@meli.edu.sa and info@turhanbilgili.com

evident at the emergency site but often contradicted amounts of inventory. Unsolicited—and often inappropriate—donations also compete for warehousing and distribution facilities that may be in short supply. Humanitarian logistics as a keystone to disaster management therefore is the function encompasses a range of activities, including preparedness, planning, procurement, transport, warehousing, tracking and tracing, delivery and customs clearance if an abroad mission is undergone (Thomas and Kopczak, 2005; Fritz, L., 2007; Kovács, G. and Spens, K. M., 2007).

Lessons learnt from 2010 earthquake in Haiti can be summoned as "logistics and the lack of transport remain the key constraints to the delivery of aid" and "coordination of logistics assistance is vital" (OCHA, 2010). This is an exceptional importance of humanitarian logistics and critical need for coordination inspiring my research in disaster relief operations.

On the other hand, acquisition, stockpiling, mobilization, delivery—these and other aspects of supplying material assistance to the victims of disasters, and the handling of those material employed by organizations in their disaster relief operations, require a robust organizational structure to ensure the efficient management and utilization of resources that in emergency situations.

This configuration provided by logistics is the art or strategy of achieving practical objectives as promptly and methodically as possible while making the most effective use of available resources provided by a number of stakeholders involved in responding to humanitarian disasters which includes local and humanitarian organizations, private companies, governments, military, and individuals (Besiou, M. et al, 2011). In any case, the veracity of Napoleon Bonaparte's observation "C'est la soupe qui fait le soldat" ("An army marches on its stomach") with a safe haven and immediate health are crucial factors to rehabilitation of infected society in disasters. Thus, three basic cohorts of disaster relief operations are addressed in this paper.

2. Literature Survey

World Disasters Report 2010 cites the death tolls caused by the Indian Ocean tsunami in 2004 (226,408 deaths), Cyclone Nargis in Myanmar in 2008 (138,366 deaths) and earthquakes in Sichuan, China in 2008 (87,476 deaths), Kashmir in 2005 (73,338 deaths) Bam, Iran in 2003 (26,796 deaths) and Gujurat, India in 2001 (20,005 deaths). Again in 2009, the number of 142 million people affected by disasters was the lowest of the decade, far below the annual average of 255 million people affected and USD 41.4 billion of damage caused by disasters. Amongst all, Asia is the most disaster affected region in the world.

In any catastrophe, the various stages in the flow of supplies from their point of origin to the moment they reach their recipients—whether they be the organizations managing the emergency or the actual beneficiaries of the assistance—are a chain made up of loops. These loops are supervised perpetually affecting the others. The focus of an integral approach that looks at all the loops in the sequence and never loses sight of their interdependence, known as supply chain logistics (Cavinato, 2004).

The humanitarian and commercial logistics requires the same basics; however the fundamentals humanitarian logistics (including personnel and managers) will have to be activated in environments with limited or no infrastructures and communications (Rickard, 2006). Emergencies and disasters impose exceptional demands on the resources, logistics, and organizational skills of the affected topography as well as the vulnerable inhabitants. The books on humanitarian logistics (Christopher and Tatham, 2011; Tomasini and van Wassenhove, 2009; Blecken, 2010; Schulz, 2009; Ayongwa and Sun, 2010) gives an overview of the possibilities and limitations of collaboration both for the humanitarian sector and the business community by a given emphasis on such a complex science because actors are compelled to work with outmost speed in interrupted environments with unknown players in unknown conditions. Most literature in emergency logistics focuses on mobilization of supplies henceforth generating transportation plans for rapid dissemination of medical supplies inbound to the disaster hit region and highlights logistics distribution by operational research perspective (Sheu, 2007; Özdamar et al., 2004; Lodree Jr. and Taşkın, 2008). There is, however, uncertainty in the demand causes disruptions in emergency logistics and hence disruptions in humanitarian relief supply chains leading to severe sub-optimality or even infeasibility which may ultimately lead to loss of life and property. In order to mitigate the risk of uncertain demand, dynamic (multi-period) emergency response and evacuation traffic assignment problems have been studied the problem of generating evacuation plans which are vigorous to uncertainty in outgoing demand (Ben-Tal, et al., 2011). Even though there seems a significant disagreement regarding what belongs to one area (e.g., humanitarian logistics) and what belongs to business and military logistics there is the history of research focusing on humanitarian/disaster relief. Traditionally, this research was carried out under the umbrella of logistics, even though researchers recognized that, compared to its commercial counterparts, it was broader in scope (Tatham and Spens, 2011).

For the purposes of this study, my acceptance on the definition of humanitarian/disaster relief logistics is the synonymous offered by Thomas and Mizushima (2005): The process of planning, implementing and controlling the effective, cost-efficient flow and storage of goods and materials as well as related information, from the point of origin to the point of consumption for the purpose of meeting the end beneficiary's requirements.

Previous studies and proceedings on disaster relief operations heretofore have highlighted a trivet concerning the main components of humanitarian, business and military logistics. For instance, the affected country's military is the first group to provide immediate reaction in a disaster and the extent of humanitarian aid may be offered by neighboring or regional countries due to diplomatic relations (Maspero, E.L and Ittmann, H.W., 2008). That military assistance may turn to be an operation to protect NGOs or other role players as well as an aggregated support to dispatch humanitarian aid. In essence, humanitarian logistics cooperated by business logistics which yield corporate level practices encloses all the aspects required to ensure an efficient and effective humanitarian supply chain (Rodman, 2004). On the other hand, both business and humanitarian logistics coincide at the same platform that the risk and the crisis are dependants of the supply chain velocity rather than cost trade-offs and performance management (Davidson, 2006).

Per contra business and military logistics; the complementary corner stone is humanitarian logistics where disaster relief operations are controlled, managed, implemented and balanced throughout the strategic allocation of relief efforts amongst simultaneous events in emergency as well as providing a reserve for potential future events. Humanitarian logistics is responsible for achieving these outcomes in a timely and cost-effective manner identifying, communicating and monitoring the supply chain outcomes that the role players are to achieve over time. In that sense, collaborative and managerial disaster relief efforts are related but distinct, and having established that humanitarian logistics is a subset of SCM overall (Christopher and Tatham, 2011).

3. Design/Methodology/Approach

The differences and similarities between the different major fields of logistics, namely logistics in humanitarian assistance, in business, and in the military, and how this can be used to the advantage of humanitarian assistance have been modeled traditionally in the a DM cycle for tri-axial logistics operations (Warfield, 2008; Carroll, A. and Neu, J., 2009) and discussed earlier asserting various concepts used in disaster management (Khan, Vasilescu and Khan, 2008). In this paper, the sum of all activities, programmes and measures has been looked for modeling which can be taken up before, during and after a disaster with the purpose to avoid a disaster, reduce its impact or recover from its losses in order to create a value through disaster relief operations but not limited to the three key stages of activities.

Pretty resembling a sine theorem, a very early model had been applied to every crisis adjusting each activity to the particularity of the event. This "recovery model" proposed by Haas et al. (1977) highlighting the overlaps and the interlinked stages in a full disaster relief cycle (figure 1). Obviously, it is mostly dependant to supply chain initiating the step of preparedness which timeframe might vary according to the event. Thus, model of disaster recovery presents clear and common criteria of a response model and allows agencies or military support to integrate their logistics activities adapted to the specific situation, but discrete functions of humanitarian, military and business logistics.

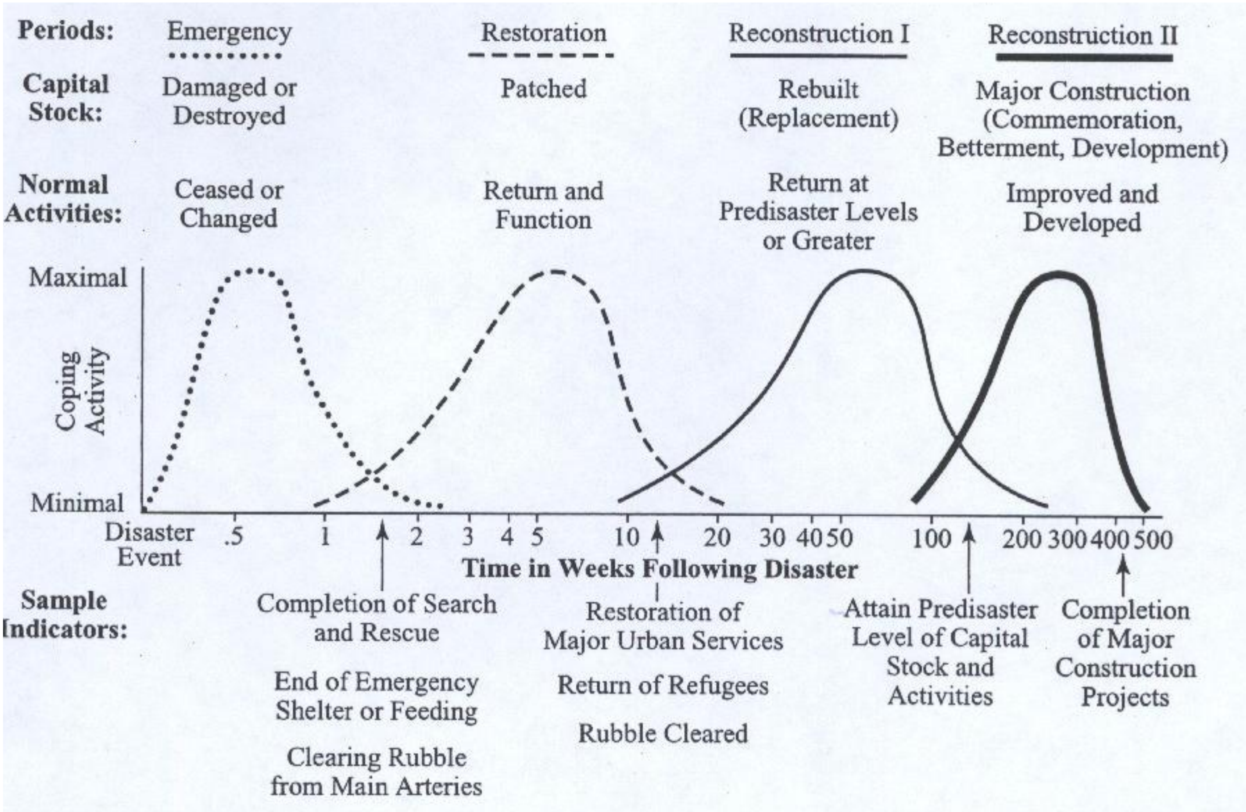


Figure 1. Model of disaster recovery

The disaster recovery model proposed by Haas et al. (1977) is somewhat a time and activity diagram whereas a strategic outlook to the disaster cycle can be improvised at the time of the emergency operations. Employing resources appropriately as a cornerstone of emergency planning and preparedness efforts, and being able to secure those that are not at hand, depends on first identifying their availability and location, as well as the sources for obtaining them in a disaster cycle. Eventually, logistics is a bridge that allows the transition between emergency and development programmes, and links the entire supply chain and all those activities demanded by logistical deployment during an emergency—the mechanism and a threshold for standardizing the various processes and all the necessary functions for information management and controlling, monitoring and following up on the flow of supplies in a continuous loop.

In short, there is a requirement for humanitarian organizations and other social institutions to better integrate each stage of the disaster lifecycle: mitigation, preparedness, response, and rehabilitation (Carter, 1991; Messer, 2003; Tomasini and Van Wassenhove, 2009) when designing disaster management programs. To achieve this, humanitarian decision makers (program directors and logisticians) need to obtain an accurate overview of the interrelated systems both within their organization, and throughout the humanitarian industry such that they can understand and predict the effect of changes to the system over time. This presents significant challenges to humanitarian decision makers as well as to practitioners of humanitarian logistics. Up to now, they have relied mainly on experience, intuition, and needs assessments to design relief and development programs on an ad hoc basis (Besiou et al., 2011).

In spite of the fact that there has been already brought the three types of logistics together as a triad; defining three aspects, namely volatility, unpredictability and asymmetry positing that these aspects are fundamentally different for each type of logistics, they indeed complement each other in an organising framework for humanitarian logistics operations (Carroll and Neu, 2009). Moreover, the scope, importance and challenge of humanitarian logistics impinge two other external components on the growth and operations of disaster relief. It is of course fully accepted that developing a robust mechanism to command a serious challenge which suitably incorporates with the velocity would be common tool providing a rationale for methodological approaches. Thus, the model has actually twofold cycle consists of risk management which surrounds pre-disaster period and afterwards crisis management which environs post-disaster phases. In its evolving design, it is also aimed to include three basic managerial activities namely information, material and cooperation management which are essential for planning, programming and implementing efforts on saving lives, protecting livelihoods, and strengthening recovery from disasters and crises. Thus, the model (figure 2) exerted here will address the objectives of emergency and humanitarian response and the pre-requisites for emergency response as well as logistics of an effective humanitarian response plan.

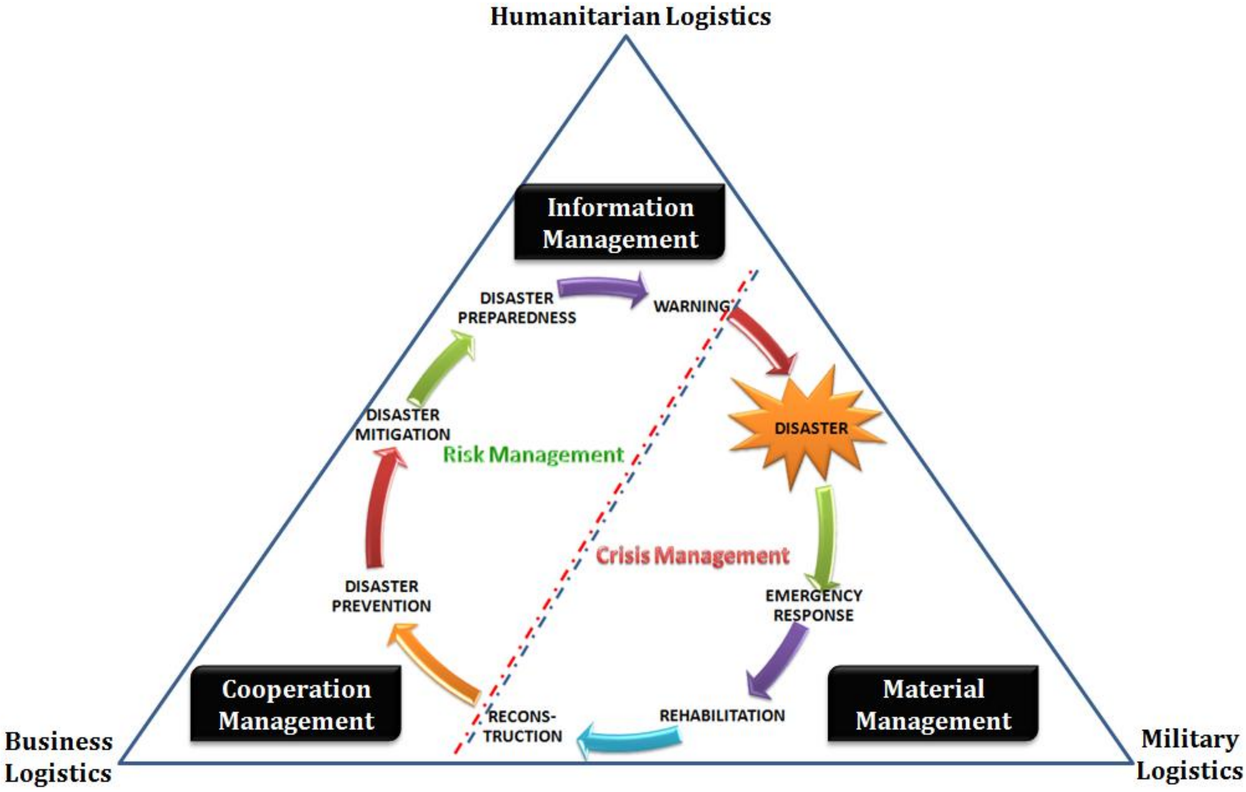


Figure 2. Contemporary model for disaster management cycle on tri-lateral logistics operations

4. Conclusion

Modeling the humanitarian logistics to create a value through disaster relief operations is quite complicated hence the design is the key parameter for planning disaster management. One significant outcome of any disaster was the realization and awareness by many organizations of the critical role that logistics plays in disaster response. To strengthen their influence and recognition, humanitarian logistics needs to be reunited in a robust design to carry out missions professionally, provide quality of operations, facilitate consistency of service and be helpful in decision criteria for the employment or resources. Due to the enormity of the disaster and the number of organizations that were present, the contemporary model for disaster management cycle on tri-lateral logistics operations highlighted the need to leverage collaboration and coordinate with the military, private sector and humanitarian organizations to provide more effective aid in the vicinity of disaster.

A smooth, speedy and coordinated response by organizations to overcome the roles assigned and create a value is the challenge brought so far in this paper. It is the same value conveyed and recognized by utilizing integrated technology systems to capture and analyze information on a timely manner resulting in a more effective and efficient relief effort on humanitarian logistics. It is therefore a forward planning process, in a state of uncertainty, which helps formulating disaster recovery plans where scenarios and objectives are agreed, managerial and technical aspects defined, and potential response systems put in place in order to prevent, or better respond to an emergency within the rationale of contingency planning.

I believe future research will hopefully carry on the idea of using the model in humanitarian relief operations justifying the obvious conclusion is that the three types of logistics, all have their pros and cons working together in the same platform but focused on providing relief for the same disaster.

References

Ayongwa, I.A. and Sun J. 2010. *Humanitarian Logistics*, Lambert Academic Publishing, pp. 4-17.

Ben-Tal, A., B.D., Chung, S. and Mandala, T. Y. 2011. Robust optimization for emergency logistics planning: Risk mitigation of humanitarian relief supply chains, *Transportation Res*. B. 45(8) pp. 1177-1189.

Besiou M., Stapleton O. and Wassenhove L.N. V. 2011. System dynamics for humanitarian operations, *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 1, Iss: 1, pp. 78 – 103.

Blecken A. 2010. Humanitarian logistics: Modelling supply chain processes of humanitarian organisations, *Haupt Verlag AG*, pp. 12-24.

Buckle P. 2005. *Disaster: Mandated definitions, local knowledge and complexity.* in Perry R.W., Quarantelli E.L. (ed). What is a Disaster? USA: Xlibris. pp. 179-180.

Carroll, A. and Neu, J. 2009. Volatility, unpredictability and asymmetry - An organising framework for humanitarian logistics operations? *Management Research News*, Vol. 32, No. 11, pp. 1024-1037.

Carter, M. 1991. *Disaster management: A disaster manager's handbook*, Manila, Philippines: ADB.

Cavinato, Joseph L. (2004). Supply chain logistics risks: From the back room to the board room, *International Journal of Physical Distribution & Logistics Management*, Vol. 34 Iss: 5, pp.383 – 387.

Christopher, M. and Tatham, P. 2011. *Humanitarian logistics: Meeting the challenge of preparing for and responding to disasters*, Kogan Page Limited (UK), pp. 17-23.

Davidson, A. L. 2006. *Key performance indicators in humanitarian logistics*, unpublished MEng Thesis, MIT.

Fritz, L. 2007. *Quoted in Fritz Institute's unique 'certification in humanitarian logistics, program establishes a standard of expertise for relief workers worldwide* [online] http://www.fritzinstitute.org/prsrmPR-FI_UniqueCHL.htm retrieved on 14 June 2012.

Haas, J.E., Kates, R.W. and Bowden, M. 1977. *Reconstruction Following Disaster*, MIT Press, Cambridge.

Khan, H., Vasilescu L.G. and Khan A. 2008. Disaster management cycle – a theoretical approach, *Journal of Management and Marketing*, Vol. VI, No: 6, pp. 43-50.

Kovács, G. and Spens, K. M. 2007. Humanitarian logistics in disaster relief operations. *International Journal of Physical Distribution & Logistics Management*, Vol. 37, No. 2, pp. 99-114.

Lodree Jr, EJ and S. Taşkın. 2008. An insurance risk management framework for disaster relief and supply chain disruption inventory planning, *Journal of the Operational Research Society*, 59(5), pp. 674–684.

Maspero, E.L. and Ittmann, H.W. 2008. The rise of humanitarian logistics, *SATC 2008*, Pretoria, South Africa, pp. 175-184.

Messer, N.M. 2003. *The Role of the local institutions and their interaction in disaster risk mitigation: A literature review*, Food and Agriculture Organization, UN.

OCHA. 2010. *Haiti earthquake situation reports #3 & 4*. Office of the Coordination for Humanitarian Affairs, New York, NY, January 14-15, available at: www.reliefweb.int (accessed May 1, 2010).

Özdamar, L., E. Ekinci and Küçükyazıcı B. 2004. Emergency logistics planning in natural disasters, *Annals of Operations Research*, 129(1), pp. 217–245.

Quarantelli E.L. 1998. *Where we have been and where we might go*. in Quarantelli E.L. (ed). What is a Disaster? London: Routledge. pp. 146-159.

Rickard, J. 2006. Humanitarian logistics: Musing aloud, *Monday Development*, Vol.24, No.20, pp. 6-7.

Rodman, W.K. 2004. *Supply chain management in humanitarian relief logistics*, Thesis, DOS, AFIT, Air University, available at: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA422958 (accessed June 1, 2012).

Schulz S.F. 2009. Disaster relief logistics: Benefits of and impediments to cooperation between humanitarian organizations, *Haupt Verlag AG*, pp. 08-34.

Sheu, J.B. 2007. An emergency logistics distribution approach for quick response to urgent relief demand in disasters, *Transportation Research*, Part E, 43(6) pp. 687–709.

Tatham, P. and K. Spens. 2011. Towards a humanitarian logistics knowledge management system, *Disaster Prevention and Management*, (20:1), pp. 6-26.

Thomas, A. and Kopczak, L. 2005. *From logistics to supply chain management: The path forward in the humanitarian sector*, Fritz Institute, San Francisco, CA.

Thomas, A. and M. Mizushima. 2005. Logistics training: Necessity or luxury? *Forced Migration Review*, (22), pp. 60.

Tomasini, R.M. and van Wassenhove, L. N. 2009. *Humanitarian logistics*, Palgrave Macmillan Limited, pp. 3-21.

Warfield, C. 2008. The disaster management cycle. *Global Development Research Centre*, pp. 17-21.

Value Stream Mapping of an Innovative Design – The Analysis of Transforming Regular Supermarket Carts to Smart Carts

Zeynep Gergin[36], Tülin Aktin[36], Ayşe Nil Sarıgöllü[37], and Serdar Altuncu[37]

Abstract

The widespread application of card payment systems has forced the retailers, manufacturing firms, and banks to carry out targeted advertising campaigns which address the personal preferences and diversity of their customers. This study aims to analyze the added value to the various stakeholders of the chain, when regular supermarket carts are transferred to smart carts. The supermarket shopping processes form the chain under consideration. A smart cart carries a hardware which communicates with RFID sensors on the shelves, and transmits information, such as, customized promotions to the consumer. The employment of "smart" supermarket carts will have benefits not only to customers and the store, but also to the banks and suppliers involved in the system.

The outcomes of the proposed innovative transformation will be evaluated using Value Stream Mapping (VSM) Technique. VSM is a visual tool that configures a detailed picture of the value chain, and examines the improvement opportunities. Mapping reviews the flow of information and materials through the chain in order to assess the value adding and non-value adding activities. Here, value is defined in the eye of the stakeholders engaged in the chain; and the current and future states' maps are drawn to display the enhanced value.

Keywords: *Customer centered innovation, Value Stream Mapping, Value chain, Supermarket shopping processes*

1. Introduction

Today, we have arrived at an epoch that was foreseen at the beginning of the century; consumers are empowered, competition is fierce, and technology is widely adapted to almost all areas of our lives. While shopping was used to be a daily activity done from the closest store by paying cash, nowadays consumers are accustomed to supermarkets for periodic requirements, and paying via one of their credit cards. What's more, they are demanding further services and information, forcing the other stakeholders of the chain to enhance their deliverables.

Retailers are continuously trying to improve their customers' shopping experiences and to affect the purchase decisions in order to improve their sales. Grocery stores are leading various promotion campaigns for these targets, together with the collaboration of their suppliers and the banks. Advertisements and promotions are effective ways of influencing sales and enhancing the business of all parties, but it will only be successful if the promotion is particularly advertised to those shoppers who are likely to be interested in the offer (Cinicioglu, Shenoy, & Kocabasoglu, 2007). Hence, the marketing strategies have focused on building a database of consumers and their preferences to develop insights from this aggregated information.

[36] Istanbul Kültür University, Turkey, +90 212 4984200, z.gergin@iku.edu.tr, t.aktin@iku.edu.tr
[37] Cardtek Group, Turkey, +90 212 3283331, ayse.sarigollu@cardtek.com, serdar.altuncu@cardtek.com

The widespread application of card payment systems has also enabled the retailers, manufacturing firms, and banks to carry out targeted advertising campaigns which address the personal preferences and diversity of their customers based on the data collected through extract of accounts. Likewise, most grocery stores identify their customers by loyalty cards and keep track of the customers' preferences. However, these systems can gather the procurement decision data of the customers after the payments are completed and the customers walk out of the store. Grocery stores and banks are in need of attracting customers' attention at the time of shopping, and would like to inform them about ongoing promotions. Smart carts that are designed for this purpose are transmitting instant information, for all the parties in the chain; the customer, the store, the suppliers and the banks, and evolve the value in the shopping processes. A smart cart carries a hardware which communicates with Radio Frequency Identification (RFID) sensors on the shelves together with IT systems of the grocery management and the banks.

RFID is a more recent term referring to a family of sensing technologies that has been in use for more than 50 years, and now a generic term for a variety of technologies that use radio waves to automatically identify individual items (Cavoukian, 2004). RFID is also used as a term of its capabilities, such as (1) the capability to capture information in settings that involve mobility of some types of business objects (e.g., products, pallets, people, vehicles, etc.); (2) the opportunity to use this kind of information collection capability to span across a variety of organizational environments and business processes that exist internal to and across operations, business units, organizations and markets; (3) the facility to interface and bring together the functionality of key systems whose information endowments will be dramatically increased, thereby increasing information available to managers; and (4) the capability of innovative emerging technologies that will change our perceptions of the meaning and constraints associated with location, space and time (Curtin, Kauffman, & Riggins, 2007:88).

The mobile device on the new designed grocery cart uses the capabilities of the RFID technology and transfers a regular cart to a smart cart. The smart cart transmits information like customized promotions from suppliers and the banks resulting in a value added shopping experience for the customer. The smart cart is also a real time targeted advertising agent that can be used by other stakeholders, providing the ability to collect and transfer the information of customer's purchase to the database of the grocery store. Furthermore, depending on the card used by the customer to activate the device, it can also communicate not only with the grocery management but also with the bank. This communication enables the bank to get the procurement information of the customer and offer campaigns instantly. Customized promotions to the consumer are price discounts, extra product suggestions next to a selected one, various payment options, extra discounts in case of paying with a specific card, extra deals related to out-store procurements, etc. Figure 1 displays the operating system of the smart cart designed by Cardtek Group, named as AYT. The prototype of AYT is considered in the current study.

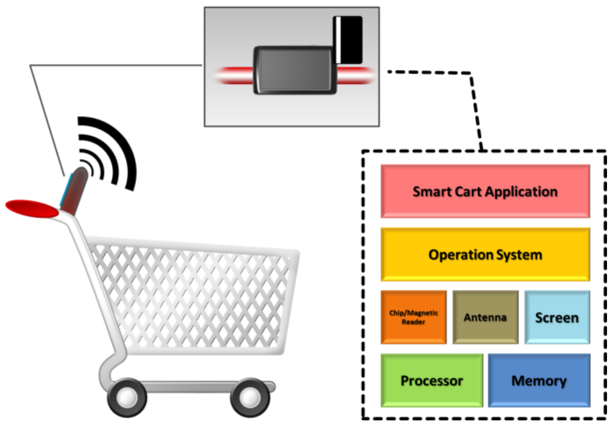


Figure 1. Operating system of the smart cart AYT

This study aims to analyze the added value to the various stakeholders of the chain, when regular supermarket carts are transferred to smart carts. Primarily, the value added to the shopping process with respect to lead time and communication/information flow is examined by the Value Stream Mapping (VSM) technique, which is a lean management methodology that enables to visualize the processes of a value chain. The paper starts with some brief information about aims of lean management with relation to the research, and the VSM technique. Then, the current map of the actual system, together with the future and ideal state maps of the proposed system are presented by discussing the improvements in the lead time of the shopping process. Finally, additional value added to all stakeholders in the chain is discussed.

2. Dynamics of the Value Chain

In the current study, value is defined for all parties of the shopping chain illustrated in Figure 2. In this chain, customer tries to complete her/his shopping with the least budget and in the shortest length of time. Grocery aims to sell the products which are more profitable according to the contracts with the suppliers, while suppliers aim to increase the amount of their products delivered to the grocery. The banks' objectives are encouraging the customer to use their card frequently.

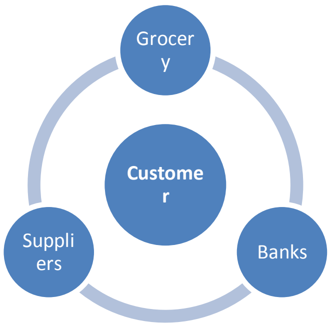


Figure 1. Stakeholders of the chain

There are various factors defining the shopping preferences of a customer. These are; the age, gender, education level, marital status, and the income of the customer, together with the region of grocery, the shopping frequency, the day of the week and the time of the day. These factors affect the items in the shopping list, as well as, the length of the process.

Customers also adopt various shopping strategies, which are listed under seven types (Walker & Cude, 1983):

1. Unit pricing – select the item with the lowest price per unit among all options.
2. Unit price (excluding generics) – select the item with the lowest price per unit among all brand names.
3. Larger sizes are better buys (excluding generics) – select the item with the lowest price per unit among the larger sizes of a product.
4. Buy generic – if unavailable use the store brand.
5. Buy sale items – if more than one item is on sale, select the lowest priced per unit; if there is no item on sale use strategy 3.
6. Buy the size of your brand with the lowest price per unit – compare the price per unit of all available sizes to select the least expensive.
7. Buy the largest size of your brand – without making any price comparison.

Researches show that, consumers widely prefer to use offered promotions, such as price reductions which make them feel smart and economical. Customers, who look in fliers and magazines for promotions before they start shopping, feel that they are good dealers and save money. Others who are perceived to be time pressured engage less in price search and promotions. The use of promotions and price information delivered in the store allows them to make quicker decisions without an extended search, however this method does not always attract the attention of today's intensely time pressured customer. Thus, all customers can be assumed to be in a will of economical buying, but they do not always have time for tracking differences between the prices (Schindler, 1992; Shimp & Kavas, 1984). This leads to the fact that these customers experience noneconomic shopping, due to not devoting significant time and effort on searching for promotions. On the other hand, another research shows that in case of opposing motivations of time concern and price, price surpasses the time constraint resulting in extra time spent in the grocery (Vermeir & Van Kenhove, 2005).

As foreseen in the end of 90s, the most important concern of the business nowadays is attracting the customers' interests with quality products and faster services in the competitive market conditions. Academics and practitioners are continuously studying on management and marketing strategies, trying to make the processes more efficient through various methodologies and inventions. The modern world's requirements are commonly fulfilled by the collaboration of information technologies with various academic and practical studies. Smart carts are one of these applications proposed to manage and realize the shopping process in accordance with lean principles.

3. Methodology

Lean management is managing the chain of operations – from suppliers to product/service delivery – using less resource, in addition to delivering the products/services with higher quality, and satisfying the customer's demand. This requires identifying the value creating activities, putting them together in a value stream, making the stream flow, creating a pull of the flow, and striving towards perfection. Getting leaner is achieved through reducing the seven types of waste; overproduction, unnecessary transportation, inventory, motion, defects, over-processing, waiting. The activities which are creating waste in the stream and preventing the smooth flow are called non-value adding (NVA) activities, and the objective is to reduce these wastes by various lean management techniques.

Value Stream Mapping (VSM) is a lean process-mapping method that is created using predefined icons (Figure 3), and enables to visualize the processes of a value chain. The first step to generate a VSM is to choose a product/service delivery as the target for improvement. The next step is to draw a current state map that is essentially a snapshot capturing how things are currently performed in the system. This is accomplished while walking along the actual process, and provides a basis for analyzing the system and identifying NVA activities, as well as, value adding (VA) activities, and proposing opportunities for improvements in the whole chain. The third step in VSM is to create the future state map, which is a picture of how the system should look after the inefficiencies are removed (Abdulmaleka, & Rajgopa, 2007). Some studies also include an ideal state map of the system showing further improvements that can be accomplished to reduce all of the NVA activities in the whole process.

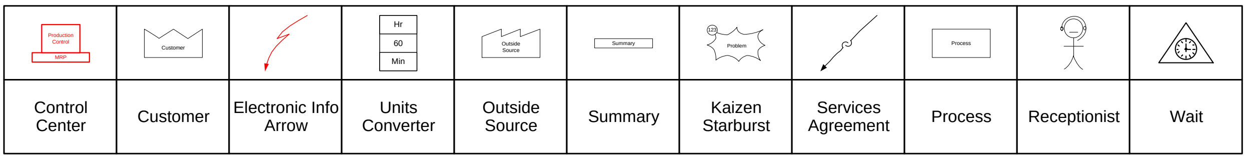


Figure 3. Common VSM icons (for service operations)

A VSM is composed of three sections (Nash and Poling, 2008);

1. Process or production flow; the portion of the map showing the flow of activities.
2. Communication or information flow; the portion of the map showing both the formal and informal communication.
3. Timelines and travel distances; the series of lines that provide information on the distance travelled and the production/service realization lead time.

3.1 Current State Map of the System

The current state map (Figure 4) shows the actual shopping system with standard carts. The grocery store under consideration is located in the north-west region of Istanbul. It is 6495 m^2 and offering 2500-3000 types of products. The cycle times of activities are measured by observing a shopping case for 14 predefined items. The sample customer is a 37 years old married woman, who is shopping for the weekly household requirements of a family with 3 members, on Saturday at 5 pm, and paying via credit card. These sample factors are selected based on the literature survey as the highest ranks, such that on any typical day women go to shopping more than men do, Saturday is the busiest day, and more shoppers arrive at the store between 4 pm and 5 pm. Additionally the customer adopts unit pricing strategy for this study.

The shopping processes are grouped under 5 main tasks according to a research conducted by IBM Institute for Business Value (The Time Use Institute, 2008). The activities under each task are explained below, and the metrics used to measure these activities are displayed in Table 1.

1. Obtaining information (pre store): preparing the shopping list, reading flyers of the grocery, checking promotions of the market and the credit cards on various media (TV, internet, etc.).
2. Entering, navigating and browsing: taking the cart from the pool, walking through the aisles, looking for the items in the shopping list.
3. Making a purchase decision: checking the items on the shelves, evaluating the prices, and putting the selected item in the cart.
4. Waiting in the queue: spending time for the predecessor customers' check out activities.
5. Check out: putting the items to the conveyor, passing the sales register paying via credit card, putting the items into the bags.

Table 1. Process metrics calculated in VSMs.

Metric	Explanation
Activity Takt Time	Target duration of an activity devoted per item
Cycle Time	Observed time to complete an activity (includes the NVA time associated with that activity)
Cycle Time Per Item	Cycle time divided by the number of items in the cart
Demand	Number of items on the shopping list
Lead Time	The time computed by adding all the VA and NVA durations
NVA Time	Non-value adding time (durations that should primarily be reduced)
Qty Per Cycle	Number of items processed
Total Value Added	Total value-added time in the value stream
Value Added Percent	Percent of total lead time that is value added

The researches show that the length of average shopping period for the defined case is varying from 30 minutes to 45 minutes according to different countries. In this study, the target shopping time is defined as 30 minutes based on the research by Yıldırım and Aydın (2012). The same research defines the average number of items for a weekly grocery shopping list as 14, hence the shopping list is limited to 14 items, and created based on the weekly household requirements of a family with 3 members. Items in the shopping list are all pre-packaged and listed below;

1. Cheese
2. Yogurt
3. Milk
4. Bread

5. Rice/ pasta etc.
6. Meat
7. Juice, soda etc.
8. Vegetable 1
9. Vegetable 2
10. Vegetable 3
11. Fruit 1
12. Fruit 2
13. Shampoo / detergent
14. Sanitary material

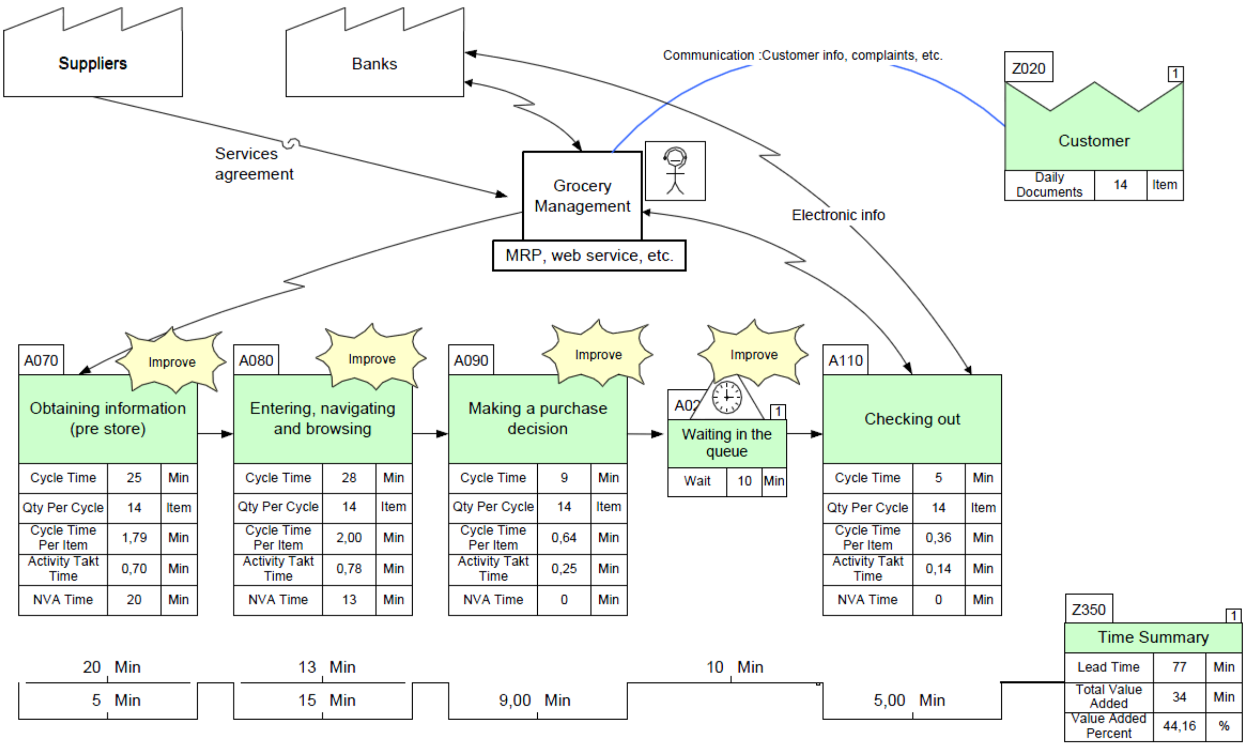


Figure 4. Current state map of the system

The current state map shows that the actual lead time of the process is observed to be 77 minutes, and only 34 minutes of this period is VA time. This means that, the customer favors only 44.16 percent of this time, and the rest is perceived as waste. VA activities cannot be excluded from the process flow, while they can be improved. On the other hand, NVA activities are the ones creating waste, hence should be attacked initially. In this map, it is seen that making a purchase decision and checking out are the complete VA activities of the whole process, whereas only 15 minutes of entering, navigating and browsing, and 5 minutes of obtaining information activities are value adding. The rest are NVA activities and need to undergo improvement in the first hand.

The takt time of the activities are calculated according to the target of 30 minutes completion time for the whole shopping process. As it can be seen from the figure, cycle time per item is greater than takt time for all activities. This is interpreted as an unfavorable situation, since the cycle time should be less than the takt time in order to satisfy the demand of 14 items within the target time of 30 minutes.

Future and ideal state maps in the following subsections are demonstrating the improvements in the metrics of the activities when the smart carts are introduced to the system.

3.2 Future State Map of the System

The future state map of the system (Figure 5) represents the system with smart carts. However, this map has not been generated by observation, since there is only one prototype of the device which is available and it is not activated on a cart yet. The values for the metrics in the map are assumed values that are determined by interviewing with the designers of the device and experts of the system.

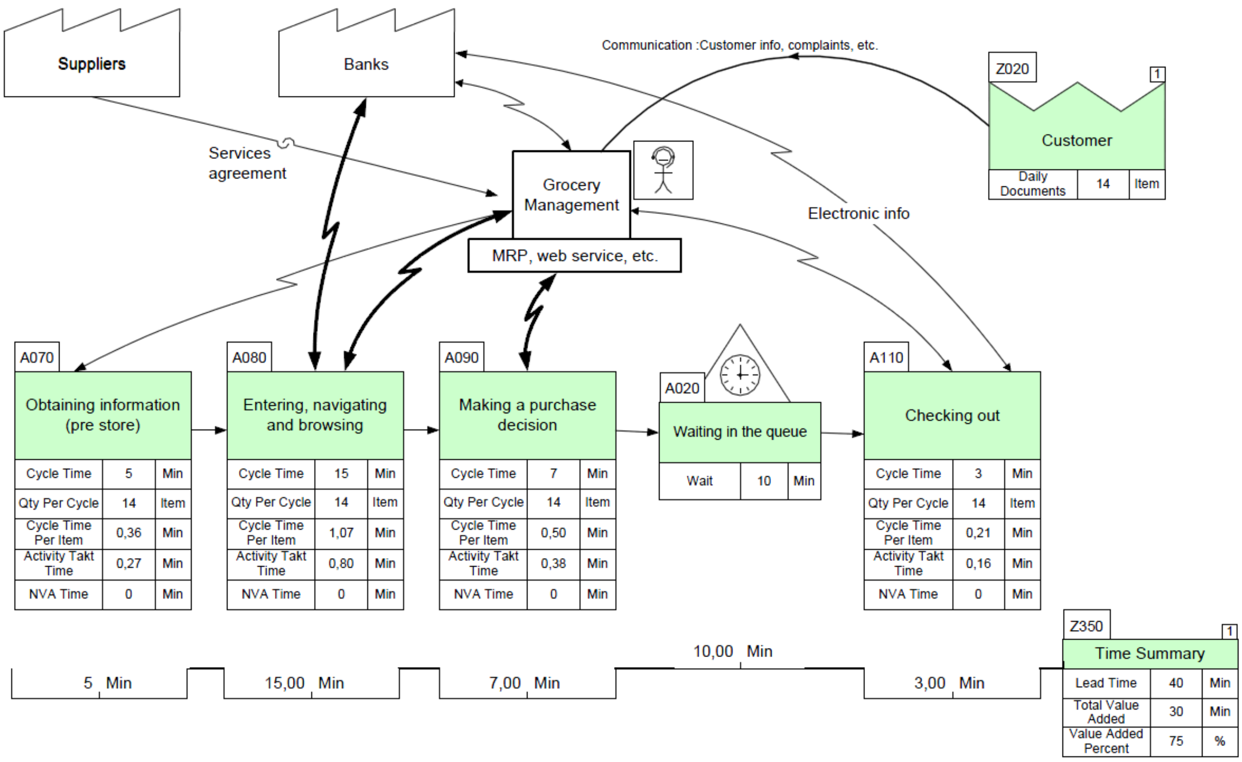


Figure 5. Future state map of the system

The change that the smart cart has introduced to the system is shown by the additional bold arrows in Figure 5. These arrows – showing electronic info communication – represent the online promotion and product navigation data supplied by the banks and the grocery management to the customer during the entering, navigating and browsing activity. The communications are two-way; first the customer introduces herself to the system via a loyalty/credit card, then the system recognizes the customer and offers customized promotions. When the customer enters an item from her shopping list to the device, the system navigates her to the related aisle. In addition, there is another electronic info communication between the grocery management and the customer for transmitting the best price of the options that the customer has asked during the activity of making a purchase decision.

According to experts' remarks, the smart cart usage primarily decreases the duration of the information search activity which is performed by the customer before entering the store, and only 5 minutes of VA time coming from the preparation of the shopping list remains for the cycle time. Besides, 13 minutes of NVA time of entering, navigating and browsing is eliminated by the navigation function of the device to find the targeted product. Consequently, the customer reaches the item without spending extra time between the aisles. This is especially important, since the shelf configurations of the stores are periodically rearranged to affect the consumer's purchase decision and to introduce new products.

Additionally, two minutes are gained from the making a purchase decision activity, as the smart cart shows the most economical option on the shelf, based on the customer's preferences aggregated from the database. Moreover, two minutes of waste in the sales register is also discarded, because the customer already knows – as displayed on the screen - the total purchasing cost, and the most appropriate credit card to be used in this purchase.

As a result, when the time summary is compared with the current state, it is observed that the lead time of the whole process has decreased to 40 minutes, and the value added percent has increased to 75. The system hasn't accomplished the target takt time, which means that, extra improvements still need to be applied to eliminate the NVA activities.

3.3 Ideal State Map of the System

An ideal state map (Figure 6) is also presented for the case for further developments of the smart cart system. This system proposes an integration of the smart cart with the payment systems, so that the customer can pass the sales register without putting the items on the conveyor and packing them afterwards, but she can directly walk through the registry which will result in one minute of activity cycle time. This is assumed to generate an additional decrease in the waiting time in the queue from 10 minutes to one minute, consequently, accomplishing the target takt time.

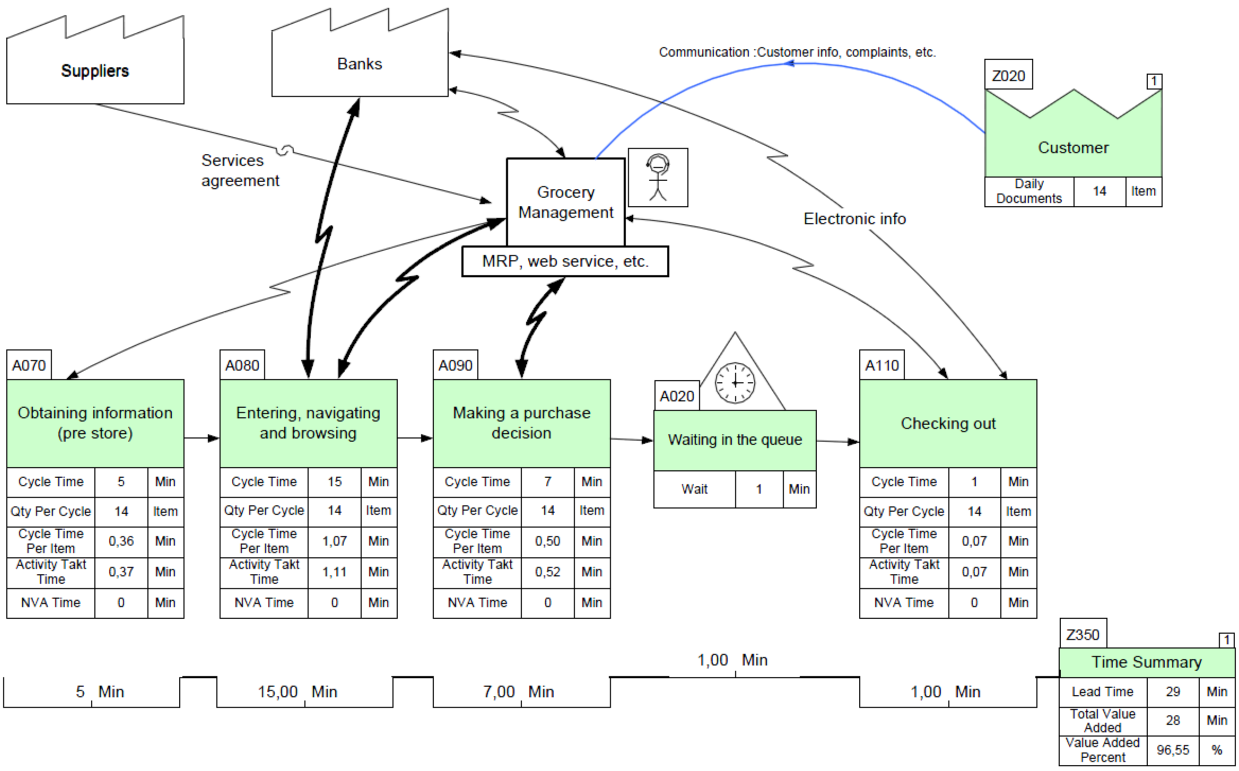


Figure 6. Ideal state map of the system

The extra improvements introduced by using a smart cart have decreased the lead time of the shopping process to 29 minutes. Although it is below the target time, the system still has 3.45 percent of NVA time. This means that further improvement opportunities exist for the system, which may be beyond the capabilities of smart carts.

4. Conclusion

In this study, the value added to the stakeholders of the shopping chain is analyzed, if regular supermarket carts are transferred to smart carts that are carrying RFID technology enabled hardware. A smart cart establishes online communication between the parties of the chain, resulting in a mutual benefit for them all. The benefits of the proposed innovation are analyzed and displayed by the employment of the VSM technique, which is a tool visualizing the transformation to a lean management system. By decreasing the wastes of unnecessary transportation, motion and waiting, VA percentage of the lead time has been improved, along with the increased efficiency for all parties.

Once this system is realized, the different stakeholders of the chain will be introduced with the following enhancements summarized below:

From the customers' point of view; they

- do not miss promotion opportunities offered by the other parties,
- have the advantage of buying products for a cheaper price, and
- decrease the time spent for the whole shopping process.

From the groceries' point of view; they

- have a more effective channel for communicating promotions,
- increase the value of the brand name by following the latest technology trends,
- attain improved customer loyalty,
- have the opportunity to hire new promotional areas to the suppliers, and
- establish synergistic partnerships through cross-campaigns with various sectors outside the chain.

From the banks' point of view; they

- have a new tool for customized promotional announcements,
- create channels to increase customer loyalty,
- have the opportunity to reach the customer before realizing the payment, and
- gain more information about the customers' spending habits, based on the contracts between the grocery and the banks.

From the suppliers' point of view; they

- have the opportunity to make special promotions,
- gain advantage over their competitors as a result of capturing the customers' attention via visual promotions, and
- can reinforce their brand in the eyes of the consumers.

It should be noted that, the values displayed on the future and ideal state maps are based on assumptions, and do not reflect any measured results. However, once AYT is adapted to the system, additional work can be performed to incorporate the real values into the analysis.

As a final remark based on the results displayed in the ideal state map (Figure 6), the current capabilities of smart carts are not adequate for further improvement opportunities of the system. It is believed that, this can be overcome by integrating future technological and/or managerial advances.

5. References

Abdulmaleka, F. A., & Rajgopa J. 2007. Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *Int. Journal of Production Economics,* 107: 223–236.

Cavoukian, A. 2004. Tag, you're it: Privacy implications of radio frequency identification (RFID) technology. *Information and Privacy Commissioner/Ontario.* Available at http://www.ipc.on.ca/images/resources/up-rfid.pdf, May 31, 2012.

Cinicioglu, E.N. , Shenoy, P.P., & Kocabasoglu , C. 2007. Use of radio frequency identification for targeted advertising: A collaborative filtering approach using Bayesian networks, *Proceedings of the 9th European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty ECSQARU '07*: 889-900. http://kuscholarworks.ku.edu/dspace/bitstream/1808 /5231/1/ ECSQARU07.pdf, April 5, 2012.

Curtin, J., Kauffman, R.J. & Riggins, F.J. 2007. Making the 'MOST' out of RFID technology: A research agenda for the study of the adoption, usage and impact of RFID. *Information Technology and Management*, 8(2):87–110.

Nash, M.A., & Poling, S.R. 2008. *Mapping the total value stream*. New York: CRC Press.

Schindler, R. M. 1992. A coupon is more than a low price: Evidence from a shopping-simulation study. *Psychology & Marketing*, 9: 431-451.

Shimp, T A., & Kavas, A. 1984. The theory of reasoned action applied to coupon usage. *Journal of Consumer Research,* 11: 795-809.

The Time Use Institute. 2008. Grocery shopping: who, where and when. http:// www.fmi.org /forms/ uploadFiles/412C30000000E.toc.Time_Use_Institute_Preview_2008.pdf, May 24, 2012

Vermeir, I., Van Kenhove, P. 2005. The influence of need for closure and perceived time pressure on search effort for price and promotional information in a grocery shopping context. *Psychology & Marketing*. 22 (1): 71-95.

Walker, R., & Cude, B. 1983. In-store shopping strategies: time and money costs in the supermarkets. *The Journal of Consumer Affairs*, 17(2): 356-369.

Yıldırım, Y., & Aydın, O. 2012. Investigation of the effects of discount announcements on consumers' purchase decisions: A case study in supermarket. *World Conference on Business Economics and Management Preceedings*, *Procedia-Social and Behavioral Sciences Journal*, available online at www.sciencedirect.com.

6. References not Cited

Chu, J., & Morrison, G.P. 2002. Enhancing the customer shopping experience: 2002 IBM/NRF "Store of the future" survey. *IBM Institute for Business Value,* http://www-935.ibm.com/services/uk/igs/pdf/esr-enhancing-the-customer-shopping-experience.pdf, May 24, 2012.

Tamura, H., Sugasaka, T., & Ueda, K. 2007. Designing a smart shopping-aid system based on human-centered approach. *e-Minds*, 1(3): 55-68.

Vermeir, I., Van Kenhove, P., & Hendrickx, H. 2002. The influence of need for closure on consumers' choice behaviour. *Journal of Economic Psychology,* 23: 703-727.

A Simulation-Based Performance Improvement Study for a Defense Logistics Agency Warehouse

Banu Y. Ekren[38], Gerald W. Evans[39], Sunderesh S. Heragu[40], and John S. Usher[41]

Abstract

Warehouses are critical for supply chains. In this study, we perform a simulation based performance improvement for the receiving area of a Defense Logistics Agency (DLA) warehouse. The studied warehouse is the largest warehouse of the DLA and located in New Cumberland, PA. First, we simulate the system. Second, we verify and validate the simulation model. Third, we conduct several experiments to decrease the average cycle time of items in the receiving area. As a result, we provide several alternative design scenarios which result in greatly improved performance relative to current performance.

Keywords: *Warehouse, Simulation, Experimentation, Performance improvement*

1. Introduction

Warehouses are critically important for supply chains. Their major role is buffering materials at various nodes in the supply chain to help offset the negative effects of variability caused by factors such as product seasonality, combined transportations, price policies, etc.

The basic operations in a warehouse are to receive goods from suppliers, store these goods, receive orders from customers, retrieve goods and ship them to customers. Receiving is the arrival of goods to a warehouse via carrier and unloading of goods at the receiving docks. In most warehouses received goods are put away into storage and later picked and shipped through shipping docks. In this case, the receiving and shipping operations become more complex to manage since they are coupled with the storage and order picking functions.

Efficient organization and storage of goods in a warehouse is a significant warehouse operation. Two primary goals are to achieve high space utilization while minimizing the time to put away inbound items and retrieve outbound items. Assignment of items to warehouse departments, space allocation, and zoning policy are all elements of storage operations (Heragu, 2008).

Order picking is considered one of the most expensive warehouse operations, because it tends to be either very labor intensive or very capital intensive (Frazelle, 2002). Managing the order picking process requires the organization of the orders to be picked and of the material handling operations of the picking. The selection of an order picking method is a strategic decision since it has a wide impact on many other decisions in warehouse design and operation.

There are various issues that should be considered in designing and operating a warehouse to meet the requirements. For instance, resources, such as space, labor, and equipment, should be allocated among the warehouse operations carefully. Also, the warehouse operations should be coordinated carefully in

[38] Izmir University of Economics, Turkey, +90 232 4888122, banuyetkin@gmail.com
[39] University of Louisville, USA, + 1 502 8526342, gerald.evans@louisville.edu
[40] University of Louisville, USA, + 1 502 8522741, s.heragu@louisville.edu
[41] University of Louisville, USA, + 1 502 8520085, usher@louisville.edu

order to achieve system requirements in terms of capacity, throughput, and service at the minimum resource cost. In this study, we simulate the largest warehouse of the Defense Logistics Agency – the Eastern Distribution Center (EDC) - located in New Cumberland, PA to investigate its performance. In the following section, we present related studies from the literature. In Section 3, we detail the simulation modeling of the system by providing the assumptions, the flow charts and the validation process. Last, we give conclusions and future research directions.

2. Literature Review

There are several studies in the literature which address the problem of warehouse design. Five major decisions are typically made: determining the overall structure, warehouse sizing and dimensioning, designing department layouts, selecting equipment and deciding operation strategies. Gu, Goetschalckx and McGinnis (2007; 2010) provide two comprehensive surveys on the operation, design and performance evaluation of warehouse problems. As they mention, most of the existing studies focus on the storage and order picking operations of warehouses (Gu, Goetschalckx, & McGinnis, 2007). Receiving and shipping related studies are very limited and therefore these areas have not received as much attention as storage and order picking problems. In this study, we investigate the receiving area of DLA's largest warehouse.

Incoming materials are brought to a warehouse usually by trucks, unloaded at the receiving docks, staged and stored. Then, materials are picked from storage, prepared, and shipped to customers via the shipping docks. The literature studies on receiving and shipping usually focus on assignment of trucks to docks, scheduling of loading and unloading activities, assignment of workers to proper tasks, etc. Most studies consider both receiving and shipping operations together.

Tsui and Chang (1990) study the receiving/shipping problem where trucks arrive from vendors to have their shipments unloaded, staged and, reloaded onto outbound trucks to deliver to customers. They propose a microcomputer based tool based on a bilinear program for recognition of the shipping pattern, and the assignment of the dock doors. In another study, Tsui and Chang (1992) propose a bi-linear model to assign inbound and outbound trucks to pre-designated doors.

Gue (1999) studies an optimization model for assignment of inbound trucks to receiving doors and assignment of destinations to shipping doors. He estimates the operational cost by using a local search procedure to find an efficient door layout. Bartholdi and Gue (1999) study a cross-docking warehouse door layout problem to minimize the total travel time and waiting time due to congestion. They propose a transportation and queuing model for a fixed door layout. Then they integrate the developed cost model and employ a simulated annealing algorithm to find a near-optimum door layout.

3. Simulation Modeling of the Warehouse

The DLA is the Department of Defense's largest logistics combat support agency, providing worldwide logistics support to the military services as well as several civilian agencies and foreign countries. DLA centers are responsible for the receipt, storage, issue, packing, preservation and transportation of more than 4 million items. DLA currently operates 25 distribution centers around the world and has sites in seven countries and twelve U.S. states (See Figure 1). We complete our study for DLA Distribution Susquehanna, PA., which is the Eastern Distribution Center at New Cumberland and Mechanicsburg, providing military and commercial repair parts, clothing and textiles, medical supplies and industrial and electronic components to military customers throughout the United States and the world.

Figure 1. DLA distribution centers in USA and in other countries

First, we observed the system at its current location and developed the flow charts for the material flows. Second, we collected required data to complete the simulation modeling of the system. Third, we developed a simulation model of the receiving area of the EDC. Last, we verify and validate the developed model. We consider the average cycle time of a received material as a performance measure for the validation purpose. Here, cycle time is the length of time from when a material is unloaded from a truck until it is inducted. After trucks are unloaded, materials are staged around the docks to be sent to the proper induction stations to be inspected and inducted before they are stowed. The induction process is completed by the DLA staff, specifically a Material Examiner Identifier (MEI). In this process, MEIs open the boxes, count the items, check the information on packing document, match them with the computer information in the WMS, etc. This process time changes based on the material type, size and the package type of a material inducted. Based on that, an induction process takes between 10 minutes and 40 minutes, for each item.

The simulated system is large and complex. There are a total of 58 induction stations, and an average of 75 workers, using material handling equipment such as a conveyor, forklifts, tow carts, and person-on-board storage and retrieval systems. The induction process at the EDC is vastly different from that seen in large commercial warehouses such as those managed by UPS, Wal-Mart, because there is a high degree of variability in the size, weight, shape, quantity, and requirements of the products handled at the EDC.

In the system, there are two types of trucks arriving to the EDC: small parcel carrying trucks – SPTs – and large item carrying trucks - LTs. Small parcels (SPs) and large items (LIs) are in box and pallet forms respectively and vary in size and weight based on the material. After boxes/pallets are unloaded, they are segregated into two or three groups based on their weights and sizes. Each group is inducted at separate induction stations. There are five main induction stations in the receiving area – I_1, I_2, I_3, I_4, I_5 – and each MEI can induct any type of materials.

We use deterministic arrival times for both truck types using 2011 data from July 1 – Dec 31. In other words, we use the same arrival times and number of pieces for LTs as in the obtained data from DLA. There are two main types of materials, M_1 and M_2. Seventy percent of the items in trucks are of type M_1 and thirty percent are of type M_2. Ninety-five percent of the boxes in a SPT weigh less than 40lbs. and they are segregated to be transferred via conveyors. Pallets in an LT are inducted in I_3, I_4 and I_5 with fifty-five, forty and five percent probability, respectively.

The assumptions that are used in the simulation model are summarized below:

1. Two types of trucks arrive at the EDC facility, SPTs and LTs.
2. There are three shifts and each has two 15 minute and one lunch/dinner breaks.
3. The number of unload workers and MEIs change according to shifts (scheduled numbers are used).

4. Unloading a truck has the highest priority. For example, when a truck arrives, the unload workers will first perform unloading operations.
5. SPTs arrive to the EDC three times a day – two in the morning and one in the afternoon.
6. Morning trucks have 400-600 boxes (shipments) and afternoon truck has 900-2000 boxes. The same number of pieces in truck is used as in the truck schedule file for LT.
7. 95% of boxes in a SPT weigh less than 40lbs.
8. The probability that a box is an M_1 or M_2 is 70%, and 30% respectively.
9. If a box weighs less than 40 lbs. and is an M_1 it is sent to I_1 via conveyor; if it is an M_2 then it is sent to I_2 via tow carts.
10. If a box weighs more than 40 lbs. it is inducted in I_2.
11. For SPT, if I_1 line is busy (queue length is greater than 150 in total) it stops to send more jobs to I_1 and boxes are kept triwalls.
12. If I_2 has more than 130 jobs then the boxes are staged in the staging area.
13. Two forklifts are seized to unload an LT. These are always available in the area. First, the unloaded pallets are staged and labeled. Then, they are transferred to the appropriate induction station via forklifts.
14. There are three main induction stations for materials unloaded from LTs. 55%, 40% and 5% of the materials in an LT are sent to I_3, I_4 and I_5, respectively.
15. M_1 has higher priority in the induction process.

The simulation model is developed using ARENA 13.9, a commercial simulation software (Kelton, Sadowski, & Sturrock, 2004; Law, 2007). After developing the model, we run the simulation model for 10 replications and observe the average cycle time of M_1 and M_2 separately. If those times had not corresponded to the actual observations, then we would have re-checked the model as well as our assumptions and adjusted them as needed until we had obtained a result closer to the actual one.

The simulation model is run for the simulated time period of July 1st to December 31st, 2011. We use specific distributions to generate the process times for induction stations. These distributions are obtained by the input analyzer tool in ARENA software.

In the simulation model, the common random numbers (CRN) variance reduction technique is used. CRN is a popular and useful variance reduction technique when we compare two or more alternative configurations. CRN requires synchronization of the random number streams, and uses the same random numbers to simulate all configurations. In CRN, a specific random number stream used for a specific purpose in one configuration is used for the same purpose in all other configurations. Thus, variance reduction is ensured.

A warm-up period of 20 days was assumed.

The model is verified by viewing the system animation as well as analyzing the output. The validation of the model is completed by comparing our results (average time from when an item is received until it is inducted) with the actual (average) cycle times in the data provided by DLA. We complete a *t*-test analysis at 95% confidence level for both types of material's average cycle times to decide whether the simulated model's average cycle time results are close enough to the actual system's cycle times or not. The *t*-test is completed in MINITAB 16.2.1 using one-sample *t*-test at 95% confidence level.

4. Conducted Experiments

We conduct eight experiments that could improve the system's performance as shown in Table 1. Experiment 0 is the current (base) system. We compare results from this scenario with eight others listed in Table 1. We explain the conducted experiments in detail below.

Table 1. *Conducted experiments*

No	Experiment
0	Initial system
1	Reduce variance 20% in all induction stations
2	Reduce mean 20% in all induction stations
3	Separate stations based on material types
4	Ignore I_4 and I_5 inductions in the EDC
5	Assign of 5, 4 and 3 MEIs as floating MEIs in the three shifts, respectively
6	Process improvements in I_1 and I_2
7	6^{th} experiment plus screen improvements in all stations
8	Combine the 5^{th} and 7^{th} experiments

Experiment 1

We assume reduced variance in the processing times at all five induction stations by 20%. It should be noted that the mean process time values in this experiment are the same as those in the base experiment.

Experiment 2

We assume the mean process times at all the induction stations are decreased by 20% while keeping the variance the same as in the base experiment.

Experiment 3

We assume separate induction stations for M_1 and M_2 at each of the four set of locations – I_2, I_3, I_4 and I_5 - (Note that the I_1 currently inducts only M_1 and thus, we did not have to implement this idea for the I_1). Each of the four sets of stations has two separate queues. When an M_1 material arrives at the I_3, for example, it is inducted by an MEI assigned to induct M_1. If there is no job waiting in the M_1 induction queue, then this MEI is permitted to induct M_2 if there is one waiting in that queue. The same logic is also used for the M_2. The simulation model assumes that approximately 30% of the MEIs are tasked with M_2 induction and the remaining for M_1.

Experiment 4

We assume that I_4 and I_5 types of materials are inducted in a building other than the EDC. Because the last six months' data show that roughly 80% of I_5 and 70% of I_5 are stored outside of the EDC, we believe inducting these materials in buildings outside of the EDC will increase the efficiency of the overall induction process. We assign the MEIs currently assigned to the I_4 and I_5 induction stations to the other stations e.g., I_1, I_2, and, I_3.

Experiment 5

We dynamically assign specific numbers of MEIs based on shifts. Namely, we assume that there are 5, 4 and 3 'floating' MEIs in the first, second and third shifts respectively. This idea implements the 'bucket brigade' concept wherein the floating MEIs help busy stations clear their backlog. Note that we are not requiring additional MEIs to be employed, but the floating MEIs are assigned from the existing capacity. Only these MEIs are allowed to change their locations when necessary. When an MEI changes his or her station, a traveling and/or set-up time is typically incurred and depending upon the number of floating MEIs, this could increase the induction cycle times. An MEI's location is changed if the station he or she is currently utilized less than 80 percent and there is another station where the utilization is greater than 90 percent. We check the utilization status for each station every hour and if the above condition holds, then the locations of the associated MEIs are changed.

Experiment 6

The process times are decreased by 30 seconds by eliminating waste times in stations I_1 and I_2. Hence, in the 6th experiment, we decrease the mean induction process times by 0.5 minutes and run the simulation model for these new values.

Experiment 7

We consider screen improvements plus waste time eliminations. We decrease the process times of I_1 and I_2 by 1 minute each, I_3 by 3 minutes and, I_4 and I_5 by 5 minutes each.

Experiment 8

We consider the combination of 5th and 7th experiments. Namely, in this experiment there are 5, 4 and 3 mobile MEIs in the first, second and third shifts respectively and the process times in the I_1 and I_2 are reduced by 30 seconds from the times considered in the base scenario.

5. Results and Interpretations

We summarize the simulation results as in Table 2. The performance measure - average cycle time - is the time elapsed from when an item is unloaded from a truck until it is inducted. From the table, it should be noted that in the initial system the mean for average cycle time of M_1 and M_2 are 8.74 h. and 12.70 h., respectively.

Table 2. *Simulation results*

Exp.	Avg. Cycle Time (hour)	
	M_1	M_2
0	8.74±0.53	12.70±0.171
1	8.61±0.49	13.54±0.33
2	4.17±0.08	5.50±0.13
3	9.37±0.48	11.98±0.26
4	5.18±0.09	6.19±0.10
5	6.73±0.21	11.67±0.53
6	6.91±0.19	12.32±0.28
7	5.20±0.09	6.94±0.14
8	4.73±0.09	6.77±0.18

From Table 2, it is observed that the average cycle time of M_1 is always smaller than the initial system's average cycle time. This means that any experiment in Table 1 works well on the system improvement in terms of average cycle time of M_1. Except for the 1st and the 6th experiments of Table 1, there is still significant improvement on average cycle time of M_2. The plant manager may want to consider floating MEIs in the receiving area because the 5th experiment shows a significant decrease on average cycle time of M_1. Additionally, if he/she also considers process improvements in all the induction stations as in Experiment 8, this decrease becomes very significant. For instance, the average cycle times of M_1 and M_2 decrease 46% and 47%, respectively. Therefore, we suggest considering the implementation of the 8th experiment in the receiving area.

6. Conclusion

In this study, we perform performance improvement in the receiving area of a warehouse. We implement the study for the receiving area of the largest DLA warehouse to improve the performance of the current system. We define eight scenarios based on process improvement in the induction stations. First, we simulate the current system. Second, we verify and validate it. Third, we run the simulation model for the eight experiments as in Table 1. Here, we aim to minimize the average cycle time of material types M_1 and M_2.

As a result, we could obtain at most a 46 % improvement in the performance measure. By this study, we also provided several design scenarios and their simulated results to DLA. This study can be extended in many directions as a future study. For instance, several other design scenarios - different arrival rates of trucks as well as different numbers of items in each truck - can also be considered. Input factors that could affect the system's performance can be defined and an experimental design may be conducted for these factors' different value levels. An ergonomic improvement study and its effect on the performance measure can also be considered as a future study.

7. References

Heragu, S. S. 2008. *Facilities Design*. 3rd ed. Clermont, FL: CRC Press.

Frazelle, E. H. 2002. *World-class Warehousing and Material Handling*. McGraw Hill, New York.

Gu, J., Goetschalckx, M., & McGinnis, L. F. 2007. Research on warehouse operation: A comprehensive review: A comprehensive review. *European Journal of Operational Research*, vol. 177: 1–21.

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: 539–549.

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: 1–4, 309– 312.

Tsui, L. Y., & Chang, C. H. 1992. An optimal solution to a dock door assignment problem. *Computers and Industrial Engineering*, vol. 23: 1–4, 283–286.

Gue, K. R. 1999. The effects of trailer scheduling on the layout of freight terminals. *Transportation Science*, vol. 33: 4, 419–428.

Kelton, W. D. Sadowski, R.P., & Swets N.B. 2010. *Simulation with Arena*. 5th Edition, New York: McGraw-Hill.

Law, A. M. 2007. *Simulation Modeling and Analysis*. 4th ed. New York: McGraw-Hill.

What Helps To Drive Success Behind Company Supply Chain

Tamás Hartványi [42] and Ferenc Tóth [43]

Abstract

In this study, supply chain elements will be analyzed and recommendation for solutions will be presented. During value chain analysis, stock management will be in focus and methods of finding proper inventory levels and improving corporate cash flow will also be scrutinized. Based on inventory management method analysis, the concept of information triangle will be introduced. The relationship between information, inventory and capacity/capability is becoming increasingly complex in today's supply chain. To manage this complexity, companies need the right organization to handle information and competence. One of the most essential factors for business success is organizational structure however, creating the right one is among the greatest challenges of all. This challenge will be further investigated considering potential risks. Moreover, the study will explore requirements for customer order execution as well as optimal distribution channels including regional and overseas deliveries. To maintain customer satisfaction, a toolkit for process improvement will be introduced including supply chain parameter adjustment and demand fluctuation management.

Keywords: *supply chain strategy, inventory management, demand fluctuation, ABC analysis*

1. Introduction

Supply chain strategy has become a buzzword - just google it and you will find almost half a billion matches in less than a second. While the business strategy constitutes the overall direction that an organization wishes to go, the supply chain strategy includes the actual operations and the supply chain to meet a specific supply chain objective. Most companies have a business strategy but are unlikely to have a well-designed supply chain strategy. Many top leaders in the electronics industry I have met during my professional career mentioned words (buzzwords rather) like Kanban, WMI and SRM and how essential supply chain management was, but I did not see the enthusiasm or dedication in their eyes. This is likely because corporate leaders tend to say what others would like to hear from them. Very few people have the experience and capability to see the holistic view of supply chain and understand the need of different techniques and tactics. If one does not understand the meaning of strategic supply chain, they might face difficulties in the long run.

2. Corporate or supply chain strategy

Companies typically work in a silo mode in which supply chain strategy remains only a department strategy instead of becoming the strategy of the entire organization. Departments and divisions have their own, sometimes conflicting targets and keep focusing on short term program to increase profit. When implementing a silo model, talented workforce might easily become frustrated and demotivate when seeing inconsistent targets within the company and they lose their drive for innovation and problem-solving.

[42] Széchenyi István University, Hungary, +36 96 503 496, hartvanyi@sze.hu
[43] Nokia China, China, +86 186 0138 8531, ferenc.toth@nokia.com

Our example company, an electronics manufacturing company had a plan to build up an order-driven operation to supply customers in the European and Middle East & African markets. The supply chain plan was targeted to develop an excellent supply base around the assembly factory and develop a high level of responsiveness and supply capability towards customers in case of high demand variability of customer orders. Plan implementation was progressing well and the company was able to establish a good cooperation with suppliers and keep up-to-date information about stock levels and customer demands. The company even created a common IT platform to share customer views about order forecast for both short and long term. This information technology tool helped to minimize the bullwhip effect as speculation was eliminated from forecasting and also supported suppliers in understanding the actual demands. The plan was well executed to create a responsive and efficient supply chain capability to serve high customer order variability. In addition, it also served as a good base for further improvements.

Excellent results justified the first supply chain strategy and enabled the company to start concentrating more on technology, quality and replenishment requirements for further developments with the suppliers. Within a few years, the company modified its supply chain strategy pursuant to the supply chain department's initiatives while the overall E2E fulfillment process did not follow strategic changes. New guidelines were implemented to switch supply base from close (local) to far (overseas). The company wanted to maximize its short term profit and based on a simple financial analysis, it developed the plan to switch from European suppliers to Far Eastern ones due to cheaper component prices. During the planning phase, the European supply base around the manufacturing company was not taken into account and development activities (JIT supply set-up, technology and quality collaboration) were required to be ramped down.

The basic intention was to change supply base from Europe to Asia. The target was to reach a cheap piece price level of all components and to earn a good saving and a high margin with product sales to increase company value. In the short term, product margin and sales figures considerably rose and the company was able to grant high bonuses to employees and leaders. In the E2E supply chain, only the sourcing part was modified but effects of the change were not carefully calculated resulting in increasing lead times of raw material supply, rising inventory levels and dramatically decreasing responsiveness capability with raw material batch deliveries from Asia to Europe. Local suppliers slowly stopped their activities and shifted their capacity to other facilities and ramped down competencies around the assembly factory. After a few years, the factory was relying on overseas deliveries. In addition, only a couple of items originated from local suppliers. Other elements of the supply chain did not change as the focus was on the customer voice. Product variety and services were still provided for EMEA customers who then enjoyed an excellent product/software customization service with short delivery times.

As product range, complexity and demand variability increased and sales figures stayed high, the batch supply base could not satisfy either internal or external needs. Due to component quality and supply challenges, the assembly company could not keep promises towards customers and at the same time they started to increase their safety stock in order to cover unstable supply. Those not building safety stocks for the uncertainties just faced product shortages and experienced loss of sale in their field. From a supply process point of view, the assembly factory easily turned to the traditional manufacturing mode without the top management noticing it. Major customers caused a bullwhip effect through the supply chain due to unnecessary safety stock and unsecure supply. The factory received many orders that were not considered a real demand in their order book to ensure enough supply base capacity for the customers in theory. However, when orders actually came in, several cancellations and product portfolio differing from the short and mid-term forecast occurred. Under such circumstances the factory could not later meet customer demands and quality requirements. It resulted in disappointed customers who started to play with the orders to manage uncertainties with supply. Whereas the assembly company had high component inventories, backlogs and excess materials which significantly increased manufacturing costs.

Overall, the company was still satisfied with the situation because demand was high for its products and they enjoyed low raw material piece price with high scrap rate at the manufacturing site. In the meanwhile, competitors developed a similar product with better functions which was more attractive to consumers and they began to purchase products of the competitors. As more and more new products appeared in the market, and products of our example company had lost their attraction, sales figures considerably went down. This new situation created high challenges for the company which had to modify its uncertain supply chain and improve its costly manufacturing process to maintain profitability.

3. Elements of a successful supply chain strategy

Our example company did not fully understand or analyze the effect of the model change in supply chain strategy and was not ready to work out the necessary competence in the organization to manage the change. When companies face serious pressures to cut costs and boost profits, they should reexamine how they source, store and deliver their products in the entire E2E channel. Here are some of the elements of a good supply chain management that must come together to achieve exceptional performance:

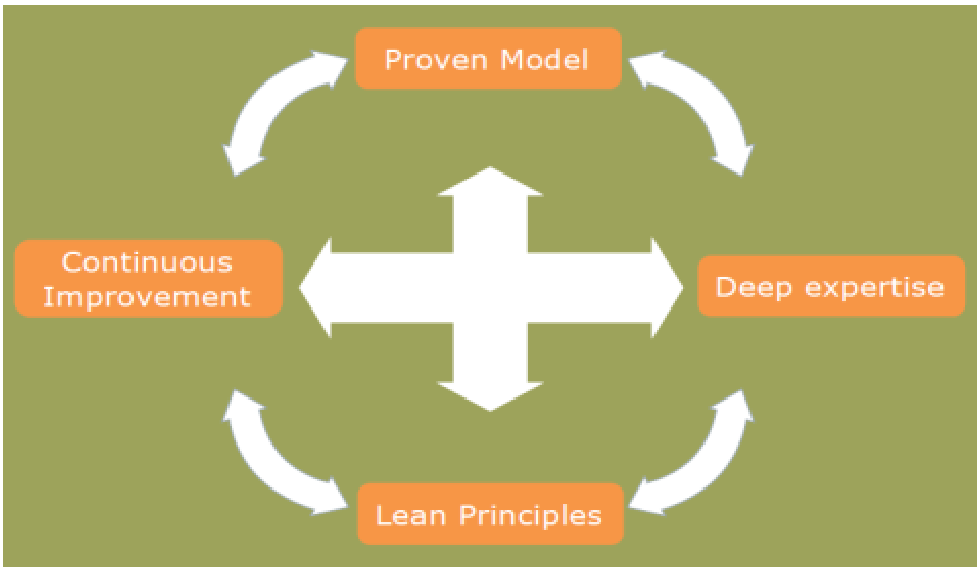


Figure 1. Four elements of success in supply chain

Proven model: companies that are undertaking a significant change to their supply chain network are most often successful if they have a model to follow. This model becomes a pattern for a standard, replicable solution set that can be applied across different areas of the supply chain. This is not to say that all supply chains should be approached with a 'cookie cutter' model. Rather, a standard solution set comprised of best practices becomes foundational and can then be customized to meet each specific logistics engagement undertaken. In the absence of a proven model, it can be difficult to know what best practices or methods will breed success.

Deep Expertise: Today's complex supply chains require applied knowledge not only in their inner workings, but also with big-picture insight of the impact that changes made in one area of the supply chain will have across the network. Great execution requires functional expertise in distribution management, transportation management, cross-docking and network design; it also requires industry expertise in the unique aspects of customer requirements, drivers of profitability, challenges and trends for a particular industry segment. Functional and industry-specific knowledge allow companies to better synchronize supply and demand to achieve the optimal flow of goods across the network.

Lean principles: Applying lean processes is key to delivering long-term value and consistent performance. In a lean culture, logistics teams are empowered to identify and eliminate waste in every process that occurs as an order is fulfilled. Lean tools, such as visual cues, problem solving jackets, and root cause analysis, result in shortened lead times, built-in quality and continuous improvement – ultimately increasing speed to market.

Continuous improvement: We have found that ongoing, incremental improvements – both small and large in scope – add up to a significant edge. An important tool for continuous improvement is Value Stream Mapping. Value Stream Maps are created for many aspects of the supply chain such as detailed workflow management, warehouse productivity, and route optimization and, on a larger scale, total landed costs. They combine engineering talent with practical operational knowledge to find the best opportunities for change and continuous improvement. (Williford, J. 2011.)

Lean principles and practices are essential in a company culture. Lean principles like work place organization must be implemented as a massive foundation for any company that wants to manage stock and keep profit levels high. Companies in a dynamic order environment tend to utilize additional IT software or Excel for their stock management as MRP I and II cannot handle uncertain situations. These two systems are only able to calculate long lead time solutions with materials management.

In what follows, methods will be introduced which may only be used if work place organization i.e. 5S, visual management, pull zones (supermarket) or Kanban are implemented as well as the audit system is in place. The information triangle (see Figure 2) is one of the methods based on which the company is able to manage its supply chain. Elements are: a.) IT information e.g. shared forecast, stock model defining the right stock size; b.) work place organization supporting factory capacity development with low variation of work place process output; and c.) stock model.

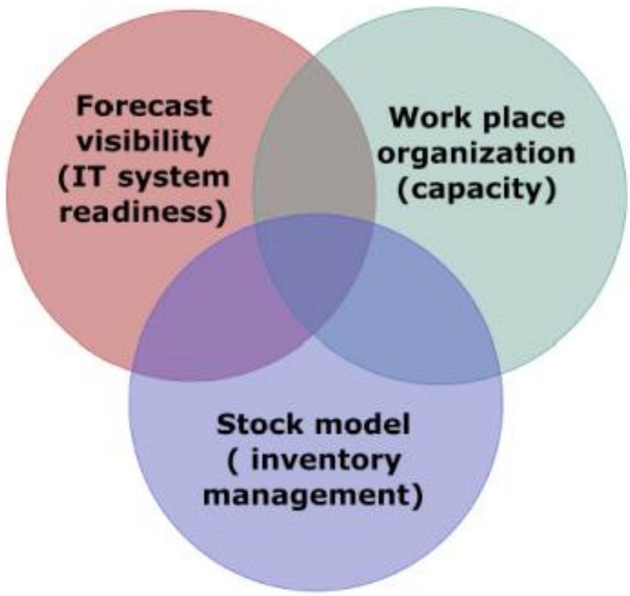


Figure 2. Information triangle

On the second level i.e. Continuous Improvement it is necessary to identify E2E process development opportunities. In that particular phase, stock management is in focus with the objective to identify required stock levels to balance out order fluctuation as well as to train and implement stock management techniques and best practices. This method is not a cherry picking process and could not be used as such. It requires systematic implementation after work place organization is applied and an organizational change is required to improve competences and the structure to achieve the expected results. With the new organizational structure, the old silo type of work can be eliminated and continuous improvement discussions can turn into fact-based activities which are appreciated by employees. Moreover, it triggers the use of continuous improvement tools.

If the final supply chain model (strategy, sourcing model, manufacturing and distribution) is developed for the business environment, it shall be controlled and documented as a working model to monitor basic parameters. If modifications are required, customer satisfaction and high profitability are still to be maintained. Parameters of a supply chain model need to be adjusted from time to time as the original calculation might not clearly define the case. Therefore, it is recommended to make a quarterly review of the specifications and business conditions.

4. Stock management

Ordinary and scientific stock management are not very far from each other although in everyday terminology the volume of stock is more emphasized. When we have inventories or stocks, it means that we have more than we actually need. This is a well-known phenomenon. Price fluctuation of gold, copper, steel or fuel is included in the daily news and not just as stock exchange information but as economic analysts' opinion on future changes influencing economic players.

Goods accumulated as inventories are expenses that need to be paid in advance – if not in households – in the industry. Such goods and products are to be warehoused, managed and prevented from misuse. All these are considered to be extra costs as a result of inventories. Due to demand uncertainty and fluctuation, it might turn out later that expenditures in inventories are a waste and as such stocking is always risky.

Product families linked to weather or agriculture are special in that sense. The producer might increase inventories expecting higher price levels and postponing sales; or in case of lower purchase price e.g. exchange rate changes, he makes the purchases beforehand (e.g. seeds).

Next only those economic players will be examined where raw materials are available for manufacturing products and hundreds of components are built into. For-profit organizations seek to keep inventories low as the volume and timing of orders is uncertain and ever changing. It is also supposed that a standard stock level is required to keep a smooth material flow. How is that standard stock level reached? In the following case, the consumption of components is linear although there has to be other types of consumption model in reality. The chart shows stock parameters: minimum and maximum stock levels, order point, lead time and safety stock.

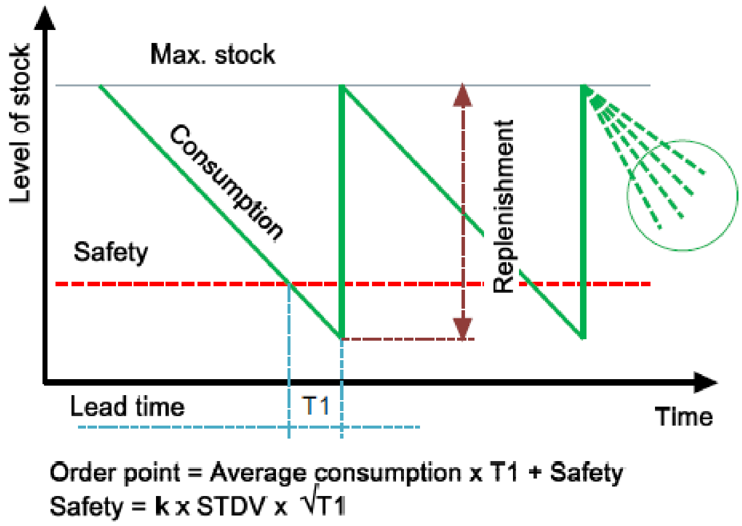


Figure 3. Stock replenishment

The chart does not need to be explained however, 'safety' should be clearly defined. During my engineering studies, I was very keen on indicators because during planning the factor 'k' over 10 in the formulae was most often a modifier in the testing phase. It was fairly difficult to understand when I was a university student. Here, factor 'k' is a service level and could be easily calculated. In every business mode, it is strategic to define the service level i.e. how safely we wish satisfy our customers' demands and the probability of order fulfillment. For example, to have a 99% probability of order fulfillment, a variance of 2.33 shall be calculated for the service level. Therefore factor 'k' will be 2.33.

4.1 ABC analysis

Naturally, it is supposed that our order data variations show a normal distribution over time. With this step, the first strategic inventory parameter is defined. The second one is the ABC analysis which is a form of Pareto analysis in which the items are grouped into three categories. Most common factors to be applied are yearly consumption costs of items, unit cost of item, specialty of manufacturing materials, availability of resources needed for manufacturing, production or manufacturing lead times and critical features of items (life cycle). A general rule is the 20-40-40% categorization.

This type of analysis gives a good picture about the inventory where consumption is linear. In cases where fluctuations are expected – for example, the green circle in the above chart – timely fluctuations in customer orders should be considered. Moreover, it is closely linked to the variations of component consumption. The more complex the business model is, the more important it is to develop the following inventory model.

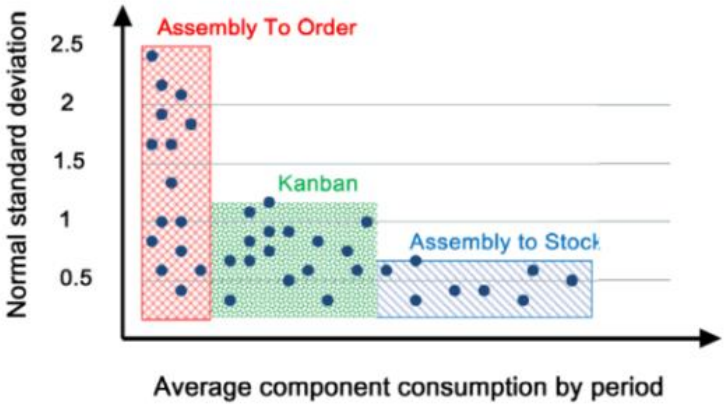


Figure 4. Volume variability

Using this method, products and components could be analyzed. On the horizontal axis daily/weekly consumption of the components is shown during a given period of time e.g. three months. While on the vertical axis, the normal variation of daily/weekly consumption is recorded. To calculate average and variance, use an Excel chart after downloading data from MRP. Results are easily displayed in the above chart, even in an Excel format.

The three categories define the relation between the average consumption and normal standard deviation. The first category includes high volume components of which daily/weekly consumption is relatively high and the normal standard deviation is well below 1. Such components are bolts and screws or capacitors and resistors in the electronics industry. Items in this category may be purchased without any further control. The supplier is required to supply a certain amount of component each week without any prior ordering (a frame agreement might be useful here). Components with a normal standard deviation of less than 1 and the daily/weekly consumption is neither high nor low belong to the Kanban category. These items need to be ordered from the supplier in unit boxes or cases and circulate them in the production area as well as between the customer and the supplier. Sometimes it is worth dividing shipments from the Far East into smaller batches and circulating them between the central warehouse and the production. The advantages of this category items are that they are well scheduled and their consumption could also be planned. Components with a normal standard deviation over 1 and low average consumption are included in the third category. Daily planning is essential here as well as providing component supply.

Areas outside the scope of these three categories are required to be investigated by the analysts and the decision-makers. Based on this strategic analysis, the organization should be designed to have enough and also the right resources to manage the third category. If service level is defined, the ABC analysis of components is conducted and the variations of component consumption is also known, we have gathered enough information to design the right purchasing and planning organization and to define the required headcount.

4.2 Day of Supply

For the next analysis, we will need the value of components as well. If we are able to retrieve data from the MRP, component prices and stock levels in terms of the orders are required (Day of Supply, DOS).

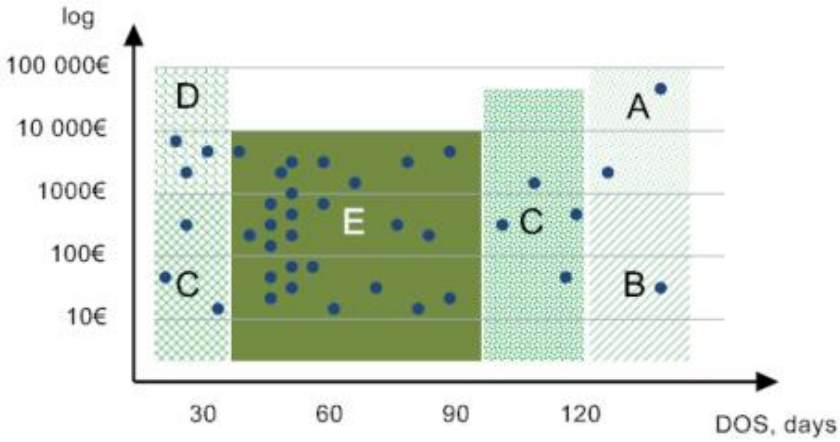


Figure 5. Component value by DOS level

Categorization could be done here as well, there are no hard and fast rules. Categories are developed based on the business model and environment. It is important that by using the chart we obtain information on components of which inventory value is high and the consumption is low compared to the stock level. Actions should be taken to reduce stock levels. In addition, it could be said that certain components have a very low DOS value which might be due to an unexpected demand increase. In that case, the component shall be repositioned and the order volume shall be reviewed to prevent shortages.

In sum, by using this model, an optimal and measurable stock level could be defined. Moreover, it could be continuously monitored which is warmly welcome by the shareholders. Costs of working capital can be reduced by a measurable and sustainable inventory control and optimization. The aforementioned models might be developed in Excel by using component basis data from the MRP.

It is no rocket science that one of the free applications of Excel could be used for that purpose. After retrieving weekly data, only the basic database shall be refreshed and the default pivot tables and charts are automatically generated. This application is PowerPivot in Microsoft Excel.

4.3 Cash Conversion Cycle

Service level based on the business model has been now defined. Using ABC analysis information has been obtained on the inventory. For the purposes of achieving positive business results, it is essential to apply inventory models in a complex environment and to use the DOS indicator to prevent inventory shortages and reduce excess materials. When defining the basic conditions, for-profit organization was one of them. Players of the economy use money for their operations that is covered by their own or external resources. In both cases, resources entail costs. By designing and implementing a good Supply Chain Strategy, less working capital is required and in some cases it might happen that the partners would pay for the costs of the working capital. If the velocity of circulation is measured in time, it could be noted that inventory value has an effect on the cost of working capital. Measuring velocity of circulation is not a new invention. However, it beautifully shows how inventory management affects business results without any detailed reports or statements. To define the CCC value or Cash Conversion Cycle, the following data are required - revenue, Cost of Goods Sold (COGS), Account Payable, Account Receivable and inventory. The Cash Conversion Cycle represents the number of days it takes a company to purchase raw materials, convert them into finished goods, sell the end products to customers and receive payment from them.

Calculation in days:

- Account Payable Turnover in days = (Account payable/COGS) x 365
- Account Receivable Turnover is days = (Account Receivable/Sales) x 365
- Inventory Turnover = (Inventory/COGS) x 365
- CCC (days) = Account Payables (days) + Inventory (days) – Account Receivable (days)

Two examples will be presented – one when the company provides for the costs of the working capital from its own resources and the other when the partner 'pays' for it in advance.

Table 1. Annual financial data of company, example 1

Revenue	65,012 €
Cost of Goods Sold	60,339 €
Net receivables	4,550 €
Inventories	16,951 €
Account payables	3,295 €

Based on the calculation, the end result is 108 days. The company shall pay the suppliers almost immediately but shall wait for long for the payment of products by the customers. Thus, when fulfilling customer orders, it is absolutely necessary to keep inventory levels at the minimum as well as maintaining service levels to reduce costs of working capital.

Table 2. Annual financial data of company, example 2

Revenue	181,933€
Cost of Goods Sold	171,629€
Net receivables	11,968€
Inventories	59,846€
Account payables	94,694€

Based on the calculation, the end result is 50 days. Seeing this, it could be said that suppliers take over the burden of covering costs and the company is in a good position in terms of cash flow as well. Therefore, it will have the option for further investment and developments.

The above examples well display the effect of supply chain strategy on corporate results with a clear indicator. It is fundamental to define service levels based on the industry and the business model, to examine inventory with the ABC analysis, to adjust the organization to the inventory model, and to have the skills to continuously monitor and evaluate inventories, as well as to include CCC among the key performance indicators. If all these are available, chances that profitability is just a matter of luck remain low.

5. Summary

The executive management of our example company has to take a number of actions to keep their customers and shareholders satisfied. Actions in a nutshell:

Improve customer collaboration and accuracy in supply chain planning: the company has to respond to order volatility by applying the aforementioned tools to better understand order behavior and to use information for supply chain planning. After successful implementation of a supply chain model, point of sale data are to be used in the process to ensure short order fulfillment lead times with Kanban replenishment between partners.

Increase upstream and downstream supply chain flexibility: increased global footprint cannot be a bottleneck of flexibility. There are several options for optimization e.g. the management needs to employ temporary external design professionals and ensure that customization occurs in the last step of execution to keep responsiveness at a high level against customer order volatility.

Focus on total supply chain cost engineering: as most elements of supply chain activities are non-value added, the potential for continuous improvement and cost savings is fairly high. Strategic decisions shall be made on which activities to outsource and insource based on the available capabilities of the company. In terms of costs, outsourced activities are often more easily monitored than internal processes.

Implement end-to-end supply chain risk management: it is necessary to look beyond the supply base and consider other sources of risk – basically everything from cash management to new product introduction and from quality to safety.

Integrate and empower the supply chain organization: the ability to meet future challenges demands strong organizational capabilities. In particular, it requires efficient and effective collaboration within the organization and with partners, efficient decision making, and the right structure and talent. No silo work is allowed within the organization!

6. Acknowledgements

The paper is supported by the European Union and co-financed by the European Regional Development fund TÁMOP-4.2.2/B-10/1-2010-0010 "Talent management system and scientific training development workshops on Széchenyi István University".

7. References

Banomyong, R. 2005. *Measuring the Cash Conversion Cycle in an International Supply Chain.* Annual Logistics Reaserch Network Conference Proceedings 2005, Plymouth, UK.

Hugos, M. 2006. *Essentials of Supply Chain Management.* John Wiley & Sons, Inc.

Simchi-Levi, D., Kaminsky, P. & Simchi-Levi, E. 2007. *Designing and Managing the Supply Chain.* McGraw Hill Professional.

Takach, J. 2010. *Five Priorities for Supply Chain Success*. Supply Chain Management Review-

Williford, J. 2011. *Four Critical Elements for Excellence in Supply Chain Execution*. http://logisticsviewpoints.com/2011/05/19/guest-commentary-four-critical-elements-for-excellence-in-supply-chain-execution/

Value Chain Stabilization With Combined Quantity-Irregularity Graphs

István Fekete[44] *and Tamás Hartványi*[45]

Abstract

In our article we investigate the possibility of utilizing the different behavior of players (materials, components, finished goods) to stabilize the entire portfolio of the value chain. Furthermore we will determine which players are able to stabilize the portfolio and create space for the irregular ones and methods how to identify the synchronicity driven load concentration and visualize and capture those differences. By using a combined quantity-irregularity graph we found the answers to these questions. Furthermore by using this combined quantity-irregularity graph we will be able to solve problems related to product clustering and hysteresis-type loop of a product during its life cycle.

Keywords: *value chain, visualization, quantity-irregularity graph, product clustering, product life cycle*

1. Introduction

The emerging network complexity of the supply chains nearly in all industries requires more sophisticated differentiation in inventory and operations management. The more granular safety stock management needs to be combined with more end to end inventory optimization alongside the value chain. Both the business processes and related IT solutions have developed radically in the last decades to meet those challenges. The advanced business processes like Sales and Operations Planning - S&OP or SIOP, where the 'Inventory' counts for 'I' - can be implemented in company of any business size. While the most advanced IT solutions often require involvement of external expertise and substantial capital investment. In our article we investigate the possibility of utilizing the different behavior of raw materials (RM), finished goods (FG) in supply chain network to meet those challenges what can be covered by advanced expensive IT solutions. Furthermore are able to further stabilize the entire portfolio of the value chain.

2. Need for Holistic Approach in Emerged Supply Chain Network Complexity

The supply chains in nearly all industries have developed into complex supply chain networks in the last decade. Such network may consist of thousands of partners, like customers, suppliers, tens of thousands of Stock Keeping Units, hundreds or thousands of storage locations. As more brand companies go to web as well the required multi-channel management creates further complexity in the supply chain network.

More companies see the green closed-loop supply chain as competitive edge what requires close linkage among product design, branding, and both forward and reverse supply chains. New product

[44] Nokia Oyj, Finland, +358 50 485 2219, istvan.1.fekete@nokia.com
[45] Széchenyi István University, Hungary, +36 96 503 496, hartvanyi@sze.hu

introduction in isolations leads to SKU proliferation what further fragments the demands and increases the irregularity of the SKU demands (Mollenkopf, 2012).

Although the brand-, technology-, and asset oriented companies have different requirements for creating competitive advantage in their supply chains, at the end, the main question is how to optimize the inventories throughout the entire supply/value chain network, assuring the targeted case-fill and service levels in all channels as well as achieving the shortest possible cash-to-cash cycle (Burnson, 2012).

As the network complexity has increased and links, dependences between nodes of supply chain network have tightened the anticipated risks and possible disruptions have increased significantly. The low detectability, low probability, high impact risks (large network disruptions) require specific approach for quick network recovery. On the other hand the risks of reasonable probability must be considered and covered by operations and integrated, extended supply chain management. We will focus more on such risk management (Sheffi, Vakil, Griffin, 2012).

3. Evolution of Inventory Optimization

In the last few decades the inventory management has developed a lot from the simplistic 'one size fits all' approach to the holistic, integrated, multi-echelon inventory optimization. There are still companies at the level of 'one size fits all' approach while only the most advanced large corporations excelled in integrated supply chain management and inventory optimization.

3.1 One Size Fits All

The most simplistic approach is to have one rule or no-rule. I.e. either there is no inventory target level just gut feeling and thumb rule or there is one rule for all items. In such case we may have inventory target for the finished goods (FG) and the upstream inventories of work in process (WIP) and raw materials (RM) are usually managed by an ERP system based mainly on forecast data.

As we neglect the differences in SKU behaviors, we do not differentiate in customer service levels, the lack of segmentation leads to high overall inventories everywhere accompanied with severe stock-outs. The unbalanced inventory profile leads to poor customer service and – in the same time – poor cash-to-cash cycle management. Surprisingly, not only small size companies use such 'one size fits all' approach.

3.2 Pareto, ABC-D Analyses

A great number of the companies are still using the ABC analysis for SKU segmentation what based on cumulative ranking of the items - mainly FG or RM - according to their used/sold volume or value. In most of the industries we can detect such Pareto distribution of the ranked items, just the steepness of the curve will vary. Usually, the first 20% of the SKU's are delivering the 80% of the value A-items, while the B-items are contributing to the 15% of the value and – at last – the rest of the C-items are accountable for only 5% of the value.

The safety stock policies then are determined to the A, B, C items separately but the same within the category. As an enhancement, some companies adjusts the cycle times - like revisit cycle - accordingly.

The long tail of C-items and 'dead' D-items are often challenged by the 'cutting the tail' approach though Stafford Beer proved thirty years ago that cutting the tail may lead to system instability and portfolio deterioration (Beer, S., 1979).

3.3 Volume-Variability Analysis

Volume-Variability analysis is dated 40 years back. When using this method we take into account the variation of the demand as well. Volume dimension is the average of periodical demand data of given SKU. Variability is the normalized standard deviation (NSD) of periodical demand data of given SKU. Using these two dimensions in volume-variability graph we can distinguish items of different behaviors. According to behaviors we are able to determine safety stock levels as well as the most appropriate planning and execution process to given FG SKU, like assembly cells or assembly line, make-to-order or make-to-stock, rate based scheduling, kanban driven, etc. (Vitasek et al, 2003). In early 2000 more widely was used Volume-Variability analysis by consultancy companies.

3.4 Multi-Echelon Inventory Optimization (MEIO)

Inventory optimization is a process to scientifically identify the right inventory levels across the supply chain. It is also called multi-echelon inventory optimization (Snyder, Shen, 2011) or multi-level inventory optimization. Several companies offer professional IT solution for MEIO.

MEIO looks at each node - or stage - of the network not just in its isolation but with its links downstream and upstream. RM portfolio or FG portfolio of given entity is seen as echelon (Snyder, Shen, 2011). Since the focus is on the network of given node on same hierarchical level the multi-echelon wording better describes the essentials of the method than the multi-level wording. Inventory optimization defines stage-by-stage (node-by-node) where to keep decoupling safety stock to cover lead times of upstream stages/processes avoiding the two extremes of “Sprinkle-It-Everywhere” and booming inventory at most expensive FG stages. Latter further complicates the inventory situation as the SKU proliferation downstream ‘kills’ the demand pooling opportunities. MEIO is further advancement of volume variability analysis in wider network context covering even 7-10 echelons, like RM’s, blank WIP’s, Colored WIP’s, Sub-assemblies, FG’s, Distribution Centers, etc. (Willems, 2011).

4. Combined Quantity-Irregularity Graphs (CQIG) – an Alternative to MEIO

The combined quantity-irregularity graphs - CQIG - offer alternative for smaller or mid-size companies to make step change from one-size-fit-all or ABC-based inventory target setting. CQIG is a further development of Volume-Variability Analysis approach in terms of visualization and of initial steps of adapting network science methodology. It was developed by authors and based on empirical data of investigation at dozen companies/factories from different industries, i.e. electronics, telecom, automotive, food - FMCG. The described method was implemented by the authors in two business units/operations and used for years with success. The presented graphs were constructed by authors based on large number of neutralized elementary data.

The CQIG considers and visualizes other dimensions as well what help to utilize the emerging network dynamics of FG and RM items. CQIG helps in adequately grouping the FG and RM items according to their behavior and setting the appropriate operations and inventory strategies to those groups. The large, regular items can further stabilize the entire supply chain network and create space for flexibility and absorbing reasonable turbulences within the network. CQIG supports the product design to utilize the existing commonalities in the portfolio and through that further stabilize the supply chain network rather than unconsciously increasing the SKU proliferation. The latter would lead to demand fragmentation and to increase in irregularity and variability.

The FG portfolio clearance can be done so that we avoid mechanistic cutting-the-tail but exiting those items what create both direct and indirect negative impact on the business performance.

4.1 Four co-existing dimensions of CQIG

We can investigate 4 dimensions on the combined quantity–irregularity graphs all time. Two of them – Quantity and Irregularity – are absolute dimensions while other two – Ranking and Synchronicity – are relative ones. See Figure 1.

4.1.1 Quantity

The Quantity dimension is represented as the size of the bubble of given parameter of given SKU. That is usually the average of the periodical volume data. In that case it is advisable to use Log10 of the average volume with rounding. It can help – for example – to visually distinguish RM items suitable for line-side kanban replenishment from those what must be kept in common inventory and delivered to order.

Apart from volume the value, profit, contribution, resource consumption data or the node's degree can be shown in this dimension as bubble size. That will help in identifying the large stabile SKU’s what can stabilize the network as well as the poor performing ones.

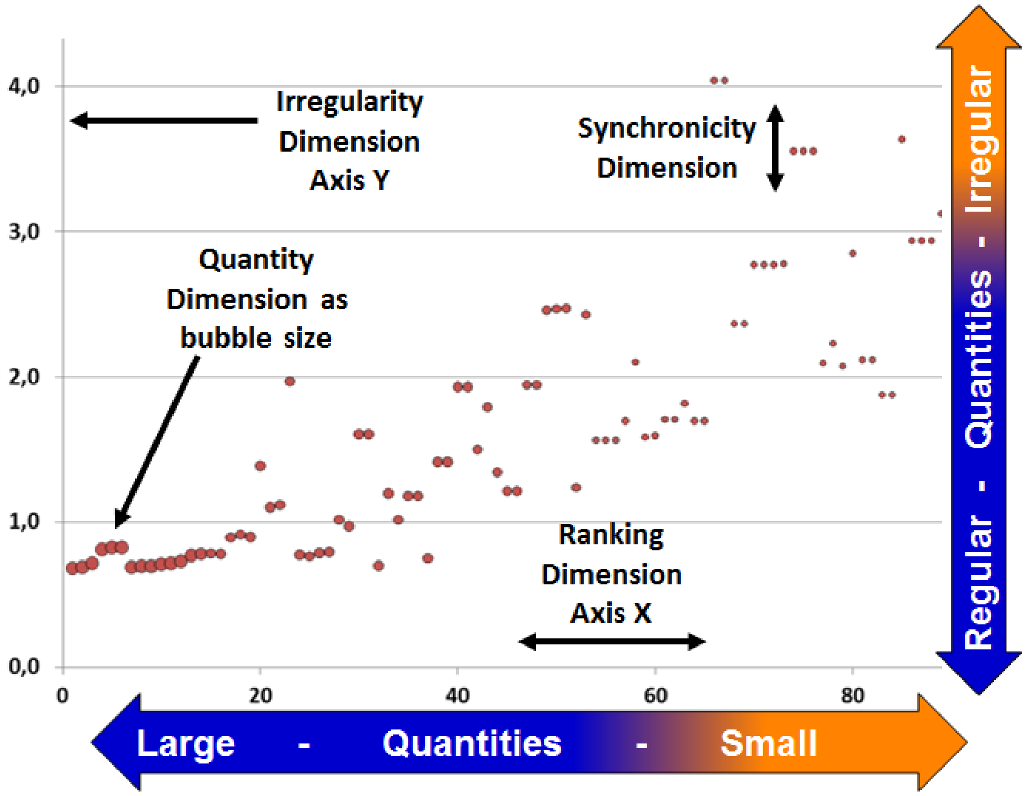


Figure 1. *Combined Quantity-Irregularity Graph*

(Source: own construction)

4.1.2 Irregularity

Irregularity is also called as variability or coefficient of variation (CoV) or normalized standard deviation (NSD), i.e. the standard deviation of the periodical volume data divided by the average of the periodical volume data. Periods are usually weeks or days. Lower is that value more regular are the periodical demands.

In network context the regular or irregular termini better describe the interaction of that FG or RM item and its effect on the subsequent sub-network. Therefore we suggest using the irregularity terminus. Irregularity is shown on the "Y" axis.

Across dozens of industries it has been proven that irregularity (or CoV) falls usually in the range of 0.5 and 4-5. Higher than 4-5 usually represents such irregular demand pattern that we have to treat that item more in project mode, e.g. new product in ramp up phase. The experience shows that above 2 it is better to think about make-to-order approach, below 2 kanban driven replenishment is appropriate, while around 0.5 even rate-based-schedule can be used as well.

4.1.3 Ranking

Ranking is a relative dimension of given item compare to other item and versus the entire FG or RM portfolio. That is the same of Pareto ranking of SKU's according to the demand volume data.

The sensitivity of Pareto ranking assures that tiniest difference in the used volumes of RM items will arrange those items side-by-side - not overlapped - if they are having identical down-stream network - same FG SKU's they are built in - and same BOM quantities. The tiny difference, as usual comes from slightest differences in scrap rate or other type of inventory leakage, discrepancy. Please note that if there is at least one FG in the common downstream network for what the built in RM's are going in different ratios then those RM's might not appear side-by-side even if the downstream FG network of those RM's is common.

4.1.4 Synchronicity

In case some RM's are having common downstream FG network then their Irregularity will be practically identical. This is because the Irregularity is normalized by the average volume and a possible difference in BOM quantities does not have any effect on the value of the respective Irregularities.

4.2 Building the CQIG

It is advisable to develop CQIG's for both FG and RM portfolios in the same time. We need to have the sales or use volume data for few dozens of periods for each SKU. If the volume datum of a given SKU for a given period is zero then we need to have zero in the spreadsheet. Otherwise the average and standard deviation calculations will be wrong. If we want to use other dimensions as well in the Quantity dimension - bubble sizes - then those should be incorporated as well.

4.2.1 Time Unit to Chose

The reasonable time unit is either day - daily data - or weeks - weekly data. We can use weekly data if the daily demand fluctuation is negligible and/or the supplier delivery to the customer or customer process does not have restriction regarding to the day of the week.

The raising expectations from customers and tightened inventories transform more supply chains to responsive ones where the day of delivery matters both for external business customers and for internal customer processes. Therefore, more often the daily data are required for the analysis

4.2.2 Building the Graph

We can use Microsoft Excel for building the graph. The SKU's are ranked according to volume Pareto and arranged alongside the axis 'X'. The SKU's are arranged alongside axis 'Y' according to their Irregularity (NSD or CoV). Size of the bubble of given SKU represents that dimension what we want to visualize; in most of the cases that can be the Log10 of volume of the SKU or the degree of RM node - i.e. how many finished goods it is built into.

5. What Tells the CQIG in network science context?

The interactions between the nodes of a supply chain network effect on its sub-network in different ways. The interactions - in the same time - create perturbations of different size changing the network's state. If an interaction - stimulus - initiates the usual, successful reaction of the sub-network then the interaction is defined as well as signal - e.g. the large, regular orders, items. The large, unpredictable perturbations may create cascading failures, especially in a tightly linked network (Csermely, 2005, Barabási, 2003). The network of finished goods and their raw materials is a tightly linked network through BOM links. The great number of common tight links creates the so called giant component of the supply chain network (Newman, 2010). Therefore, large, irregular items, orders can disrupt certain part of supply chain network. The smaller are the decoupling inventories in the network the larger the impact and extent of such disruption will be. The large number of small interactions creates overall noise in the network and defocusing, fragmenting especially the execution processes. See Figure 2.

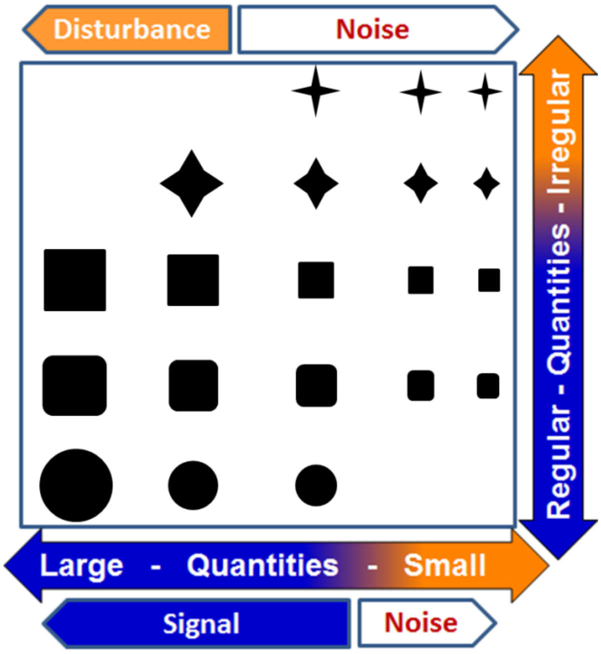


Figure 2. *Items in Combined Quantity-Irregularity Graph*

(Source: own construction)

5.1 Major Finished Goods Behavior Types

It is advisable to analyze both the finished goods and raw materials of a company in relation to each other as well. In case of finished goods we distinguish three major behavior types (Figure 3).

5.1.1 Large Regular Finished Goods Items ('Cooling FG' behavior)

Large regular items are at bottom left segment of the graph. See Figure 3, FG Graph Case 1. Those have large downstream network towards customers generating large volumes. The wide commonality and demand pooling effect result in regular volumes as well. The maturity of the downstream network can further decrease the irregularity.

Those finished goods items can be more in continuous flow, produced according to rate based scheduling having inventory in FG form (Make-to-Stock items).

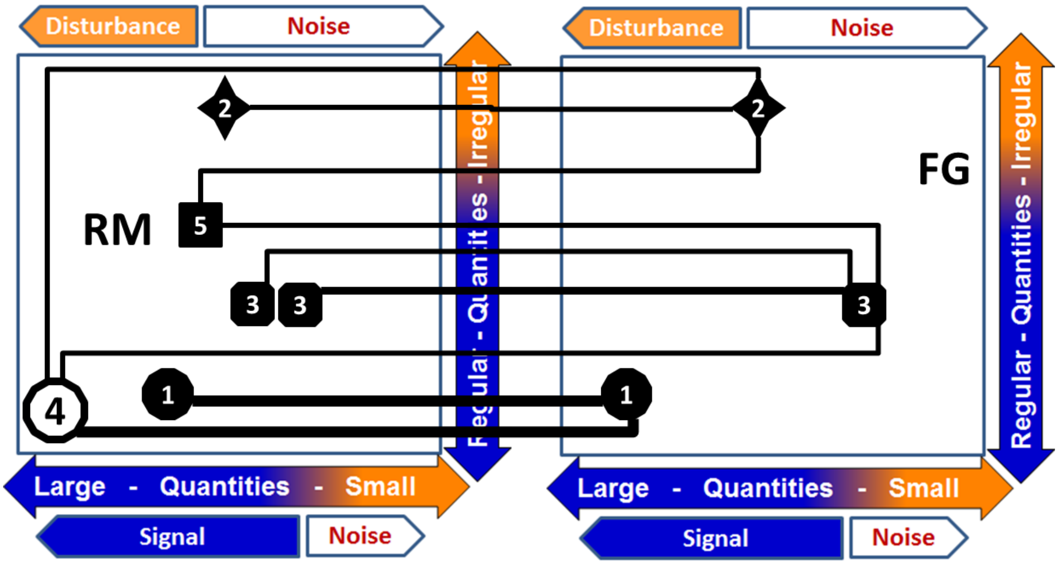


Figure 3. *Relationships of Finished Goods and Components*

(Source: own construction)

Furthermore, thanks to large consumption in resources those large stable finished goods items can create space for flexibility for other less regular finished goods in shared machine capacity and manning as well as in use of common components. In that case we consciously increase the target inventory of such FG item and we trigger its replenishment with FG kanbans where the yellow/amber inventory contains the flex for the portfolio. That can "cool-down" the upstream network, while the obsolescence risk increase is negligible as the regular large sales assure quick inventory turns.

5.1.2 Large Irregular Finished Goods Items ('Disruptive FG' behavior)

Large irregular items are at mid-top left segment of the graph. See Figure 3, FG Graph Case 2. Those have large but more homogenous downstream network - e.g. focused promotion of new product - generating large volumes in the one hand. On the other hand the less mature and/or more homogenous downstream network results in narrower commonality and minor pooling effect. That is causing high irregularity in demands. Such SKU's may cause large disruptions for the entire upstream network. Often those are the ramping-up finished goods of high priority.

Therefore, for large irregular finished goods items we need flex in resources as those need to be made-to- order against unpredictable demands. Upstream reserve can be created for common machine, manning, and materials through space creation by large regular FG items as described above. Simultaneously we have to ensure aligned buffer in specific components of the large irregular finished goods item, otherwise the space creation on common resources will be wasted. Further risk distribution can be achieved by holding inventory in FG form and/or make possible the backlogs in deliveries.

5.1.3 Small Regular or Irregular Finished Goods Items ('Noisy FG' behavior)

Small items are at the right part of the graph more distributed in upper segment than in lower one. See Figure 3, FG Graph Case 3. Small items have smaller downstream network. More narrow and homogenous is the downstream network more irregular will be that item, e.g. customer specific finished goods variant. The small items create 'noise' in the system what defocus our efforts and resources.

Small finished goods items need to be in make-to-order mode. Created space by large regular finished goods items may ensure responsiveness regarding to common machine, manning, and materials. With increasing the production order quantity we can reduce the 'noise' effect. If the step change in the variation funnel is large then we better postponing the customization, e.g. produce FG to stock and pick to order rather than letting small fragmented customer orders upstream. In that case the specific components may have less/no safety inventory.

5.2 Major Raw Material Behavior Types

In case of raw materials we distinguish five major behavior types. For the sake of simplicity we determine purified behaviors of raw materials in this section while later - in section 5.3 - we highlight the combinations of real behavior and the duality of specific/common distinction.

5.2.1 Specific Raw Material of Large Regular Finished Goods ('Cool RM' behavior)

Such large regular specific raw materials inherit their "cool" behavior from their cool finished goods parent and those are at bottom left segment of the graph. See Figure 3, RM Graph Case 1. As a result of inherited behavior the Irregularity of such RM will be the same as of the parent FG while the Ranking dimension depends on both the respective BOM quantity and the behavior of all the other raw materials.

Such "cool" raw material can create stability in upstream network and processes, e.g. if we put such raw material into kanban replenishment in internal logistics, i.e. more continuous flow vs. pick-to-order.

5.2.2 Specific Raw Material of Large Irregular Finished Goods ("Hot RM" behavior)

Large irregular specific raw materials inherit their "hot" behavior from their hot finished goods parent and those are at mid-high segment of the graph. See Figure 3, RM Graph Case 2. As a result of inherited behavior the Irregularity of such RM will be the same as of the parent FG while the Ranking dimension depends on both the respective BOM quantity and the behavior of all the other raw materials.

Such "hot" raw material can create spikes in upstream network processes as the parent FG needs to be produced to order and the RM itself is picked-to-order.

5.2.3 Raw Materials Built-in the Same Finished Goods in Same BOM Quantity ('Sync RM' behavior)

RM items what have common downstream FG network and are having same BOM quantities in each FG item of that common network will appear on the CQIG as grouped bubbles side-by-side horizontally. See Figure 3, RM Graph Case 3. Those RM items are in full sync what can cause load spikes in upstream processes, resource needs.

Items in sync need to be treated in similar way, e.g. all are either in line-side kanban or all are piece-picked, otherwise we waste the opportunities. To avoid load spikes due to sync effect those RM's could be pre-processed as subassemblies or kits.

5.2.4 Raw Material Built-in Large Number of Finished Goods ('Hub RM' behavior)

Raw materials what are built into large number of finished goods items are large regular RM items at bottom leftmost segment of the graph. See Figure 3, RM Graph Case 4. Those RM items have large heterogeneous downstream network of FG items with wide commonality resulting in large and regular volumes with minimum demand uncertainties in the one hand. On the other hand these RM items are the hubs of giant component with hundreds or more links what can have huge impact on network performance if such hub is taken out (Newman, 2010, Barabási, 2003). Therefore it is crucial to protect such hub against network perturbations from upstream, i.e. cover the supply uncertainties with safety stocks and sourcing alternatives if possible.

5.2.5 Raw Material Built-in Small Number of Non-Correlating Finished Goods ('Intermediate RM' behavior)

Raw materials what are built into small number of non-correlating finished goods items will inherit an intermediate irregularity. See Figure 3, RM Graph Case 5.

5.3 The Combination of Real Raw Material Behaviors and the Duality of Specific/Common Distinction

In reality a raw material item rarely goes only in one-and-only-one finished goods item, i.e. pure specific component. Therefore, a raw material item will be common within its FG cluster and specific to that cluster in the same time. Figure 4 is based on neutralized data of real product line.

The large FG cluster of same color items derived their aggregated behavior to those RM items what have exactly the same downstream network, i.e. those go to same FG items in same BOM quantity. In the same time we can observe the 'cool' behavior, the aggregated result of FG parents, and the synchronicity. The ramping up FG cluster of other color is having similar 3 RM items of its own color though those RM items inherited smaller and more irregular aggregated volumes.

The narrower is the FG cluster the smaller is the volume and usually higher is the irregularity of those components, as it can be seen regarding raw materials common for and specific to FG's country cluster versus raw materials common for and specific to FG's of just one big customer of the same country cluster.

Such pattern analysis helps to determine the replenishment and inventory holding modes towards suppliers and in internal logistics as well. Furthermore we can visually evaluate the probable consequences of introducing another variant cluster or delisting one.

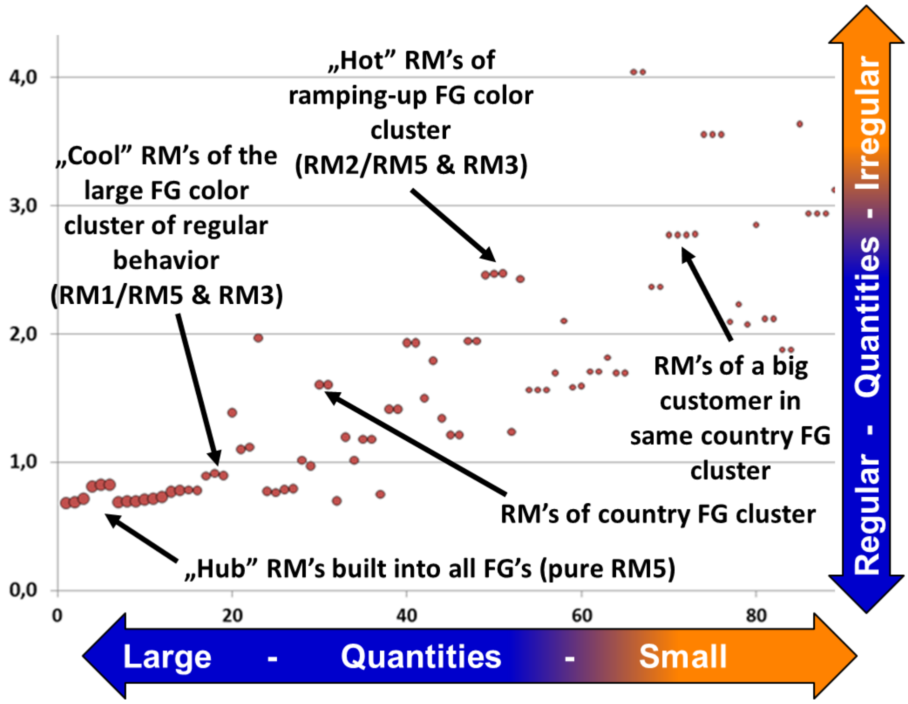


Figure 4. Raw Material Clusters in Relation to Finished Goods Clusters

(Source: own construction)

5.4 Product Life Cycle Effect

When comparing different time ranges of a product we can detect a hysteresis-type loop in CQIG in accordance with phases of product life cycle. Trial production is seen as small, very irregular quantity item in the graph (Figure 5, Case 1.). At ramp-up the product may disturb the network. As it gets larger sales the larger distribution, customer, consumer networks reduce the irregularity (Figure 5, Case 2.). With mature network the quantities are large and regular (Figure 5, Case 3.). At decline the quantities become again smaller and more irregular (Figure 5, Case 4.). Such hysteresis curve may be so small that the product does not get regular sales quantities (Figure 5, Case 5.).

If introducing high number of new products in short period of time then that will fragment the demands upstream causing increasing "noisy" raw material behavior. If we launch large product range with focused activities comparable to the large "cool" items' sales/usage quantities then we can't utilize the large regular FG items for cooling enough the supply chain. In that case less we segregate its value chain through dedicating resources upstream more we run the risk of cascading disruption in our value chain network.

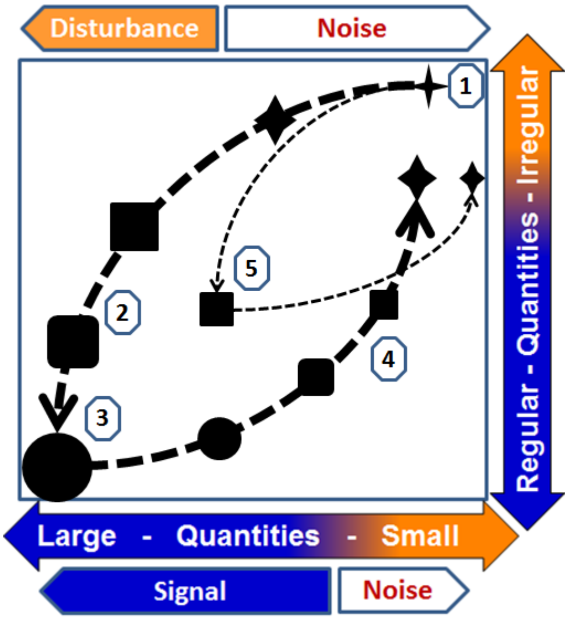


Figure 5. Product Life Cycle as Hysteresis-type Loop in CQIG

(Source: own construction)

6. Conclusion

Comparing to volume-variability graphs the Combined Quantity-Irregularity Graphs better visualize the behavior and relationships of raw materials and finished goods of given company. Apart from behavior of given raw material and finished goods we take into account the relevant cluster's behavior as well when stabilizing the network and improve its adaptability. The red-amber-green kanbans create well defined frames for freedom in the supply processes for quick response but without disrupting the surrounding network. The red level is the safety stock inventories (calculated in the usual ways) covering the uncertainties with expected service level while the amber/yellow quantity is the defined freedom of the supply process, the room for maneuvering. If a large regular finished goods item is several times larger than the disruptive one then the above described 'space creation' may be applied so that the large regular item will not itself become unstable for the upstream network (man, machine, material).

Raw materials behaving like hubs with lots of downstream links to finished goods parents have very regular demands, i.e. very low demand uncertainty what may result in very low calculated safety stock level. For such raw material the focus is to assure supply without disruption.

Determining the yellow/amber quantities of kanbans was more empirical. Therefore, we would like to investigate the sensitivity of 'cooling' finished goods on the size of its yellow/amber inventory.

Currently the combined analysis of FG and RM graphs and BOM links is not user friendly. We aim to develop capability for visualizing the partial quantities and irregularities of any filtered finished goods logical cluster.

The initial analyses show that the degree of RM nodes - number of FG they go into - show scale-free distribution. As Barabási proved the scale-free networks are very stable against random failure while those are very vulnerable on removing/blocking just few hub-type nodes. We would like to better understand the possibilities of adapting successful solutions from other complex networks.

The spatial networks, like road-networks and airline-networks have been already subjects of network science investigations. We see high potential in investigating more thoroughly the other sub-networks of the value chain with network science methodology, like raw materials and finished goods networks.

6. Acknowledgements

The paper is supported by the European Union and co-financed by the European Regional Development fund TÁMOP-4.2.2/B-10/1-2010-0010 "Talent management system and scientific training development workshops on Széchenyi István University".

References

Barabási Albert-László, 2003; *Linked*, First Plume Printing

Beer, S., 1979; *The Hearth of Enterprise*. John Wiley & Sons

Burnson, P.; Supply chain "differentiation" is key to success in 2012; Supply Chain Management Review; January 06, 2012

http://www.scmr.com/article/supply_chain_differentiation_is_key_to_success_in_2012/

Csermely, P. 2005; *A rejtett hálózatok ereje.* Vince Kiadó, Budapest

Mollenkopf, D. A.; Demand and supply integration in closed loop supply chain; Supply Chain Management Review; February 23, 2012

http://www.scmr.com/article/demand_and_supply_integration_in_the_closed_loop_supply_chain/

Newmann M. E. J., 2010; *Networks.* Oxford University Press, New York

Sheffi, Y., Vakil, B. and Griffin, T.; New software tools to manage risk and disruptions; Supply Chain Management Review; March 28, 2012

http://www.scmr.com/article/new_software_tools_to_manage_risk_and_disruptions/

Snyder, L. V., Zuo-Jun Max Shen, 2011. *Fundamentals of supply chain theory.* Hoboken, New Jersey, John Wiley & Sons Inc.

Vitasek, K. L., Manrodt, K. B., Kelly, M. 2003. Solving the supply-demand mismatch. *Supply Chain Management Review,* September/October 2003: 58-64.

Willems, S. P., 2011. How inventory optimization opens pathways to profitability. *Supply Chain Management Review,* March/April 2011: 30-36.

A Study on the Perceptions of Seferihisar Residents for the Concept of Cittaslow

Buğra Karabulut[46], Selçuk Nas[47]

Abstract

The concept of sustainable development is a worldview that is aiming to harmonize socio-economic interest in concerns related to the environmental values and natural recourses with the rationalism way. Also this concept aims to transfer the values to future generations. To implement this worldview, some towns have actualized concept of Cittaslow in their town in the last decade. The town of Seferihisar is the first example of the Cittaslow application in Turkey. This study aims to explore the changes on social life of Seferihisar residents with the applications of the slow city concept. In the study structured questionnaire were used to investigate perceptions of Seferihisar residents about concept of Cittaslow. The data obtained are summarized in content and descriptive analysis techniques. With the results of the study, Cittaslow practitioners have been elucidated that what changes were created on the life of the Seferihisar residents.

Keywords: *Cittaslow, Seferihisar, Life of the residents*

Introduction

The Slow Movement is a philosophy that criticizes the speed of modern life and advocates a cultural shift toward slowing down life's pace in many areas of life (eating and drinking way of life, economic life, traffic, relationships, etc.) that has appeared in recent years [1]. Slow movement is launched against the hegemony of McDonald's and other icons which have become a symbol of the fast food culture and it transformed the anxiety which is caused from increasing level of fast life and fast food habits and the disappearance of local taste into a social response [2]. This movement started with the protest in McDonalds restaurant opening in Carlo Petrini's Roma Piazza di Spagna in 1986 [3]. The broad target of the diverse slow movement is the advancement of alternative/unorthodox approaches that support and promote community-based initiatives, sustainability and social equity in the face of "fast capitalism" (Steele 2012; 179). Slow movement contains subcultures which appears by the aim of avoiding the hurry without checking the watch, increasing the life quality (Sezgin ve Ünüvar 2011; 107-108). Cittaslow movement is one of the subcultures in this context.

Cittaslow is an international union composed from towns which avoid to be a homogenous place that is created by globalism and want to take part in world's stage by conserving its local identity [4]. The movement of Cittaslow was born in 1999 through the Paolo Saturnini's brilliant intuition, past Mayor of Greve in Chianti, a little town of Tuscany [5]. Cittaslow network quickly spread throughout the world. Today, Cittaslow network is expanded to 25 countries. Seferihisar is the first town in Turkey that is accepted to Cittaslow network. Considering the fact that Seferihisar is the first town that joined the network of Cittaslow movement in Turkey, it can be said that it is a very new concept for Turkey as much as the town itself. The purpose of this study is to expose the residents' expectations from Cittaslow

[46] Dokuz Eylul University, Turkey, +90 554 5401608, bugrakarabulut@gmail.com
[47] Dokuz Eylul University, Turkey, +90 532 3315131, snas@deu.edu.tr

movement and their proposals for more successful action. In this study, the recognition level of Cittaslow, slow city movement's effects on residents and daily life and its' awareness level in Seferihisar is surveyed.

1. Cittaslow

Cittaslow, which means 'slow city', "is an international network of small towns that originated in Italy less than a decade ago with the aim of addressing the 'Slow Food' philosophy in their urban design and planning" (Miele 2008; 136). Mayer and Knox (2010; 1555) supposes Cittaslow movement's aim as integrating technology in various control systems such as air, noise and light pollution, contemporary energy systems, waste-cycling plants, composting facilities and it tries to give courage or support business through ecologically sensitive or delicate, locally authentic and gastronomically purposeful tourism.

The Cittaslow movement has started in October 1999 by Paolo Saturnini, mayor of Greve-in-Chianti and he organized a meeting with three municipalities (Orvieto, Bra and Positano) to define the attributes that might characterize a "Slow City" stated by Mayer & Knox (2006) in their article. Before 2002, there were already 28 slow cities were approved for Cittaslow movement. All of the members were Italian. When we came to 2008, there were some addition to towns which made total number of approved as slow cities more than 70. It was seen that in March 2012, there were 25 countries and nearly 150 slow cities. Most of these towns were located in Italy, but there was also a noticeable rising in countries like Spain, Portugal, the UK, Norway, Poland, Germany, Slovenia, Turkey and some other countries which were far away from Europe like New Zealand and Australia [6].

1.1 The Criteria of Cittaslow

In order to classified as "Slow City", the candidate city must accept the regulations of Slow Food and must realize 50% of the criteria that is accepted in Cittaslow guideline. Besides, the population of the applicant must be under 50.000. After that the candidate town is obliged to compile an application to committee, where members are from other Slow Cities. After the application process, the observers of the other slow cities visit the candidate town and examine the improvements by first-hand for how the candidate town applies the obligations of Slow City concept (Knox, 2005).

As known today, there are 59 different criteria that any town of any country who is considering for applying to join Cittaslow Union Membership. These are split into 6 broad headings as environment policies, infrastructure policies, enhancing the quality of the urban fabric, celebrating and promoting local produce and local products, hospitality and community, communicating awareness and understanding of Cittaslow [7].

According to Knox (2005), to be eligible for membership, candidate cities must guarantee to introduce a variety of measures from the advertising of organic agriculture to the creation of centres for visitors so that they can easily reach local traditional food and also candidate cities must also attempt to protect their sources and naturality of the raw ingredients and to prevent the fast progress of fast food and cultural standardization.

1.2 The Effects to City Life

Miele has argued in his article (2008) that a slow city should aim to working towards a set of goals that try to improve the life standart of its citizens and quality of city's for visitors. One of the ingredients of slow city concept is to make borders against the spread of the 'fast life' shaped in the 'fast food' restaurant chains which are replacing fastly traditional restaurants in the world.

Paolo Saturnini suggests at the congress 'Citta`Slow Project for a Utopian City' in April 2007 that "Slow Cities were not born as a conservation movement, but, rather, as a movement that in the wake of modernisation and globalisation asks itself about how to transfer 'cities' in a globalised world without making them lose their soul in that journey". (Miele, 2008)

The requirements of Cittaslow firstly involves a strong commitment to the obligations of the movement by city major. In the longer distance, success will be depended on promoting a new political dynamic that combine an alliance of city leadership, local businesses and residents in support of Cittaslow ideals (Mayer & Knox, 2010; 1554).

Cittaslow concept provides lots of opportunities to the residents, but there are also problems which need to be solved. According to Mayer and Knox (2010) first of these problems is “prescriptive slowness”. In order to abstain from this danger, Cittaslow movement hopes to propagate vitality through farmers’ markets, festivals and the creation of inviting public spaces. The second problem of this movement is “expensiveness”. When the slow cities become more popular, the affluent metropolitan residents choose to make their second homes in this city. As a consequence house and shopping prices will go up. The third danger of this movement is “pushing out the poor and young residents”. The poor and young residents can not find the way to live because of the expensiveness and the house shortages. The fourth is “judgment of authenticity”. Who is to judge authenticity? Authenticity” turns out to be a very slippery and contestable concept, open to abuse and misinterpretation (AlSayyad, 2004). The fifth is “reconciling the identities of cultures”. The question is to be answered that how to reconcile local identity, neighbourliness and sense of community with the arrival of migrants and immigrants from regions with radically different cultures?

1.3 Other “Slow” Movements

In this part of writing, other slow movements are mentioned. The most important slow agenda, “Slow food movement” has started in Rome in opposition to the planned opening of a McDonald’s restaurant. The Slow Food movement has spread from Italy to become an international alternative agenda to “fast” food and it could success to be the pioneer of the other slows (Steele 2012; 180). According to “Slow Food International” data from 2012, the movement comprises 100,000 individual members representing 150 countries and 2000 local chapters at present. Mayer and Knox (2010) explains the movement’s goal as protecting the “right to taste” by preserving almost-extinct traditional food products, raising the awareness of the pleasures of eating (including the social aspects of sharing a meal), taste education and paying attention to traditional agricultural methods and techniques. The movement that opposed to dependence on outsourcing, aims a sustainable city by regional manufacturers’ self development and use of local products (Sezgin ve Ünüvar 2011; 117-118). Thus, it is possible to say that there is a close relationship among the slow concepts. Some of the concept such as “slow city” and “slow fashion” are inspired by slow food movement. Another slow agenda, “slow home” aims to make the conditions more suitable for people’s health, to provide easier life style and protecting the environment as the other slows. “In 2006, the Slow Home initiative formed in the USA as a critical response to the mass housing, development industry and fast housing which the founders describe as “community-blind, cookie-cutter design”” (Steele 2012; 182). Opposite of the fast housing, the slow home movement emphasizes to “design”. By this way, creativity, effectivity and practicality of buildings of houses are provided. In the long term, it is possible to say that slow housing will provide lots of advantages for nature and environment. Apart from that “slow fashion” is one of the subcultures of the slow movement. Today, fast life style effects harmfully the clothing industry and textile. Rights of the workers, environment or natural resources can be effected by the fast production’s negative influence. This situation causes “Slow fashion” concept as a new slow movement. According to Kate Fletcher (2007) slow fashion is a process about designing, producing, consuming and living better. Slow fashion is not time-based but quality-based. By this way, slow fashion with the shift from quantity to quality, takes the pressure off time and overcomes the negative influence of fast fashion [8]. Another slow movement, “Slow travel” takes its inspiration from 19th centuries travelers and completes slow city and food movements [9]. According to Nicky Gardner (2012) in the writing of “a manifesto for slow travel” slow travel aims travelers to make conscious choices and it targets deceleration rather than speed. Thus, the journey becomes a moment to relax, rather than a stressful interlude imposed between home and destination [10]. Besides, slow movement shows its influence on tourism as it affects the other industries. Şule Tuzlukaya (2010) states that “Slow tourism” depends on protection and development principle of natural sources and cultural values. Authors of the book named as “Slow City”, Mete Sezgin and Safak Unuvar (2011) defines slow tourism as “efforts for presentation of responsible, innovative tourism that aims protection of every individual person’s contribution to relish particular nature, landscape, culture, gastronomy, history and tradition”. From this point of view it’s thought that slow city movement cannot be treated detached from slow tourism. Another extension of slow movement that we confront with appears as “Slow media”. Although technology offers many advantages in various ways, it alienates people from their social lives. Pioneers of slow media movement Sabrina David, Jörg Blumtritt and Benedikt Köhler (2009) announced the idea of “the main obstacle for us take joy from life is media and communication technologies” by publishing Slow Media Manifest to the world [11].

2. Cittaslow in Turkey

2.1 The General Knowledge About Seferihisar

Seferihisar is located in south-west axis of İzmir city center. Seferihisar which is 45 km away from the city center of İzmir is surrounded in the west by the Aegean sea and Urla district, in the north by Konak, Urla and Güzelbahçe districts, in the east by Menderes district and in the South by the Aegean sea [12]. Today it is one of 30 districts of İzmir [13]. The district covers an area of 385 km^2 [14]. There are 9 villages as Beyler, Çamtepe, Düzce, Gödence, İhsaniye, Kavakdere, Orhanlı, Turgut and Ulamış, 2 towns as Doğanbey and Ürkmez, 6 wards as Turabiye, Cami Kebir, Hıdırlık, Tepecik, Çolak İbrahim Bey, Sığacık [15]. The oldest settlement in Seferihisar region is Teos, a city of Ionia, which was built by Cretans who escaped from Akalar in B.C. 1000. Hence, it is believed that the history of settlement in this area is over 3,000 years [16]. According to the data of ADNKS, the total population of Seferihisar is 30,890 in 2011. This data demonstrated that 27,422 of population are lived in city center and 3,468 of population are lived in villages. Its economy mainly depends on agriculture and tourism. The most important agricultural products are olive and tangerine; in addition, wheat, barley, corn, grapes and cotton are also breeded. Early vegetables are produced in greenhouses.There are a lot of touristic places on the coastal region [17].

2.2 The Application Process of Seferihisar

Cittaslow's membership process started with sending a intention letter to Italy, the center of Cittaslow, by Seferihisar City Hall in 17th June 2009. In this letter that advertise Seferihisar also, goals and intention being Cittaslow was pointed. After sending the intention letter, a project had been made for being accepted to membership of Cittaslow about 59 criterions which one of these available and which ones could put into practice. After sending the intention letter, an answer came from centre of Italy that accepts candidate of Seferihisar's memberships. After taking the answer of being candidate of membership, in 23 November 2009, Seferihisar Mayor Mr. Tunç Soyer, was invited to Italy where all of the Cittaslow cities all around the world was together and made a presentation about Seferihisar. In 29 November 2009, Seferihisar had the title, Cittaslow that means "slow city" and had been one of the city which is symbolized with "Snail". Thus process of membership started in 17th June 2009, had been completed in 28th October 2009 and Seferihisar had been accepted to membership of Cittaslow (Keskin 2010:76).

2.3 Other Cittaslow Applications in Turkey

2.3.1 Gökçeada

Gökçeada, older name: Imbros, is the largest island of Turkey having an important tourism and economic potential with its own specific geographical and environmental conditions and protected, untouched natural resources. It is located at the entrance of Saros Bay in the northern Aegean Sea, also the westernmost point of Turkey. With an area of 279 square kilometers, Gökçeada contains some wooded areas [18]. According to the data of ADNKS, the total population of Gökçeada is 8,210 in 2011. This data demonstrated that 5,937 of population are lived in city center and 2,273 of population are lived in villages. In Lidzbark Warminski town of Poland, in 2011 Slow Cities General Meeting carried out between June 23rd and 26th of 2011 (June 23 to 26, 2011) Imbros included CittaSlow international network. Gökçeada is announced as first Cittaslow island in the world[19].

2.3.2 Taraklı

Taraklı is a district in southeast of the province of Sakarya and 65 kilometers away to center, 200 kilometers away to İstanbul and 200 kilometers away to Ankara. While Taraklı was a town connected to the district of Geyve, it became a district on June 27, 1987. As its location, Taraklı is a district located in east of its 28 kilometers away to the Göynük district of the province of Bolu, in west of its 34 kilometers away to Geyve district, in south of its 30 kilometers away to the Gölpazarı district of the province of

Bilecik [20]. According to the data of ADNKS, the total population of Taraklı is 7,272 in 2011. This data demonstrated that 2,997 of population are lived in city center and 4,275 of population are lived in villages. Taraklı is included Cittaslow international network in Lidzbark Warminski town of Poland in 2011 Slow Cities General Meeting with Gökçeada, Akyaka and Yenipazar[21].

2.3.3 Akyaka
Akkaya located within borders of the province of Muğla, in the most southwestern tip of Turkey, at the eastern end of the Gulf of Gökova. The population of Akyaka Resort located in the middle of Marmaris and Mugla and within borders of the district of Ula is around 1500 in the wintertime and is reaching 3000 – 4000 in the summertime. At the end of the Gulf of Gökova, Akkaya with Mount Sakartepe in north of its and with the Plain of Gökova in south of its wins acclaim because of this location[22].

2.3.4 Yenipazar
Yenipazar is away 8 kilometers from İzmir–Denizli State Highway. This district did not receive immigration and that's why it protected Aydin Culture. Also it is famous with its own specific types of pita. It is a small district in the view of village [23]. According to the data of ADNKS, the total population of Yenipazar is 13,078 in 2011. This data demonstrated that 6,294 of population are lived in city center and 6,784 of population are lived in villages.

3. Methodology

The purpose of this study is to expose the residents' perceptions and expectations from Cittaslow movement and their proposals for more successful action. In this study, the recognition level of Cittaslow, slow city movement's effects on residents and daily life and its' awareness level in Seferihisar is surveyed.

The interview method used in the study is considered to be a form of both art and science due to the fact that it covers many dimensions such as ability, emotion, concentration, mutual understanding, prediction, mental alertness and discipline (Patton, 1987: 108).

3.1 Data Collection Method

In order to collect the profile data related to respondents, the structured interview form was prepared. In this interviews, age, genders, marital status, child, education level, employment, type of business, origins, home ownership, were asked. The perceptions of Seferihisar residence for the concept of Cittaslow were collected using with the same structured interview form. Below questions were prepared considering the Cittaslow literature.

1. Do you have any idea what Cittaslow is?
2. Have you ever joined informative meetings or activities for Cittaslow?
3. Did Cittaslow movement appeal to you?
4. What are your expectations from Cittaslow movement?
5. What kind of opportunities did Cittaslow movement provide for you and your relatives?
6. In your opinion, has Cittaslow succeded in Seferihisar?
7. What do you recommend for more successful practice?

The structured interview form was applied to the Seferihisar residents from January to June of 2012.

3.2 Sample Size

Target population of the study was residents of Seferihisar. In order to representing all segments of Seferihisar residents, judgmental sampling method was used. During January - June of 2012 over a 6 month period, 83 residents who inhabit in Seferihisar participated in this study.

3.3 Data Analysis

Content analysis technique is used for analyzing the data. Content analysis is an approach to the analysis of documents and texts that seeks to quantity in terms of predetermined categories and in a systematic and replicable manner (Bryman, 2008; 274). This analysis, commenced with coding (Berg, 2004), systematically recording of "perceptions of the respondents" criteria and counting how often the certain criteria are being used (Neuman, 2006) for each questions.

4. Findings

4.1 The Profile of Residents

The average age of 83 responded who are between 17 and 72 and interviewed within this research was found 40.98. It was found that while 76% of interviewed persons have children 24% of them have not children. It was found that 25,30 % of interviewed persons were graduated from primary schools, 19,27 % of them were graduated from secondary schools, 32,53 % of them were graduated from high school, 21,68 % of them were graduated from a university, and 1,2 % of them have master degree. When Seferihisar residents' business conditions were examined it was seem that 61,44% of them are currently engaged in a business, 12,04 % of them are retired and do not engage any business, 3,61 % of them are students and 22,89 % of them are only housewife. It was observed that 53 % of interviewed persons are native of Seferihisar, and 47 % of them had migrated from other cities for different reasons. It was observed that 79,52 % of residents live in their own homes and 20,48 % of them live in rented homes. It was found that 83 % of interviewed persons were already settled in Seferihisar before Cittaslow movement, and 17 % of them were settled in Seferihisar 28 November 2009. As generally, it was determined that interviewed persons are Seferihisar residence for approximately 23,46 years. 67 % of interviewed persons have specified that they have other relatives in Seferihisar, and 3 % of them have specified that they have not any relatives in Seferihisar

According to the research results, 88% of residents, who were interviewed, have known well information about Cittaslow movement. 12% of residents have no information about Cittaslow. It was determined that 29% of responded joined the informative meetings, 71% of responded has not joined any of these meetings or activities yet. According to the measurements, 76% of people made clear that Cittaslow movement was attractive. 24% of responded implied that they have no interest in the subject.

According to the result of expectations of Seferihisar residents interview results, 7 criteria, which are expected from Cittaslow concept are; economic development, protection of environment, development of the city by preserving, acquire a different character of the city, changing the dining culture, protection of local production, organizing the structuring. The results are shown in Table 1.

Table 1. The Expectations from Cittaslow Movement

	"What are your expectations from Cittaslow movement?"	Frequency
1	Economic Development	31
2	Protection of Environment	26
3	Developing with Preserving	17
4	Differentiation	16
5	Eating Habits	12
6	Protecting Local Production	11
7	Construction	8
8	No Gain - No Expectation	17
9	Different Expectations	9

Considering the result of the opportunities, provided by Cittaslow Movement for Seferihisar residents are; recognition of the city, economic gain, conservancy of local production, increasing of population, working opportunity for women, increasing p***rotection*** and ***development activities for the environment***, provide the increasing in cultural and social activities. The results are shown in Table 2.

Table 2. The Opportunities, Provided by Cittaslow Movement

	"What kind of opportunities did Cittaslow movement provide for you and your relatives?"	Frequency
1	Recognition of the city	37
2	Economic Gain	35
3	Conservancy of Local Production	29
4	Population Growth	22
5	Increasing P***rotection*** and ***Development Activities for the Environment***	12
6	Increasing Cultural and Artistic Activities	9
7	***Increasing*** numbers of ***women*** workers	8
8	Increasing at Social Activities	6
9	No Gains - No Idea	18

Considering the results, 71% of residents think that Cittaslow is successful, 14% of residents think that Cittaslow is successful partially, and 8% of residents think that practices is unsuccessful, 7% of residents determined that they have no comment.The results are shown in Figure 1.

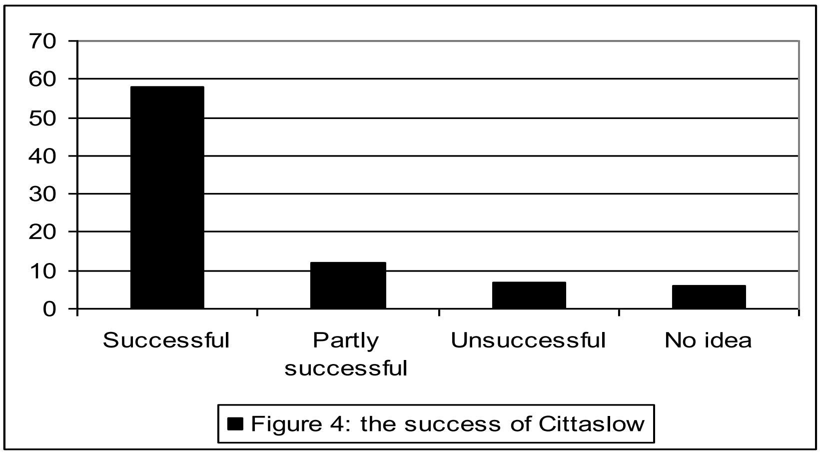


Figure 1. The accomplishment of Cittaslow Movement in Seferihisar

The recommendations of Seferihisar residents for a more successful application on Cittaslow

Movement stated respectively as below; increasing the publicity activities, protection and development of environment, fulfilling the responsibilities of executers, making social investments, development of local production, and development of the city by protection.

Table 3. Recommendations for More Successful Application

	What would you recommend for a more successful application?	Number Of Participants
1	Increasing at Publicity Activities	37
2	P***rotection*** and ***Development of Environment***	16
3	Responsibilities of Practitioners	14
4	Social Investments	13
5	Promoting of Local Production	13
6	Developing with Preserving	12
7	Reorganize the View of City	6
8	No Idea	16
9	Different Suggestions	2

5. Conclusion

In this research, the effects of Cittaslow movement to the life of society were analyzed in Seferihisar. Considering to the residents of Seferihisar perception on Cittaslow movement in Seferihisar were found as a successfully. On the other hand, It was seen that the Cittaslow concept was not understood clearly by all residents of Seferihisar. Because, results showed that, some of the citizens perceive the Cittaslow concept as an economic development model. Moreover, it is seems that, expectations of the young population will not be satisfied with the concept of the Cittaslow.

Nevertheless, it was possible to say that Cittaslow movement is a big advertisement tool for Seferihisar. It was evaluated that Seferihisar has started a big development process and it was addressed its name in the international and national arena. Even only this situation provides a big gain for Seferihisar. However, considering the results of research, publicity process did not create enough effect in the society. It was thought that municipality has to give weight for publicity activities and make people conscious in the frame of Cittaslow movement for providing success and recognition by the citizens.

Finally, there are some problems about Cittaslow future in Seferihisar. It is obvious that there is appreciable development in every part of the city life. In addition to opportunities offered by the concept of the Cittaslow, some of the threats will be waiting the practitioners to be an obstacle in this process, as mentioned by Mayer & Knox (2010). The practitioners of Cittaslow movement have to be ready to struggle with these problems. As a further study, the research has to be developed to identify problems that may arise in the process of Cittaslow movement and to develop alternative strategies on overwhelming the threats.

6. References

AlSayyad, N. 2004, The End of Tradition? (New York, NY: Routledge).

Berg, B. L. 2004, *Qualitative Research Methods for the Social Sciences,* USA: Pearson,271.

Bryman, A. 2008, *Social Research Methods.* Oxford University Press. New York.

Doğutürk, G. 2010, *Mimari ve Yaşam Kalitesi Bağlamında Yavaş Şehir Hareketi ve Seferihisar Örneği*

Heinonen, S. & Halonen, M. & Daldoss, L. 2006, *Slow housing – competitive edge for innovative living* *environments,* Page 95

Keskin, E.B. 2010, *Sürdürülebilir Kent Kavramına Farklı Bir Bakış Olarak Yavaş Şehirler (Cittaslow): Seferihisar Örneği*

Knox, P. 2005, *Creating Ordinary Places: Slow Cities in a Fast World*, Journal of Urban Design, Vol. 10. No. 1, 1–11, February 2005

Knox, P. &Mayer, H. 2006*, Slow Cities: Sustainable Places In A Fast World,* Journal of Urban Affaırs, Volume 28, Number 4, Pages 321–334.

Knox, P.&Mayer, H. 2010, *Small-Town Sustainability: Prospects in the Second Modernity*, European Planning Studies Vol. 18, No. 10, October 2010 Pages 1545-1565

Miele, M. 2008, *Citta`Slow: Producing Slowness against the Fast Life*, Space and Polity, Vol. 12, No. 1, 135 156, April 2008

Neuman, W. L. 2006, *Social Research Methods, Qualitative and Quantitative Approaches.* Six Edition, USA: Pearson, 322, 44

Patton, M. Q. 1987, *How To Use Qualitative Methods In Evaluation*. Newbury Park, CA: Sage.

Pietrykowski, B. 2004, You *Are What You Eat: The Social Economy of the Slow Food Movement,* Review Of Social Economy, Vol. Lxıı, No. 3, September 2004, pages 307-321

Sezgin Mete ve Şafak Ünüvar, 2011, Sürdürülebilirlik ve Şehir Pazarlaması Ekseninde Yavaş Şehir, Çizgi Kitabevi, Konya

Steele, W. 2012, *Do We Need a 'Slow Housing' Movement?*, Housing, Theory and Society, 29:2, 172-189

INTERNET SITES

[1] http://tr.wikipedia.org/wiki/Yava%C5%9F_Hareketi, 25.07.2012

[2] http://www.facebook.com/groups/5832212719/events/ : Keskin, Enes BATTAL Sürdürülebilir Kent Kavramına Farklı Bir Bakış Olarak Yavaş Şehirler (CITTASLOW): Seferihisar Örneği, 35, 25.07.2012

[3] http://tr.wikipedia.org/wiki/Yava%C5%9F_Hareketi, 25.07.2012

[4]http://www.cittaslowseferihisar.org/index.php?option=com_content&view=article&id=55&Itemid=62 24.07.2012

[5] http://www.cittaslow.org/section/association , 26.07.2012

[6]http://www.cittaslow.org/download/DocumentiUfficiali/CITTASLOW_LIST_march_2012.pdf, 19.07.2012

[7]http://www.pkc.gov.uk/Promoting+Perth+and+Kinross/Cittaslow/An+Introduction+to+Cittaslow/Cittaslow+membership+criteria.htm, 25.07.2012

[8] http://www.theecologist.org/green_green_living/clothing/269245/slow_fashion.html , 20.07.2012

[9] http://en.wikipedia.org/wiki/Slow_Movement#cite_note-3 , 20.07.2012

[10] http://www.hiddeneurope.co.uk/a-manifesto-for-slow-travel , 20.07.2012

[11] http://en.slow-media.net/manifesto, 20.09.2012

[12] http://tr.wikipedia.org/wiki/Seferihisar,_%C4%B0zmir, 25.07.2012

[13] http://tr.wikipedia.org/wiki/Seferihisar,_%C4%B0zmir, 25.07.2012

[14] http://okulweb.meb.gov.tr/35/19/586112/ilce.html , 20.07.2012

[15] http://izmirliyizbiz.tr.gg/Seferihisar.htm, 25.07.2012

[16] http://www.turkiyekoyleri.com/web/Town.aspx?ID=418 , 19.07.2012

[17] http://www.turkcebilgi.com/ansiklopedi/seferihisar, 25.07.2012

[18] http://www.cittaslow.org/network/location/295, 11.07.2012

[19] http://www.gokceadarehberim.com/nm-cittaslow_g%C3%B6k%C3%A7eada-cp-357 , 01.07.2012

[20] http://tr.wikipedia.org/wiki/Tarakl%C4%B1, 13.07.2012

[21] http://sakaryalife.com/2011/06/30/tarakli-artik-tescilli-bir-sakin-sehir/ , 22,07.2012

[22] http://tr.wikipedia.org/wiki/Akyaka,_Ula , 03.07.2012

[23] http://tr.wikipedia.org/wiki/Yenipazar,_Ayd%

Brazilian Shipbuilders Risk Rating

Pires Jr,F.C[48], *Barauna Vieira, C*[49]*.,Assis,L.F*[50], *Queiroz,J.V.*[51]

Abstract

The shipbuilding sector is the main element of the shipping industry supply chain. As the shipbuilding itself is a very unstable and volatile industry, it becomes a critical source of risk for shipping investors. The problem is particularly critical in developing countries. The Brazilian maritime industry is experiencing a very rapid expansion process. A number of greenfield shipyards projects are under development as well as the modernization and expansion of existing shipyard facilities. The general economic growth has provoked the increasing of coastal shipping activities and consequently an increasing demand for domestic ship construction as the cabotage trades are reserved to national flagged ships. However, the poor performance records and the lack of continuity of shipyard operations are obstacles for shipowners to order newbuildings.

The development of shipbuilding risk evaluation tools will be a significant contribution to the maritime industry recovery in Brazil. This paper presents a multicriteria approach to establish a risk rating for Brazilian shipyards. The methodology is then applied to the analysis of a set of typical shipbuilding companies. The shipyard risk rating is based on accounting and financial indicators , operational performance and technical and managerial capabilities and is useful to financers, insurers and other stakeholders, besides the shipowner , in the decision making process.

Keywords: shipbuilding, shipyard, risk analysis.

1. Introduction

The Brazilian shipbuilding industry has gone through two expansion periods in the last fifty years. In the first, from 1960 to 1979, Brazilian shipyards ranked second worldwide in terms of tonnage built ,with a work force of 40,000 employees. Nevertheless, for the two next decades, the industry experiences a deep crisis , and many shipyards closed down.

From the year 2000 onwards the sector started a recovery and reached a situation of very strong growth at present. As a consequence, a number of green shipyard projects are presently under development in different regions of the country along with the modernization and expansion of the existing shipbuilding facilities.

Most of this growth is due to the rapid development of offshore oil and gas E&P activities. Besides platforms and other offshore facilities, many oil tankers and supply boats have been ordered to Brazilian shipyards.

On the other hand, the economic development of the country has led to the increasing of costal shipping activities as well, and as the cabotage trades are reserved to Brazilian flag ships there has being an increasing demand for domestic ship construction.

The Government has been providing a decisive support for the industry expansion. In Brazil, most shipbuilding projects are financed by the state owned Development Bank. The funds made available to

[48] Federal University of Rio de Janeiro, Brazil, floriano@peno.coppe.ufrj.br
[49] Federal University of Rio de Janeiro, Brazil, barauna@peno.coppe.ufrj.br
[50] Federal University of Rio de Janeiro, Brazil, felipe@peno.coppe.ufrj.br
[51] Federal University of Rio de Janeiro, Brazil, joseane @peno.coppe.ufrj.br

finance ships are provided by a governmental fund, the Merchant Marine Fund (FMM). The FMM grants very favorable financing conditions to ship-owners for building in domestic shipyards. Virtually all merchant ships built in Brazil in the last 50 years were financed by the FMM (Pires Jr et al., 2005). In 2011 only, the FMM approved US$8.3 billion for new buildings and US$ 2.8 billion for the construction of new or the expansion of the existing shipyards.

However, in spite of the very optimistic panorama, the poor performance records and the lack of continuity of shipyards operation are obstacles for ship owners to order newbuildings. The Brazilian shipyards have always had difficulty in accomplishing the contracted terms. Even for the period of more intense and continuous production, the records show systematic delivery delays and cost overruns. Delivery delays and overbudgeting are still common, which hinder the international competitiveness of the Brazilian industry.

In this context, the development of shipbuilding risk evaluation tools can be a significant contribution to a sustainable development of the maritime industry recovery in Brazil.

Shipping is a capital-intensive industry and ship owners operate in a very risky environment due to the cyclical nature of the business. As a consequence, to cope with their capital needs shipping companies are forced to rely on banks and financial institutions to finance the acquisition of a new or a second-hand ship.

Financial institutions, in order to minimize credit risks, impose several requirements that must be satisfied by the loan applicant and assign values and grades to evaluate the financial health of the firm and its soundness.

To model the decision process however is not trivial due to the fact that most critical parameters involved are qualitative rather than quantitative.

This paper presents a multicriterial approach to establish a risk rating for Brazilian shipyards based on accounting and financial indicators, operational performance and technical and managerial capabilities representative of a set of typical shipbuilding companies.

The resulting risk rating is a useful guide for financers, insurers and other stakeholders besides the ship owner.

2. Risk Analysis in Shipbuilding

Very few references can be found in the literature concerning the risk analysis in the shipbuilding area. Lee et al (2007), perhaps the best known among them, identifies the critical risks in the Korean shipbuilding industry and examines the relationship between them according to different phases of the construction process: 284 specialists from the 10 top Korean shipbuilders ended up with a list of 26 risks. To examine the relationships between the risks Lee used the association rule of a data mining process.

A summary of his conclusions is presented in Table 1.

Table 1 - Phases of the construction process and associated risks

Phase	Risks
1. contract signature - steel cutting	work force, design and finance
2. steel cutting - keel laying	supply of material, workforce, equipments, technical, management and finance
3. keel laying – launching (erection)	technical (change in ship design), management (overrun)
4. launching - delivery	exchange rate, interest rate, specification adherence, natural disasters

Source: Lee et al (2007)

Guimarães et al (2009) present a risk analysis process relative to the Brazilian shipbuilding industry. Delphi and brainstorm methods were used for identifying the risks, with the participation of 14 specialists of different sectors of the shipbuilding sector. A risk breakdown structure (RBS) is developed divided in six levels: external, financing, procurement, project, construction and trading. The level construction was further subdivided into three sublevels: technological, infrastructure and equipments, and workforce. The risks were evaluated within these levels and classified according to the level of probability of occurrence (never, rarely, eventually, frequently, very frequently, systematically and always) and the level of impact on the scheduling and project budget. As a result each risk was classified relative to level of criticality for each phase of the project.

Celik et al (2009) developed a model for selecting a shipyard for repair works using an axiomatic fuzzy methodology, a data mining technique in that linguistic classifications (poor, good, excellent etc) can be transformed into fuzzy numbers and then post-processed. He then creates an analytical structure of criteria in order to choose the shipyard. The weights for each criterion were obtained using a Analytic Hierarchy Process (AHP) software: 25 main risks were divided in four classes; cost, service quality, competitive service offered by specialized companies, and prestige/organization capacity of the shipyard.

3. Comparing Risks of Shipbuilding Projects in Brazil

Many aspects and industrial features must be considered in the process of selection of a shipyard. In order to develop a methodology to analyze the shipyard risk to help the decision making the first step is the identification of the risks.

To define the structure of risks in the particular case of the Brazilian shipping industry a preliminary list similar to the one proposed by Guimarães et al (2009).

With the concourse of a panel of specialists the main risk categories are set up in a hierarchical structure and then scored according to a scale from 1 to 9 proposed by Saaty (1990), in order to make pairwise comparisons between the criteria.

The priority weights of the attributes are then computed employing the software Expert Choice®.

Comparisons are also obtained within each risk category and subcategories. The calculated weights for each risk category are shown in Figure 1.

- Risks
  - External (.109)
    - Strike - urban transport (.052)
    - Strike - ports or customs (.080)
    - Changes in tax regulation (.157)
    - Natural disasters: storm, flooding (.076)
    - Inflation (.169)
    - Exchange rate (.180)
    - Failure in infrastructure development (.286)
  - Finance (.088)
    - Warranties (.299)
    - Insurance contracting (.230)
    - Bank project analysis (.213)
    - Risk rating by bank (.258)
  - Procurement (.126)
    - Acquistion problem for main inputs (.127)
    - Shipping or transportation problem for main inputs (.166)
    - Noncompliance of main inputs (.452)
    - Divergence in measuring Domestic Content (.256) *
  - Planning (.143)
    - Failure in project management (.500)
    - Failure in scheduling (.500)
  - Design (.183)
    - Design erros (.071)
    - Bill of material: delay or underspecification (.070)
    - Missespecification of the scope of the project (.479)
    - Delay in delivering design documents (.061)
    - Design subcontractor delay (.144)
    - Design modifications doe to equipment specifications changes (.174)
  - Construction (.351)
    - Technological (.222)
      - Production error (.157)
      - Failure in productivity estimation (.182)
      - Noncompliances - inspections from CS (.259)
      - Noncompliances - inspections from stakeholders (.244)
      - Accidents (.159)
    - Infrastructure and resources (.258)
      - Difficulties in obtaining equipments (.168)
      - Delay or noncompliances for building facilities or installing equipments (.230)
      - Equipment stopping or failure (.324)
      - Low performance (.278)
    - Workforce (.520)
      - Lack of engineers or managers (.184)
      - Lack of qualified workers (.075)
      - High turnover rate (.102)
      - Loss of key people (.309)
      - Strikes, problems with the trade unions (.073)
      - Lack of experimented team in shipbuilding or project management (.256)

(*) In Brazil there are special incentives related to the domestic components share in total production cost

Figure 1. Shipbuilding projects: Risk breakdown structure and weights

The weights calculated from their matrices presented little divergence.

4. Shipyards Rating Risks

A second application of utmost importance to Brazil is the development of a methodology to set up a rating of shipyards and other shipbuilding facilities. The main beneficiaries would the government ,banks and finance institutions that would use the rating to support decisions concerning the drawing of incentives programs ,the definition of finance priorities and classes of risk to formulate conditions and terms of finance granting or warranties .

The model is then implemented using the software Expert Choice®. Figure 2 shows the pairwise comparison matrix.

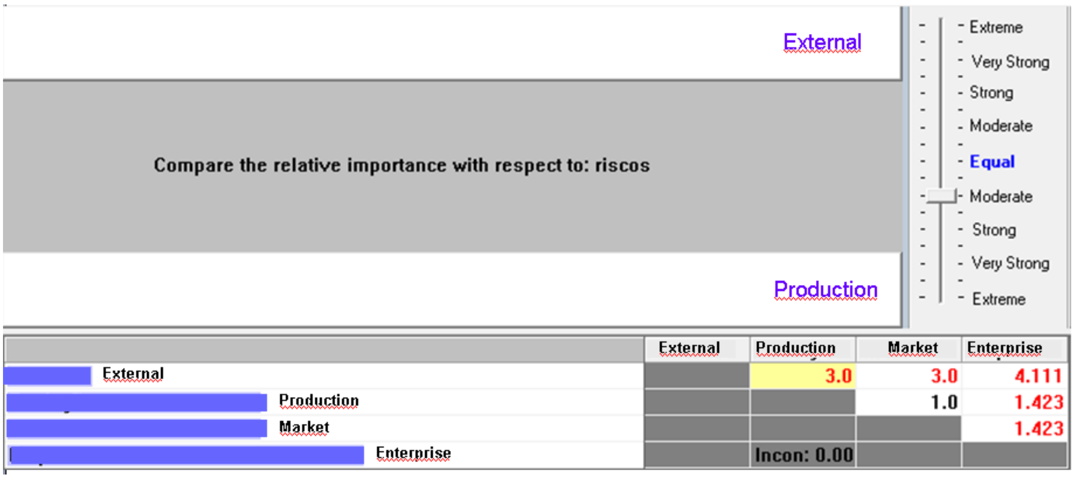


Figure 2. Expert Choice®: pairwise comparison matrix.

The final weights for the risk categories are presented in Figure 3.

Risks

- External (.090)
  - Macroeconomicc enviroment (.329)
    - Inflation (.500)
    - Exchange rates (.500)
  - Governmental policies (.552)
    - Sectorial policies (.500)
      - Demand from Government (.439)
      - Changes in financing system(.250)
      - Changes in taxation (.254)
        - Changes in ship import taxation (.500)
        - Other taxes (.500)
      - Failure of sectorial incentive benefits mechanisms (.057)
    - Local governmental policies (.500)
      - Local incentive benefits (.300)
      - Government provided infrastructure (.700)
  - Weather (.118)
- Production (.267)
  - Technical (.266)
  - Facilities (.204)
    - Difficulties in obtaining equipments (.167)
    - Deployment of resources (.833)
      - New facilities: delay or noncompliances (.444)
      - Equipment: delay or noncompliances (.444)
      - Computer systems: delay or noncompliances (.111)
  - Workforce (.416)
    - Lack of engineers or managers (.417)
    - Lack of qualified production workers (.417)
    - Turn over (.167)
  - Procurement (.115)
    - Lack of access of critical inputs in the international market (.500)
    - Difficulties in obtaining critical inputs (.500)
- Market (.267)
  - Orderbook (.608)
    - Low size of orderbook (.621)
    - Buyer's reliability (.240)
    - Orderbook quality (.139)
      - No compatibility of the ordebook with the shipyard (.800)
      - Lack of standardization (.200)
  - Global market worsening (.392)
- Enterprise (.376)
  - Economic and financial situation (.614)
    - Poor availability of cash (.423)
    - High debt index (.577)
  - Historical (.117)
    - Contracts not accomplished (.392)
    - Instability (.392)
    - Poor performance (.216)
  - Management (.268)
    - Staff (.754)
      - Quality of top management (.667)
      - Intability of top management (.333)
    - Systems (.246)
      - Poor quality of information Technology (.333)
      - Poor quality of managerial structure (.667)

Figure 3. Risk rating: Risk breakdown structure and weights

The relative importance of each item within each subcategory is easily highlighted with the help of graphs. For example, Figure 4 shows that the item Human Resources has the highest priority within the category Production (0.416).

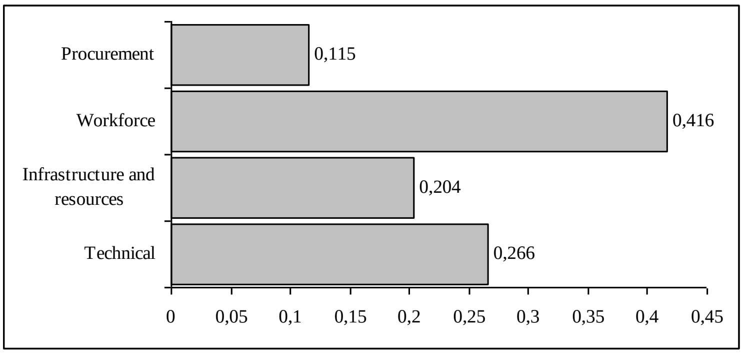


Figure 4. Priorities with respect to Production risk category

One can further examine the priorities of the items within the subcategory Workforce ,as in Figure 5 and observe that Lack of engineers and Lack of qualified operational staff are equally important each with priority 0.417.

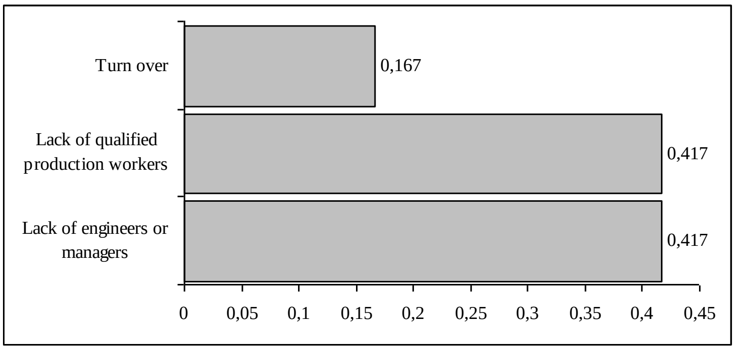


Figure 5. Priorities with respect to Workforce risk subcategory

It is worthy noting that the risks pertaining to the category Enterprise (0.376) are the most important in the develpment of the rating.

In order to set up the rating six fictious shipyards were considered as representative of the ship building market in Brazil:

Shipyard A is well located in a region of high socio-economic development in the country's most important shipbuilding region. It has a long tradition in the market, continuous production and good relations with suppliers. However, its management is not very efficient incurring in not uncommon failures in contract completion time and delays in scheduling. A non -homogeneous order book affects the development of the facilities.

Shipyard B is a new shipyard recently installed in a less developed region with no tradition in the shipbuilding sector; consequently it is subject to logistic problems such as lack of human resources and supplies.

In spite of that it has a full order book mainly from the Government sector. Although it presents a good policy to attract workers and create qualified work teams the evasion of high personnel is significant.

Shipyard C is dedicated to the sector of supply boats, as well as ship jumborization and repair. Located in the main pole of ship construction in the country is part of a n international group with shipyards in different countries but has not many orders in its book.

Shipyard D is also part of a large international group, has a large area and facilities adequate to the construction of big ships and offshore platforms and also offshore supply boats.

Shipyard E is located in a less developed region ,being dedicated to building small and medium sized ships such as chemicals and gas carriers ,supply boats and container ships and additionally conversions and repair works .It has a high rate of debt and its demand comes mainly from the international group to which it belongs.

Shipyard F is also located in a less developed region, building small size ships like river barges, that makes up the main percentage of its order book , tugs and fishing boats. The shipyard deals with national suppliers since imported supplies are almost unnecessary.

Graphs like the one shown in Figure 6 help to highlight the strong and weak points of the shipyards within each risk category.

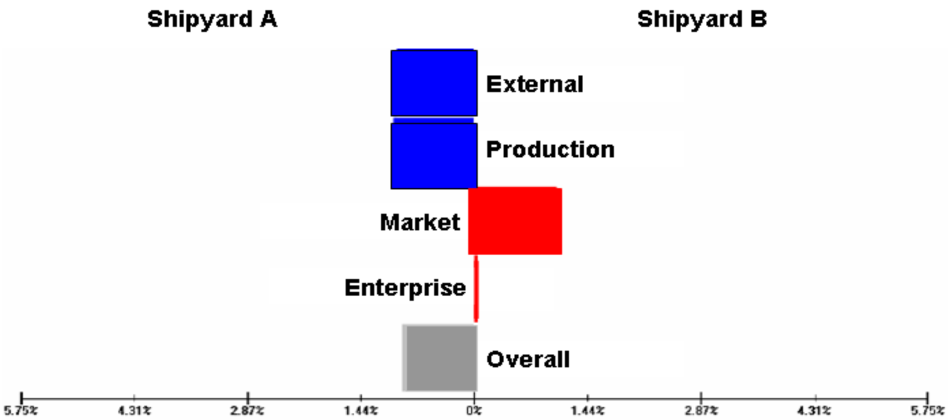


Figure 6. Weighted head to head between Shipyard A and Shipyard B

The weight of the risks of each category and for each shipyard are as shown in Figure 7.

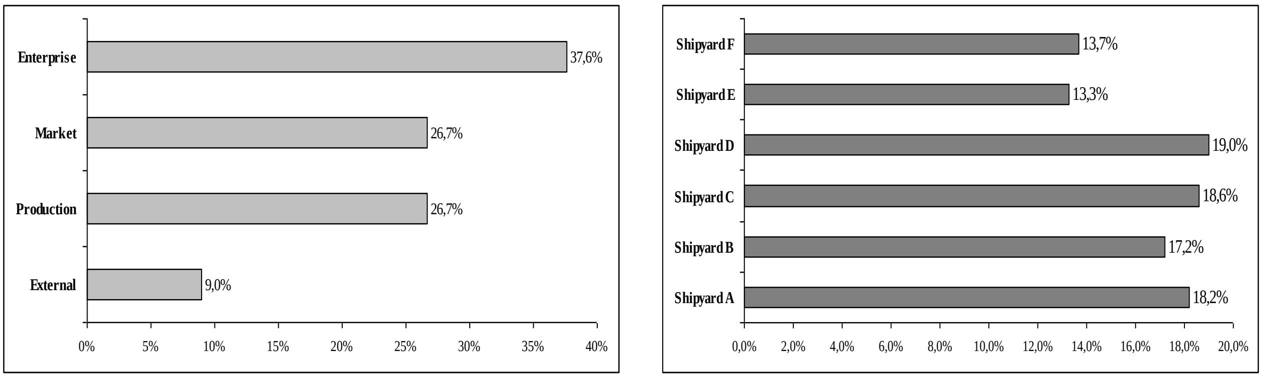


Figure 7. Weight of the risks of each category and for each shipyard

The performance of the shipyards considering all the categories of risk is shown in Table 2.

Table 2. Performance of the shipyards

SHIPYARD	GRADE
A	0.825
B	0.783
C	0.857
D	0.883
E	0.623
F	0.613

Therefore, from the point of view of financing institutions, shipyard D is the one that offer less risk .

Following procedures similar to the adopted by risk assessment agencies such as Standard&Poors, Moody and Fitch these grades were associated to a table of risk rating shown in Table 3 .

Accordingly, shipyards C and D obtained the classification AA.

The problem herein is an illustrative example that uses the methodology to develop a tool for analyzing the risk in a very complex sector of the shipping industry in Brazil.

The model can be very easily adapted to cope with different problems in various environments; it is a simple to use tool that can treat the problem in a very dynamic way, enabling the analyst to understand the importance of each variable leading to a sound decision.

Table 3. Performance of the shipyards

SHIPYARD	CLASS	GRADES
	AAA	0.900~1.000
C,D	AA	0.850~0.900
A	A	0.800~0.850
B	BBB	0.750~0.800
	BB	0.700~0.750
E,F	B	0.600~0.700
	CC	0.550~0.600
	CC	0.550~0.600
	C	0.500~0.550
	D	0~0.500

5. Conclusions

The Brazilian shipbuilding, after a long period of inactivity, is undergoing a fast recovering process. This process is driven by an extremely large newbuilding demand, mainly related to the offshore oil and gas industry, and induced by governmental policies. However, due to the long crisis, there is a shortage of qualified manpower, technical and managerial capabilities and infrastructure.

In this context, the risk perception by owners, financers, insurance companies and other stakeholders becomes an important barrier for new contracts. Therefore, the development of methodologies and criteria for risk analysis, adequate to the Brazilian shipbuilding environment, is a valuable contribution to the recovery process as a whole.

This paper presented the risk breakdown structures – RBS – and the analytical approaches for two different problems.

The first is the problem of comparing alternative proposals, from different shipyards, to contract a newbuilding. This analysis is performed from the shipowner point of view.

The second is the problem of establishing a risk rating methodology for shipyards, or shipbuilding companies, from the point of view of governmental agencies, banks or insurance companies.

The paper discussed the identification of critical risks for the Brazilian shipbuilding environment, as well as the development of the hierarchical RBS, and the AHP – Analytical Hierarchy Process – approach for both problems.

The methodology and RBS developed for shipbuilders risk rating was applied to a set of shipyards, which are typical of the main groups of players at the present recovering stage of Brazilian shipbuilding.

6. References

Pires Jr, F., Assis, L. F., and Souza, C. M. 2005. An analysis of the Brazilian ship financing system. *Maritime Policy and Management*, 32:3, 209 – 226.

Celik.M,Kahraman,C.,Cebi,S.,Er,D. 2009.Fuzzy axiomatic design-based performance evaluation model for docking facilities in shipbuilding facilities. *Science Direct Expert Systems with Applications*. vol. 36:250-260.

Guimarães, L.F., Pires Jr., F.C.M., & Assis, L.F. 2009. Risk Analysis in Shipbuilding Contracts. 13th Congress of International Maritime Association of Mediterranean – IMAM 2009.

Lee,E.,Shin,J.G.,Park,Y. 2007. A statistical analysis of engineering project risks in the Korean shipbuilding industry. *Journal of Ship Production*,v.23:4 559-615.

Saaty,T., L., 1990 How to make a decision: the analytic hierarchy process. E*uropean Journal of Operational Research*,48;9-26.

Creative Industries as the Source of Innovations: The Case of Design Industry in İzmir

Leyla Öğüt[52]

Abstract

One of the key issues of debate in modern business and *economic development of regions and cities* is *creativity.* From an economic development viewpoint, creative acitivites enhance entrepreneurship, strenghten innovative capacity, improve productvity and hence generate *economic development.* Hence, development policies increasingly emphasize identification of *creative sectors* and enhancement of socio-economic conditions fostering creative capacities*. Creative sectors* include, science, engineering, technology, design, arts craft, media, entertainment, and the knowledge-based professions of law, finance and health care. *Turkey,* with $3.5 billion worth of design goods exports, is included in the *top 10 list of exporters of design industres* within developing coutries (UNCTAD 2010). The purpose of this study is, within the creative economy perspective, to analyze the potentials of the "design sector" in *Izmir City,* and its possible contributions to fostering Izmir's creative economy

Keywords: Creative Economy, Creative industries, Development, İzmir

1. Introduction

One of the key issues of debate in modern business and *economic development of regions and cities* is **creativity.** From an economic development viewpoint, creative acitivites strenghten innovative capacity of societites by enhancing entrepreneurship, improving productivity and hence generate *economic development.* Hence, development policies increasingly emphasize identification of *creative sectors* and enhancement of socio-economic conditions fostering creative capacities. **Creative sectors** include, science, engineering, technology, design, arts craft, media, entertainment, and the knowledge-based professions of law, finance and health care (UNCTAD, 2010)

Design sector is the third-largest creative subgroup for developing countries, after art crafts and new media. It is an important part of the creative economy given that it cuts across the artisan, manufacturing and services components of the value chain, interacting with technology, tourism and culture. ***Turkey*,** with $3.5 billion worth of design goods exports, is included in the **top 10 list of exporters** of **design industres** within developing coutries (UNCTAD, 2010). In Turkey, the current regional development polices, efforts have been increasingly oriented towards fostering innovative and creative sectors inorder to enhance the creative potentials of regions and cities.

The purpose of this study is, within the creative economy perspective, to analyze the potentials of the "design sector" in **Izmir City**, and its possible contributions to fostering İzmir's creative economy.

[52] Inditex Group, Bershka, (Visual Coordinator), Izmir, Turkey,+90 232 3421200, leyla_ogut@hotmail.com

Amoung the six sub-groups of design sector, we concentrate on ***fashion and ready wear***sector in İzmir, with special emphasis given to the ***wedding dress and accessories*** group. "İzmir Development Agency" has determined "fashion and ready wear sector", as one of the **key sectors**amoung seven others, with highest employment, output and innovative capacity in the city (İZKA, 2010a)

2. Towards A New Development Paradigm

Development is a value loaded concept which encompasses different values and assumptions as to what a *developed society* means and what the process of development involves. Development may be regarded as a goal towards which countries strive, and also a process which involves casual relationships and lie at the heart of development process (Ingham, 1995: 33-34)) Yet there is no straight forward answer to what development means both in terms of a goal and in terms of process. Since the birth of development economics and sociology after the Second World War, varius *paradigmas of development* ranging from the "growth oriented development paradigm" of 1950's to the contemporary "human develoment paradigm" have emerged. Each paradigm incorporates different sets of values, central concepts and specific assumptions about the meaning and process of development of societies, regionjs and countries

2.1.Two classical Paradigms of Development: State versus the Market Dichotomy

Until 1990's, *two classical paradigms*, two extreme views have dominated the development studies. The two extreme views have been usually expressed as the "state" versus the "market" , dichotomy (Kooiman, 1994; Morgan, 1997) and the relevant development paradigms assosciated to these views are the *structuralist paradigm versus the neoliberal paradigm* of development.

Structuralist development paradigm : During the post-war period (1950-1975) the *structuralist paradigm* of development dominated development thinking and development is identified with **economic growth** *based on inward oriented industrialization*. Development of regions and countries are associated with investment in *physical capital, inward oriented industrialization and modernizationof the social, political and economic structure of the countries.*The state assumed the central role in promoting and sustaining development and development planning, state control of trade and finance and pursuit of other antiliberal/interventionist policies chacterized the central role of the state during the post-war period. Such protectionist/anti-liberal and interventionsit policy instruments were materialized underthe general policy strategy of *'import substitution strategy'* in most of the developing countries for more than two decades starting from 1950's. The principal economic argument infavor of the developmental state was "the market failures" – the divergences between private and social valuations- especially in the mobilization and coordination of investment decisions for development/industrializaiton purposes.

Despite the success of structuralist development paradigm in terms of sustaining gorwth in GDP and industrializiaton, starting from 1970's such practices proved to have various social, political and environmental costs (Balassa, 1983; Krueger, 1978). Accompanied with the onset of globalization and new World Dynamics of capitalism, there was a need to redifine the meaning of development and construct a credible and new framework for development.

Neoliberal development paradigm: During 1980's and early 1990's many economists, the heads of the major international economic instititutons such as IMF, World Bank and key U.S. government agencies advocaded increased use of the market mechanism as a key instrument for promoting greater efficiency and hence reduced role for the state. The 1980's and 1990s witnessed the emergence of free-market economics and market mechanism as a key instrument for promoting greater efficiency and more rapid economic growth. The reflections of these on the new development paradigm has been the emergence of neoliberal development paradigm which suggests to reduce the role of the state, to providing the basic conditions for a market economy to work (Findley, 1991). This in turn is based on the assumption of "efficient markets", that the market is sufficent to ensure rapid economic development as long as the state maintains to its core services which can not be delivered by the private sector. In this new development paradigm – also referred to as the "Washington Concensus"- the manin concepts that are associated with high development and growth were : *outward orientation, integration of domestic markets with World markets with special emphasis on exports, deregulation, liberalization of foreign trade and capital* *movements.* However in the mid 1990's the shortcomings of the "market" as a mechanism of promoting economic development were also recognized[53].

2.2. Towards a New Development Paradigm: Innovations as the Engine of Growth

As a reponse to the failures of the two extreme views on development and coupled with the new conditions engendered by globalization and fierce competitiona, from 1990's onwards a search for new alternatives in development thinking emerged. The new paradigm focuses on the "*endogenous growth and development"*phenomenon which essentially involves regions and nations to create their own economic growth by fostering and utilizing their indigenous capacities such as *entrepreneurship, technology,local skill base and human capital.* At the heart of this quest for new development paradigm lies the concept of *technological improvements and innovations* being the main engine of sustainable growth of regions which *secures competitiveness in the face of increasing pressures from global economy* . The new paradigm is essentially based on the endogenous growth literature *(Romer, 1990)*

According to EU and OECD literature, innovation means *changing ideas and knowledge into things that have value added; that generate income for the society and which are commercialized (EU Commission 1995; OECD, 2010a)***.** Hence the concept of "innovation" links economic, cultural technological and institutional aspects of development and involves the *creative capacity of society* for fostering innovations.Innovation is defined according to the Oslo Manual, as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD and Eurostat, 2005). Acording to this definition the following four types of innovation are defined:

Innovations take various forms such as new marketing techniques, a new product, a new production process, a new technology, new organizations and are the *main source of economic growth and development of regions and societies.* The below figure shows the increasing share in GDP of investment in intangible assets which mainly includes innovations compared to investment in physical capital for various countries.

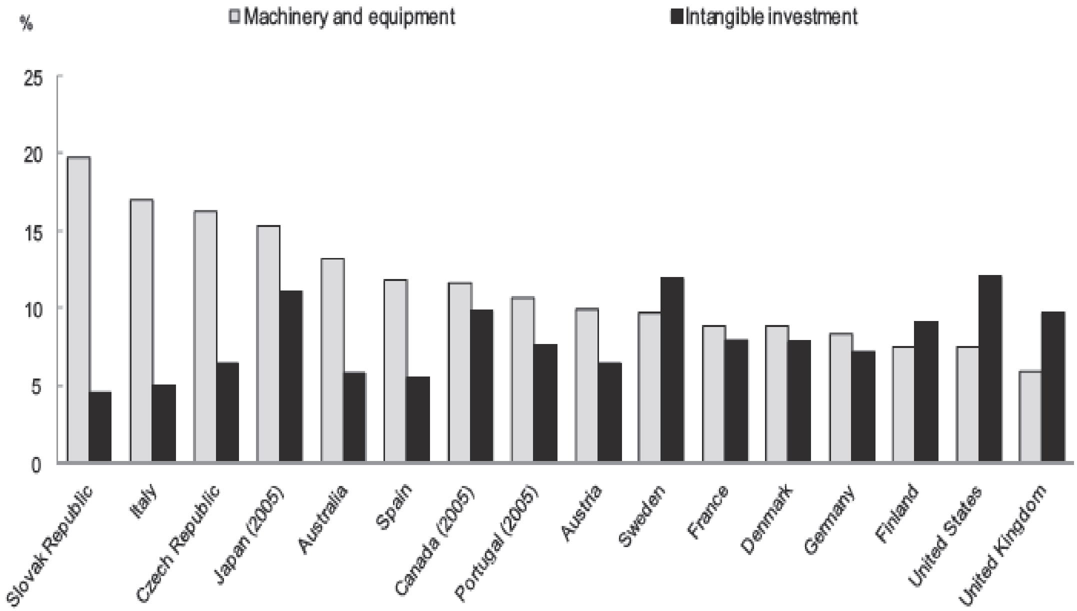


Figure 1. Investment in Fixed and Intangible Assets as a Share of GDP – 2006 (OECD, 2010:)

[53]Some of the shortcomings of the "markets" in promoting economic and social development withing the debate over "markets" versus "state" are : the prevalance of market imperfections, presense of substantial externalities, the existance of pre-capitalist structures and hence the necessaity of transforming these strucutures, the inability of markets providing a a fair income distribuiton . See Tony Killick (1991), "Development Strategies: the Role of the state and Private sector" *Proceedings of the World Bank Annual Conference on Development Economics*, 1990, Oxford University Pres.

One of the most important characteristics of this new development paradigm which focuses on the central role of innovations is that, the coordination of decisions and the organization of the mobilization of resources for development are seen in a network approach. According to this new approach or "network paradigm" the co-ordination of economic development is achieved niether through an organizational hierarchy nor through the price mechanism of the traditional market model. Rather the central argument of the network approach is that co-ordination takes place through *interaction* amongst the institutions/actors of different kinds (including firms, financial institutions, local chambers of commers, government agencies, public bodies, innovaiton centers, etc) which act in an interactive process. (Amin and Thrift, 1995: 14). Due to the interactive learning nature of innovations and innovative capacity, in the new development paradigm , "*region*" or **"***city"* rather than the "*nation*" is given a central status as a mode of economic co-ordination. It is argued that such interactions amoung actors are socially and culturally embedded and hence they are more territorially/regionally specific (Storper, 1995).

Creative capacity in the contex of innovations in the new development paradigm refers to the formulation of new ideas and to the application of these ideas to produce original works of art and cultural products, scientific inventions and technological innovations. Therefore the economic aspect of creativity from this new view point involves its contribution to entrepreneurship, to fostering innovation, enhancing productivity and hence promotion economic growth and development (OECD, 2008).

3. Creativity and Creative Economy

The new development paradigm's central argument is that creativity, knowledge and access to information are increasingly recognized as powerful engines fostering economic growth and promoting development in a globalizing world. *Creativity* in this context means the "*formulation of new ideas and to the application of these ideas to produce original Works of art and cultural products, functional creations, scientific inventions and technological inventions*" (OECD, 2008, p: 3). There may be different forms of creativity expressed in different areas of endevour (OECD, 2010).

- *Artistic creativity* involves imagination and generation of original ideas
- *Scientific creativity* involves experimentation and finding new ways of problem solving
- *Economic creativity* on the otherhand involves innovations in various fiels which are relatted to fostering competetive advantage of regions and societies.

From a socio-economic development view point, the relationship between creativy and development is usually expressed under the concept of "creative capital" which is the outcome of *four other forms of capital* that determine the economic development process. These are *human, social, cultural and institutional capital*. These four forms of capital also constitute the framework for the creativity index referred to as the 5C model.

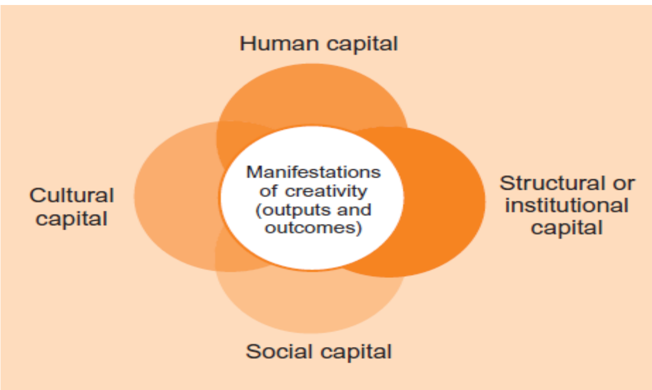


Figure 2. Interplay of four forms of Capital: 5Cs: Creativy +4Capitals(OECD, 2010: 4)

Creative economy, is the main concept that links creativity to the development *of regions and societies.*It can be defined in reference to the following features (UNCTAD, 2010).

- Creative economy offers a *multidisciplinary* model to the development strategy of societies as it embraces economic, cultural, technological and institutional aspects of societies.
- Its multidisciplinary natüre focus on the networking and interactive actions of regional actors to foster innovations and hence economic growth
- It involves mainly knowledge based activities with innovation and development dimentions
- It offers multidisciplinary policy strategies for economic growth and development

World exports of *creative gooods and services* have been increasing significantly and they have reached reached $592 billion in 2008 with an annual growth rate of 14 per cent since 2002. On the other hand about 30 per cent of the total workforce in the world are employed in the creative industries. Hence the *creative industries* lie at the heart of creative economy.

3.1.Creative Industries

Creative industries comprise various knowledge-based activities producing both goos and services ranging from arts and crafts, publishing, music, and visual and performing arts to more technology-intensive and services-oriented groups of activities such as film, television and radio broadcasting, new media and design.

Different models have been developed inorder to classify creative industries. The most popular model is the UNCTAD classifying model and this model comprises the following industries as creative industries:

- *Visual arts* : painting, sculpture, photography and antiques;
- *Performing arts*: live music, theatre, dance, opera, circus
- *Media*: publishing and printing media and audiovisuals
- *Design* : ınterior , graphic, fashion and jewellery, toys;
- *New media* : Software, videogames
- *Creative Services:* architecutral, advertising, recreational, R&D and digital and other services
- *Traditional and Cultural expressions:* art crafts, festivals and celebrations and archaeological sites, museums, libraries

The increasing share of creative industries can be seen through the increasing flow of creative goods and services World wide. The below table 2 shows thatthe value of world exports of creative-industry goods and services reached $592 billion in 2008, from $267 billion in 2002 whichb accounts for an annual growth rate of 14%. Exports of creative services increased by 17 per cent annually, rising from $62 billion in 2002 to $185 billion in 2008. On the other hand the share of *developing countries* in world export of creative goods and services have been increasing; in 2002 exports from these countries accounted for 37% of total World exports while in 2008 this share increased to 43% (UNCTAD, 2008 and 2010). On the otherhand the breakdown of exports of goods by sectors, *design sector* wth a shre of 59%, has the highest share in World exports in 2008.

3.2. Creative Cities: 3 T Factors Talent, Tolerace Technology

Creative economy also applies to the concept of "creative cities". The arts and cultural heritage, media and entertainment industries the concentration of creative industires and of the "creative class" makes cities as domians of creative economy. The "creative class"concept which has been introduced by R. Florida (Florida 2002) focuses on the creative role of people in the creativity age. Florida defines this group as those engaged in science, engineering, technology, entrepreneurship, arts, culture, music, entertainment, and the knowledge-based professions of law, finance and health care (Florida and Tinagli, 2004).The cities that gain competetive advantage in the global World and experience high growth and development are those that have the conditions/factors to attract the creative class. From a policymaking perspective the three factors that contribute to enhancement of cretive class and creative cities are *talent, tolerance and technology*- 3T factors (Florida, 2002).

- *Talent* refers to the availabilty of human capitalin a city.
- *Technology* refers to the technological infrastructure and the extent of R&D expenditures.
- *Tolerance* on the other hand refers to political stability, existance of law, atolerant socio-cultural environment; availabilty of public services which may be measured by the diversified *arts and cultural fabric* of the city.

*"The Creative City concept argues that Cities have one crucial resource – their people. Human cleverness, desires, motivations, imagination and creativity are replacing location, natural resources and market access as urban resources" (OECD, 2010, p: 13).*About 60 cities World wide called themselves as "creative cities" and amoung the outstanding ones : Manchester, Toronto, Cincinnati, Washington, London, Montreal and Paris may be cited.

4. Izmir on the Road to Becoming a Creative City

Izmir is one of the most important metropoles in Turkey after Istanbul and Ankara..Being the third province with the greatest contribution to Turkey GDP with its GDP capacity of 13.383 million TL according to 2001 current prices, following Istanbul and Ankara. Regarding GDP per capita on the other hand, it is the sixth ranking province in Turkey with a value of 3,215 $ (3,894 TL. (İZKA, 2012). Other features of the city which may contribute to its creative economy potential are:

- It is the second largest commercial center in Turkey
- Contributes 9.3 % of Turkey's total industrial production
- Has 10% of the total business and 9.7 of the total employment in Turkey
- Very high tourismpotentialwithith its geographical position, infrastructure, natural, cultural, archaeological values
- Has 4.1 % of total imports and 6 % of the total export of Turkey
- Foreign direct investment in Izmir increased by 10 times between 2004 and 2007.
- Has More than 4,000 export companies; exports increased by 40% during 2007-2010

Inorder to understand the potentials and dynamics of izmir City relating to the creative economy , below we identfy the inventory of the 3T factors of talent, technology and tolerance in Izmir.

4.1. Talent and Izmir[54]

The driving force behind innovation and hence a creative economy is human capital, which relies onbroad education as well as on the development of wide ranging skills for the work force . Universities, colleges and vocational training centres are essential nodes which produce and attract the human capital needed for innovation.

The below table shows the percentage of population over 15 having higher education Acordingy Izmir with a %10.77 rato, ranks the second after Ankara (%15.45) amoug the 81 cities in Turkey. Moreover this ratio for women with higher eduation is %9 in Izmir much higher than Turkey's avarage value of %6.2, and it ranks the second after Ankara.

[54] For a detailed study on creativity and Izmir see, Kumral, N., (2010),

Table 1: Percentage of People and Women having higher education (İZKA, 2009a)

	% of people with higher education to total population over 15 years	**% of women with higher education to total population over 15 years**
Ankara	15.45	13.12
Izmir	10.77	9.29
Istanbul	10.59	9.22
Turkey avarage	7.9	6.2

4.2. Technology and Izmir

Technology and innovation are critical components of a communities ability to drive economic growth. Recently OECD has been trying to improve the measurement of technologcal improvement and innovation in its wider context (OECD, 2010) Some of the widely used indicators for the measurement of the tehnological and innovaitv endownment are; Expenditure on R&D, patent data and trade marks.

Izmir has the science and technology infrastructure and human capital with its seven universities and technology centers and is the second territory with the most concentrated industry in Turkey.

- R&D expenditure on city basis is not available in Turkey, however the percentage of firms that utilized public supports on R&D may also be an indicator of firms expenditures on R&D. The percentage of firms that utilized public R&D support in izmir is as low as *%0,58 for 2006 and %2,56 for 2008* (İZKA 2009b).

- The number of applications İzmir made to Turkish Patent Institute; trademar applications have increased by 86%, patent applicatons by 230%; utility model applications by 126% and industrial design applications by 35% as of year 2008 compared to year 2002 (IZKA, 2009)

- According to a study (URAK 2009)which calculated the competetiveness Index of cities in Turkey, İzmir stands as the third competetive province in Turkey with a competiteviness value of 43.20. (The relevant index for Istanbul and Ankara are 83.5 and 48.20 respectivelly). However , in the same study, accoring to the the *trade marks and innovative capacity* indicator, Izmir ranks 11th amoung the 81 provinces in Turkey. The first three provinces are Istanbul, Ankara and Bursa.

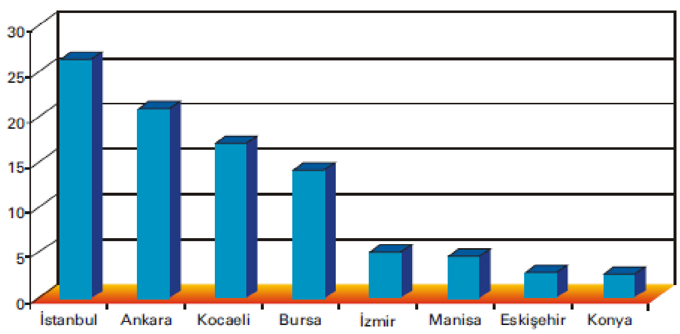


Figure 3: Provinces receiving the highest R&D Grants (IZKA, 2009a)

Despite being a province with high science and technology infrastructure and open to innovation, Izmir is not benefiting enough from financial grants provided for R&D. As the Figure shows, with regards R&D grants provided by TUBITAK and Undersecretariat of Foreign Trade, Izmir comes at fifth rank.

4.3. Tolerance and Izmir

At the core of creative city there are *three domains*: the arts and heritage culture; media and entertainment industries and creative business and creative class. Cities that provide a tolerant and diverse atmosphere are the ones that attract and enhance creative class. In other words , the cities that provide a *diverse, tolerant and broad mix of cultural experiences* are also the ones that are succeeding in the new economy (OECD, 2010: 13).

"Quality of life" is one of the indicators to evaluate the extent of tolerance in a city. A composite index value to measure the quality of life has been computed for varous cities in Turkey. The indicors used in the ine are: professors and university staff per person, number of people with a university or masters degree, doctors per person, cars per person, hospital beds per person, urbanizaton ratio, number of five star hotels, electricity consumption Izmir ranks the forth after Ankara, Istanbul and Eskişehir with the highest quality of life index values. (URAK 2009) . A nother index value which is composed of indicators such as; .number of telephones per person, public sector investments in trasansportation and communication, internet use and vehicles per person, İzmir ranks the second (index value 78.4) after İstanbul (URAK, 2009).

Interms of number of cinemas, theathers and museums Izmir ranks the third amung the 81 cities in Turkey Given these indicators Izmir is one of those cities in Turey wth the highest level of life quality. However some factors that adversly affects the quality of life in İzmir are; high inward immigration rate and Hgh population intensity. According to 2007-2007 cencus Izmir with 27 thousand immigrants, is the fourth city which receives highest inward immigrants after Antalya, Bursa and Ankara (İZKA, 2009a)

5. Izmir and The Design Sector : "Wedding Dress Cluster"

Design sector is the *third-largest creative subgroup* for developing countries, after art crafts and new media. Design deals with the creation of forms and appereances for products and is an important part of the creative economy given that it cuts across the artisan, manufacturing and services components of the value chain, interacting with technology and culture.

According to UNCTAD 2010 data*, Turkey* is included in *the top ten exporters* amoung the developing countries of creative industries of *Design Products and Visual art* . In terms of *design industry* Turkey's share in World exports is 1.6%, with an export volume of 3.5 billion dollars and growing at a rate of 11% during 2003-2008. As figure 4 shows, design sector has the largest share in terms of Turkey's creative goods exports in 2008.

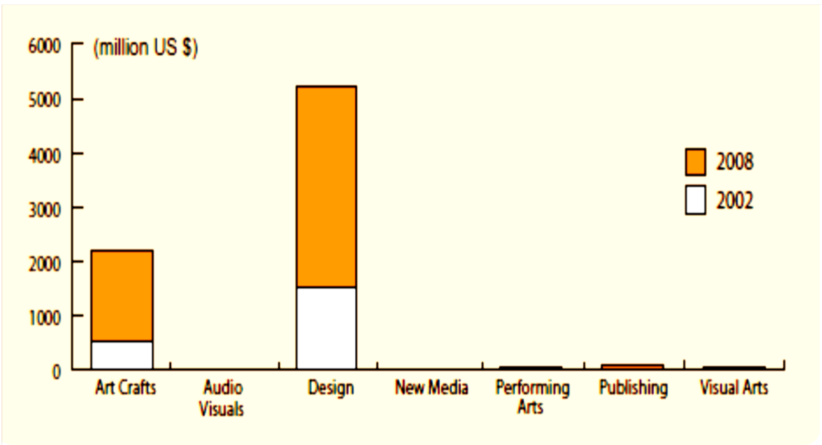


Figure 4. Creative Goods; exports by product groups 2002-2008 (UNCTAD, 2010

Design sector includes the following products: *Interior objects; jewellery, toys, fashion, glassware and original drawings for architectural plans.* Table 2 gives exports and imports data of some of the desşgn subsectors for Izmir and İstanbul for 2011. Izmir seems to be perfoming well in the exports of furniture and interior goods amoung other sub groups of the design sector

Table 2: Exports and Imports of Design Subsector in Izmir and in Istanbul 2011 (TUIK, 2009)

		İZMİR	İZMİR	İSTANBUL	İSTANBUL
ISIC	ISIC Name	Export (TL)	Imports (TL)	Exports TL	Imports
3694	Toys	885.887	22.384.480	33.496.491	402.575.016
3610	Furniture (interior goods)	114.318.667	23.044.751	513.688.096	627.982.916
3691	Jewellery	18.683.622	11.386.799	2.219.813.333	555.967.001
2610	Glassware	11.646.630	52.746.102	1.261.957.312	718.640.093
1912	Bags and accesories	3.131.246	8.170.321	195.532.090	373.702.241
1911	Leather goods	11.634.215	37.082.380	118.018.675	208.581.126
2424	Parfumes and cosmetics	32.974.400	30.046.191	1.220.140.341	1.426.201.794
7421	Original designs of architecture	0	37.084	44.543	332.256

Within the "creative city" context, the crucial resource of cities is their people, as they change their creative ideas into *economic values*. It is commoly accepted that the impact of creative people on the development of the creative industries is likely to be optimized through cooperation within *a cluster strategy* (UNCTAD, 2010) . Clustering strategey has recenty become one of the main tools in fostering innovation and hence competetive advantage of regions and nations .

Accordingly, Izmir development Agency (IZKA), as one of the pilot development agencies in Turkey, within the context of the 2009-2013 Izmir Development Plan, has been conducting a project on "Development of Clustering Strategy for Izmir" since 2009. To this end, varius anaysis and road maps were carried out inorder to develop clustering in key sectors in the province. According to a recent study carried out by İZKA, (İZKA 2010a)*design* sector together with other five sectors have been identified as having high potentials for cluster formation in the city. The six sectors are as follows:

- Motor vehicles
- Industrial Ventilation and Air
- *Design Sector : Wedding dress and accessories*
- Chemisty
- Processed Food
- Lojistics

Accurate data for the fashion an textile sector in izmir is not available, and yet fashion industry and especially the *weddign dress and accessories sector* deserves special attention given its potential as an innovataive custer as well as its trade potential for the city. Ready wear and fur industry constitutes 7% of total employment, 2.5% of exports in Izmir and more than 3,000 firms are active in the sector (İZKA, 2010). The wedding dress sector, constitutes one of the sub sectors in the design sector which is the fastest growing creative industry world wide. Izmir is increasingly becoming the most important center for wedding dress production and marketing in Turkey. Nearly 1000 firms are active in this sector. The outcomes of the study can be summarized as follows:

- The sector is succesful in terms *of domestic marketing and production, human resources, financial resources and knowledge and experience*.
- The sector has been found insuffient in terms of foreign marketing and sales and design varieties.
- The interfirm network relations are at a medium level
- Clustering capacity and organizaitonal capabilities are inadequate

- The wedding and fashion fairs such as IF WEDDİNG, have contributed to the organizaiton capacities
 and network formation of this sector.

The reports suggests that programmes aimed at building institutional capacity in the form of enhancing networking and collaboration amoung the main actors and improving international connections are necessary to foster cluster formation in the wedding dress sector. *Main actors* in the wedding cluster in Izmir are identified as: İZFAS, İZKA, Izmir Chamber of Commerce, Aegean Chamber of Industry, Aegean Association of Ready Wear, various firms in the sector, Fine Arts Faculty, Fashion and design Departments of Dokuz Eylül University and Izmir University of Economics and other supporting industries such as producers of fabrics, tulle, lance and free lance designers and suppliers of accesories.

6. Conclusion

The vision of Izmir city is to become a World Metropole, by securing sustainable development with an international reputation. In this endevour its core values are participation, innovation, reliability and protecting its natural, cultural and human riches. Given this mission and the potentials of the city, the new paradigm of development which focuses on creativity and creative economies as main movers of innovation constitute a viable agenda for Izmir City and its people.

This study underscores some of the basic factors – 3T factors- about Izmir's potentials of becoming a creative city. I is one of the most dynamic metropoles in Turkey with an advanced science and technology infrastructure, human capital endownment and with its broad mix of cultural heritages, Izmir has a reputation for its tolerant socio- cultural atmosphere. Besides these strenghts, right mix of policies are essential to enhance the potentials of the creative economy in Izmir .Some points that deserve consideration are: human capital lies at the heart of a creative economy and this calls for high quality education and developing diverse skills; fundamental R&D that feeds future innovation is mainly funded by the government hence more and better access to publicR&D grants shoud be secured; higher and better access to modern ICT Technologies is also an important determinant of fostering the technology basis of the region (OECD, 2010a and 2010b)

In recent years, *the cluster approach* is seen as an important national and international competitiveness tool which enhances innovative and creative capacities of regions. Clustering is defined as a combination of enterprises, which are operating in the same line of business, in the same value chain, collaborating and at the same time competing with each other, and various public and private institutions supporting them (Porter, 1990).

In this study we emphasize the possible contributionsof design sector and particuary that of the *wedding dress clustering* to enhancing the creative capacity of Izmir. Although IZKA report emphasizes the *wedding dress cluster* formation in Izmir we may expand the idea and instead of a *wedding dress cluster* we suggest a "*creative*wedding sector clustering" in Izmir. Following suggestings are worth mentioning:

- A "creative *wedding sector cluster*" would involve not only the *producers and designers of wedding dresses* and accesories but designers of coctail and evening dresses;, organizations and organizers of wedding and similar ceremonies and designers of jewelleries .
- *Fashion industry* owing to its wide range of products including perfume, jewellery and accessories such as scarves, purses and belts should also be integrated as a supporting industry to a "wedding sector cluster". Original ethnic textiles, combined with the diversity of works by fashion designers may increase the export potential of the wedding cluster and its connectivity to the World
- Cultural diversity, free trade and free expression and -flow of new people, new ideas and new products are necessary for a cluster to be creative. Hence governments must put in place policies to support new and innovative entrepreneurial efforts and new samill and medium sized enterprizes
- A "creative wedding sector cluster"needs more than business, it should integrate business with arts, education, culture and tourism. In this regard forinstance, tourism sector may be a nother supporting sector of the wedding cluster, through organizaitons of honeymoon and similar occasions

Policy strategies aimed at fostering the development of creative economy should also recognize the multidimentional nature of this process - besides the economic needs, special demands of the local communitiesrelated to education, cultural identity, social inequalities and environmental issues should be taken into consideration.

References:

Amin A. and N. Thrift (1995) *Globalizaiton Institutions and regional Development inEurope*, Oxford University Press, London

Balassa B. (1983) Outward Orientation and Exchange rate Policy in Develooing Countries: The Turkish Experience, *The Middle East Journal* vol. 37, no. 3

European Commission, 1995, *Green Paper on Innovation*, December.

Findley R. (1991) The new Political Economy: Its Explanatory Power for LDC's, inMEIER G.M (Ed.) *Politics and Policy Making in Developing Countries,* California, ICS Press

Florida, R. (2002), *The Rise of the Creative Class, Basic Books*, New York, London.

Florida, R. , Tinagli, I. (2004), *Europe in the Creative Age*, Carneige Hall Software Industry Centre, DEMOS

İzmir Kalkınma Ajansı –İZKA- (2009), *İzmir Situationa Analysis,* İZKA yayını, İzmir**.**

İZKA (2009b), *İzmir İli ve İlçelerinin Kümeleme Stratejilerini Geliştirmeye Yönelik İstatistiksel Analiz Çalışması Sonuç Raporu* , İZKA yayını, İzmir

İZKA (2010 a). *İzmir Kümeleneme Stratejisinin Geliştirilmesine Yönelik Araştırmalar: Sonuç Raporu*, İzmir.

İZKA (2010 b). http://www.investinizmir.com/rising-star-izmir/economy-in-zmir.html, 12,07.2012

İZKA, (2012*) Sayılarla İzmir*, http://www.izka.org.tr/files/sayilarlaturkiyeizmir_ocak.pdf, 13.07.2012

Kooiman J. (1994) Social Political Governance: Intruction', in Kooiman J. (ed), *Modern Governance,* Sage Publication, Lonfon

Krueger A. (1978) Foreign *Trade Regimes and Economic Development, Liberalization Attempts and Consequences,* Vol X, NBER, NewYork Kumral, N. (2011) *Kalkınma Ajansları ve Yaratıcı Bölgeler*,

Kumral N. (2010) Yaratıcılık ve İzmir Üzerine, *EGE University Working Papers in Economics*, No: 10/01

Morgan K. (1997) 'The Learning region: Institutions, Innovation and Regional Renewal',*Regional Studies*, Vol. 31.

OECD, (2008). Annual Development Conference, 3-4 , April 2008, St. Vincent and the Grenadines.

OECD, (2010a) *The OECD Innovation Strategy* 2010, OECD Publication

OECD, (2010b) *Measuring Innovation, A New Perspective*, OECD Publication

Porter, M. E., (1990). *The competitive advantage of nations,* The Free Press, New York

Romer, P.M. (1990) Endogenous Technological Change, *Journal of Political Economy***,**98, pp: 71-102

Storper M. (1995) 'The Resurgance of Regional Economics, ten years later: the region as a nexus of untraded interdependencies', *European Urban and Regional Studies,* Vol 2.

Türkiye İstatistik Kurumu (2009), *Bölgesel İzleme Göstergeleri TR31 İzmir 2008*, TUİK, EBSO, İTO, İzmir

UNCTAD, (2010). *Creative Economy Report 2010*, UN Publicaitons, NY

UNCTAD, (2008). *Creative Economy Report 2008*, UN Publicaitons, NY

URAK 2009-2010 *İller Arası Rekabetçilik Endeksleri*, http://www.urak.org/haberler/URAK_IllerarasiRekabetcilikendeksi2009-2010.pdf, 10.06.2012

Retail stockouts: An examination of the extents and causes in a Brazilian retail chain

Fernando Aguiar; Mauro Sampaio[55]

Abstract

The purpose of this paper is to identify the extents and causes of stockout of a high turnover item from a large retailer in Brazil. A case study was conducted. The data were obtained from a sales and inventory database of a Brazilian retail chain. Multiple regression and cluster analysis were used to analyze data and test hypotheses. It was identified an average annual stockout rate of 11.5% for the product. The regression analysis were able to explain 56.9% (adjusted R^2) of the variations which occur on an annual stockout rate of the stores through five variables, and cluster analysis confirmed the existence of three groups of hypermarkets.

Keywords: *Stockouts, retail, stock, logistics, cluster analysis, regression analysis*.

1. Introduction

The theme of stockouts is becoming more and more recognized as a critical problem to retail (Corsten, Gruen, 2003; Grant, Fernie, 2008, Eroglu, Williams, Waller. 2011). In this study, stockout is defined as an event in which a retailer has demand for a certain item but that item is not available for sale. The first study concerning stockouts was performed by Peckham (1963), who reported stockout rates of 8.5 %. More recent studies (Corsten, Gruen, 2003. Eroglu, Williams, Waller. 2011) point to a world stockout rate of about 8.3 %. The rate reported by Peckham (1963) is similar to that of Corsten and Gruen (2003). In spite of all efforts to improve the level of logistic services in the past 60 years, the stockout rate remains high.

In that time, most publications in this field focused on two main questions. The first one aimed to identify the causes of stockouts and the second one intended to investigate the behavior of consumers when facing stockouts. It can be said that the literature is rich in studies about the second question, since there are more than 1,000 articles published on the issue. As for the first question, there is a shortage of assessments about the causes of stockouts, since only 19 articles were found to deal with the matter in the past 60 years (Marqui, Alcântara, Christopher, 2010), which indicates there is room for further studies.

The problems generated by stockout go beyond the loss of sales. Several hidden costs emerge: customers may not go back to the store or try out products from competitors and advertise might not be effective. Under the perspective of the supply chain, stockouts may distort forecasts, and mistakes may result in income losses and/ or exaggerated and unnecessary investments in stocks.

Both retailers and manufacturers would like to identify and map the causes of stockouts in their supply chains, if these are reduced, the retailer's income may increase in up to five per cent (Corsten, Gruen, Bharadwaj, 2002). In spite of the importance of the matter, until now few studies have been dedicated to stockouts in developing countries such as Brazil.

The aim of this study was to investigate the stockout levels of an item of high inventory turnover in an important Brazilian retailer and to identify its possible causes. Retailers normally have difficulty identifying the causes of stockouts and even how to measure them. They have the information in their databases, but they exploit them little as sources of information for improving their processes.

[55] FEI University, Brazil, msampaio@fei.edu.br

In short, this study intends to answer the following questions: What is the level of stockout of an item with high inventory turnover in a large retailer in the Brazilian market? Which factors may be related to the stockout rate of an item with high inventory turnover in a hypermarket chain?

In order to reach the goals of this study, it was structured in five sections, including this introduction. The second section reviews the literature on stockouts. Section three reports on the methodology used. The fourth section presents the results, while the last section presents the conclusions of the study.

2. Literature Review

The first work to investigate stockouts was Peckham's (1963), which warned retailers and manufacturers about the potential losses resulting from lack of products on the shelves, however, it was related to consumer's behavior facing the lack of a product.

Publications on this topic have focused on one of two broader issues. The first issue was the measurement of the stockout levels in retail stores (the focus of this work), and the second one has focused on consumer's behavior when facing stockouts.

The literature on stockouts, with emphasis on its causes, is shown in table1, after an extensive study of publications in the EBSCO and Proquest databases.

Stockouts are caused by inefficient practices in stores, retailer distribution centers, retailer main offices or supplier operations. According to Marqui, Alcântara and Christopher (2010), it is possible to segment the causes of stockouts in retailers into three large groups:

- Planning problems
- Order processing problems, and
- Replacement problems

In Brazil, one of the few known studies on stockouts was carried out by the Retail Services Division of ACNielsen Brasil in July 2004. The study analyzed the main causes, as well as consumer's attitudes when they do not find the product on the shelf. They studied 528 SKUs (Stock Keeping Units) in 587 self-service stores 5 or more check-outs, the result was an inventory unavailability rate of 8.0%. The study also concluded that the causes of stockouts are in several points along the supply chain, but the main opportunities for improvement were found between the Distribution Center and the retailer's shelves. Nonetheless, as the sample was restricted to hypermarkets in São Paulo and Rio de Janeiro, it was not possible to perform statistical generalizations.

Vasconcellos and Sampaio's (2009) study, however, conducted directly with retail store managers states the opposite. Suppliers were mentioned as the ones mainly responsible for stockouts.

Table 1 lists the variables identified in the literature which influenced the stockout, but not all of them may be investigated through a database as per the proposal in this study. The specific variables selected for investigation in this study are stated in the next section.

		Authors / Factors identified in academic articles	1- Emmelhainz et al., 1991	2 - Chaouch, 2001	3 - Corsten and Gruen, 2002	4 - Corsten and Gruen, 2003	5 - Kaipia and Tanskanen, 2003	6 - Gimenéz and Ventura, 2003	7 - Kucuk, 2004	8 - Pibernik, 2006	9 - Van Woensel et al., 2007	10 - Grant and Fernie, 2008	11 - Hardgrave et al., 2008	12 - Pramatari and Miliotis, 2008	13 - Waller et al., 2008	14 - Morgan and Dewhurst, 2008	15 – Grant and Fernie, 2009	16 - Khalid, 2008	17 - Aastrup and Kotzab, 2009	18 - Pramatari et al., 2009	19 - Pero et al., 2010
Planning	1	Misalignment between the capacity of meeting demand and frequency of replacement	√		√	√		√		√		√		√	√	√		√			√
Planning	2	Frequency of product purchase		√		√				√		√		√	√	√					√
Planning	3	There is no specific management model for the mitigation of waste of perishable products									√										
Planning	4	High number of SKUs in the assortment				√			√												
Planning	5	Item exclusions made by the store team				√			√		√										
Planning	6	Planogram planning and allocation				√									√		√				
Planning	7	Store layout				√												√			
Planning	8	New items in the store's assortment				√															
Planning	9	Imprecise data and information	√			√					√							√			
Planning	10	Promotions and price decisions				√												√			
Planning	11	Advertising				√			√								√				
Order generation	1	Imprecise data on sales history		√		√	√					√	√	√						√	
Order generation	2	Sales forecasts with low accuracy and long cycles				√	√			√		√	√	√				√		√	
Order generation	3	Products Not ordered, with delayed orders, and wrongly ordered				√	√			√		√	√	√					√	√	√
Order generation	4	Employee's experience in case of manual orders				√	√			√	√	√	√	√				√		√	

Table 1: authors and variables identified in the literature

Replacement cycle	1	Number of employees (insufficient or badly trained)		√	√							
	2	Congested storage area	√	√				√			√	
	3	Errors in material receipt		√								√
	4	Absence of replacement procedures (clear and defined)		√	√							√
	5	Clear definition of the time of the first and last replacement to be carried out daily					√					
	6	Planogram (badly executed and managed)		√		√		√	√	√		
	7	Losses or thefts		√								

Source: the author

3. Methodology

As the objective of this study was to investigate stockout levels of a high turnover item of an important retailer in the Brazilian market and to identify its possible causes, a phenomenon the researcher has no control over , the methodology suggested by several authors (Eisenhardt, 1989; Yin, 2003; Cauchick Miguel et al., 2012) is case study. The knowledge available on the phenomenon is scarce.

Thus, according to Yin's (2003) parameter, this study is a unique case, incorporated and of the explanatory type due to the limited access of the researcher to restricted information of an important retailer in the market.

The data in this study were obtained from a sales and inventory database of a Brazilian retail chain. The chain has 113 stores throughout the Brazilian territory (hypermarkets) and 10 distribution centers (DC). The product selected for the study was the beer Skol in a 350 ml can.

There are three basic justifications to support the choice of this retail store and the product Skol for the study. The first one concerns the increase of concentration in the Brazilian market. Therefore, a survey carried out with data on one of the largest retail chains allows a larger generalization of results than in a concentrated study in a smaller retail chain with few stores.

Secondly, the product selected, the 350 ml beer can, the main product of the brand and market leader in sales in Brazil since 1999, is considered the fourth best selling beer in the world. That is a high inventory turnover product of strategic importance not only for the maker but also for the retailer, whose preoccupation in avoiding stockouts must be critical in their distribution strategies.

Thirdly, the lack of studies carried out in developing countries like Brazil. Consequently, this study offers an opportunity to compare results in Brazil with those obtained in other places in the world. In general, the results found were different from those in studies carried out in other parts of the world, namely in Europe and the USA. The investigation also contributes to identifying the strengths and weaknesses of the distribution centers of the retailer investigated.

The main sources of data for this study are those in the points of sale (POS) of the beer Skol during the year of 2009, as well as inventory data from a large Brazilian retailer. The main data collected were: sales history, prices and daily stock level, log containing the logistic variables used by the stores and the DCs, registry of suppliers and their delivery addresses, promotions calendar, addresses of the stores and of the DCs, list of the main competitors of each store, as well as a demographic survey of each store's clients incomes.

Several consistency verifications were performed, such as: sales graphs and individual inventories of all stores and DCs analysis, as shown in figure 1 for the store with the lowest stockout rate and in figure 2 for the store with the worst stockout rate.

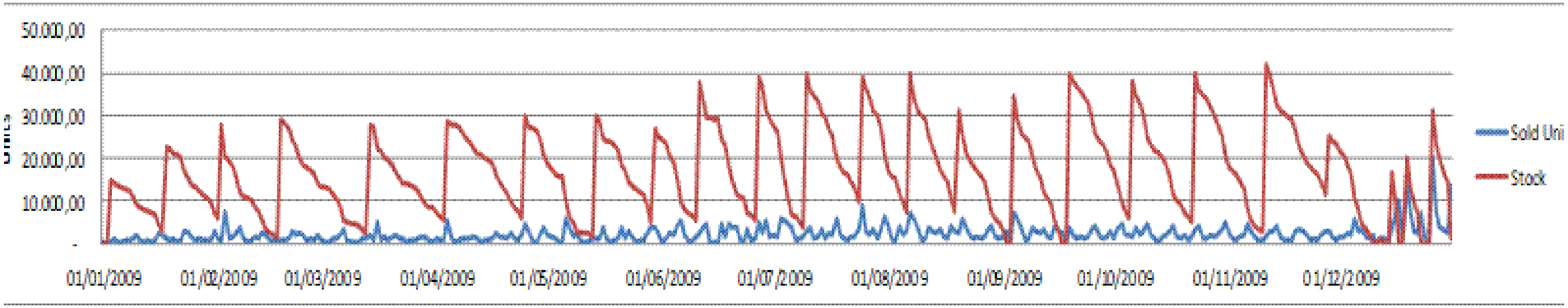


Figure 1 – Graph containing the daily evolution of sales and inventory for the store with the lowest stockout rate of 2.2% per year in Manaus

Source: the author

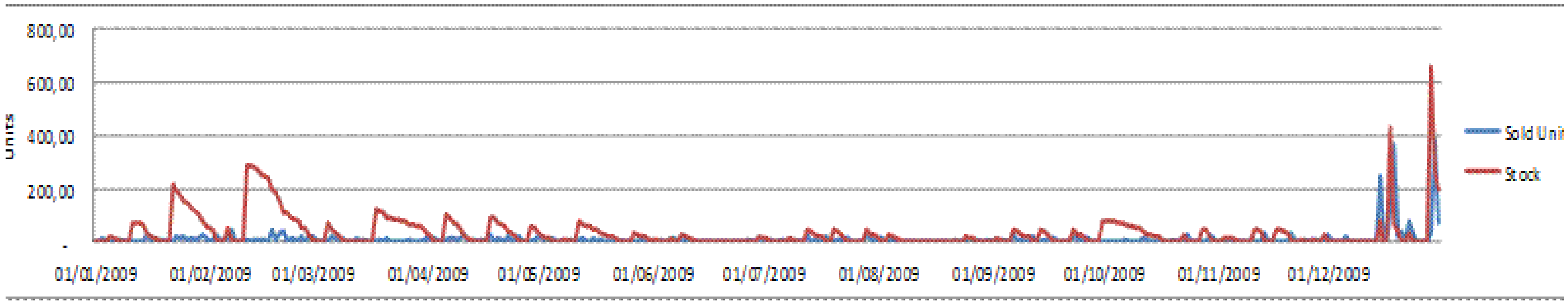


Figure 2 - Graph containing the daily evolution of sales and inventory for the store with the highest stockout rate of 26.3% per year in Rio de Janeiro

Source: the author

For the result of the survey, a database with reliable sales, inventory and price indicators was used, along with other information for the 113 stores and 2 DCs directly involved in the distribution of the beer Skol.

Annual stockout rate measurement

The literature has several traditional forms of measurement of the stockout phenomenon: audit of the physical inventory, analysis of point of sales data, interviews with consumers, as well as information on the suppliers.

There are advantages and disadvantages in each of these forms of measurement: the audit is a reliable measurement method. However, it is expensive and consumes the scarce resources of the organization. The measurement of the inventory levels in the stores is easily accessed through information systems. The problem is that there is a percentage of inconsistencies. Normally, there is a difference between the real physical stock and that found in the system (Fisher, 1997). The information from the consumer is interesting, but it is not reliable, since it depends on the cashier's commitment to systematically ask the consumers questions. Besides, there is also the possibility that the consumer's perception is incorrect. The information provided by the suppliers is reliable, but only a small quantity of items (SKUs) in a supermarket has restockers paid by the manufacturers. The measurement used in this work was derived from the literature: analysis of the point of sale data. The analysis of the inventory data shows the low stock. For example, when the stock level for an item (SKU) in a store is zero, it almost always implies a stockout situation. Nevertheless, according to Khalid (2008), the inventory data in the system are not an exact reflection of what is actually on the shelves due to reasons such as:

• The item is available in the storage area, but it is not being supplied to the shelves.

• Loss (theft or damage) of the item which may cause a discrepancy between data in the system and the actual availability of items.

• Harmful retail practices, especially due to incorrect sale logging for similar items.

For a minimization of these problems, there was a reduction of 5% of the average stock in the inventory volume in the stores with the objective of correcting discrepancies existing between systemic stock and the actual one. The 5% is an average systemic error rate used by the market and has been validated at the retailer being studied in the case of beer.

In spite of the problems identified, the analysis of the point of sale is still a reasonable estimate of the level of stockout of the store (Khalid, 2008). Though not exact, it is close to the actual value. This procedure is adopted by traditional market research companies, such as ACNielsen (2004).

For the purposes of this analysis, the day when there was no sale and there was no stock available in the store's inventory was considered stockout, which is similar to the criterion adopted by Khalid (2008), as per Figure 3.

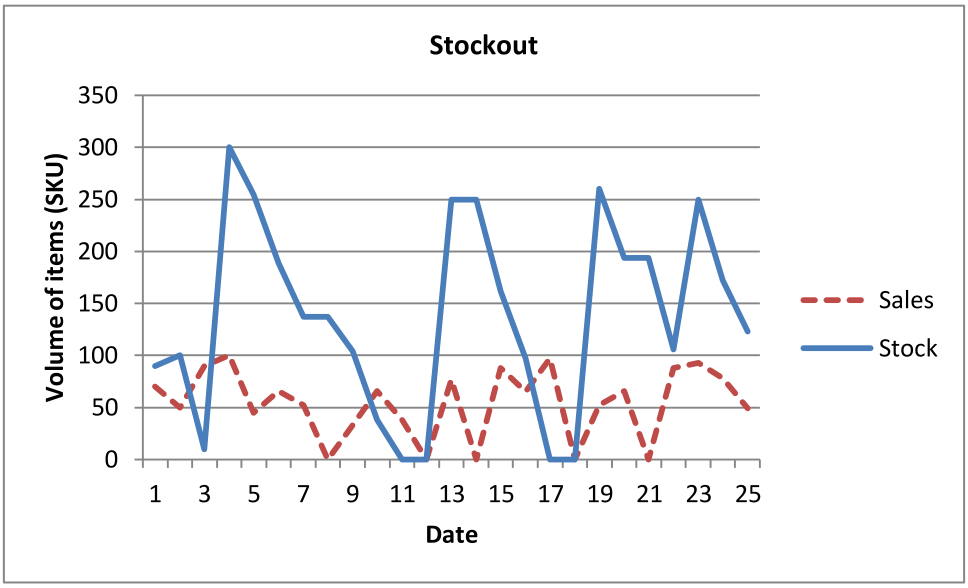


Figure 3 – Stockout illustrative model

Source: Adapted from Khalid (2008)

According to Figure 3, the dates when there was simultaneously zero stock and lack of logging of a sale were considered stockout, that is, days 12 and 18. In spite of understanding that the stock may be present in the back office area and not at the point of sale, generating a stockout, unfortunately, the technique of point of sale stockout cannot identify this situation. Due to this, it can be said that the point of sale data analysis technique is an estimate of the stockout rate of the store, but it is not 100% reliable. Performing an audit together with the data analysis of the point of sale would be ideal, but the company studied does not have this routine structured for the product analyzed or even for other products, making the analysis impossible. That is a limitation of the study which makes the current analysis impossible, stimulating further studies in this area of interest.

MEASUREMENT OF THE VARİABLES WHİCH İNFLUENCE THE STOCKOUT RATE

Some variables were selected for investigation. Two criteria were established for the choice of variables in this study: (1) variables mentioned before in the literature and (2) variables which can be measured by means of indicators coming from a database. Similar criteria were used before by Khalid (2008). The variables of interest were grouped into three categories: (1) supplier's characteristics; (2) characteristics of the replacement cycle, and (3) market features. Each of these characteristics will be discussed separately. Literature sources are presented in Table 2, while the items of the real scale used in the study are presented in Table 3.

Table 2 - Variables predicting stockouts

Supplier's characteristics	
• Long replacement lead time	Corsten e Gruen, 2003, Khalid 2008.
• Replacement frequency	Corsten e Gruen, 2003, Khalid 2008.
Characteristics of the replacement cycle	
• Frequency of product purchase	Corsten e Gruen, 2003.
• Level of stock on hand	Khalid, 2008.
Market features	
• Sales volume	Khalid, 2008.
• Promotions and price decisions	Corsten e Gruen, 2003.
• Competitive intensity	Khalid, 2008.

Source: the author

Type of delivery: The supplier has two delivery alternatives: either they deliver to a Central DC and the retailer delivers the products to the stores, or they deliver them directly to the store. In the case studied, Skol beer is delivered in São Paulo's and Rio Grande do Sul's DCs and sent to 20 % and 10 % of the retailer's stores respectively. The rest of the deliveries, 70 %, are performed by the supplier, from DCs or factories, directly to the retailer's stores.

Distance between the deliverer and the store: the distance between the deliverer and the store can also influence the store's stockout rate. The deliverer may be a DC or the supplier.

Quantity of deliveries: The delivery frequency per day of the week may influence the stockout rate. As the greatest demand happens on weekends, it is expected that deliveries at the beginning of the week cause stockouts faster than the stores can replace their stocks near the weekend.

Quantity of annual replacements: The frequency of purchases of the item Skol beer was estimated in this study by means of an indicator of the number of annual replacements. There are stores which work with a weekly replacement standard and even stores which make replacements every two days.

Stock level: The stock levels were estimated using three indicators: average daily stock, inventory turnover and annual average replacement lot. All parameters of stock models may affect the stockout rate, but the inventory turnover is a more reliable assessment indicator of stock levels. It is defined as the number of times in a year that the inventory the company maintains is sold. The isolated parameters of average daily stock and average replacement lot size are limited since they do not take into consideration the store's sales levels, but they were tested anyway.

Sales volume: It was verified whether the sales volume affects the stockout rate. Larges stores, in terms of sales volumes, may be treated differently by their deliverers (DC or supplier) and affect the store's stockout.

Promotions and price decisions: Advertising has the mission of developing customer loyalty and of creating an environment in which the costumer feels comfortable and encouraged to make purchases. This environment may alter the consumer's behavior and encourage him or her to make purchases ahead of time and, consequently, cause stockouts. In developed countries, stockout rates at promotion times are twice as high as those in times of regular sales. In developing countries like Brazil, there is no data on the influence of promotions in stockout rates.

Competitive intensity: The competitive intensity was measured regarding the number of supermarkets and hypermarkets present in the area of influence of each of the 113 stores of the retailer studied. As the hypermarkets are larger, weighting with a higher weight for the hypermarket was considered (weight 3) compared to the supermarket (weight 1) in the region where the retailer's store is located. The existence of a store supply policy which gives preference to those stores which have a high number of competitors in the same area was verified.

Table 3 - Items used to measure independent variables

Supplier's characteristics
2.1Long replacement lead time
a. Form of delivery: External supplier or distribution center.
b. Distance between deliverer and the store.
2.2Replacement frequency
a. Quantity of deliveries on Mondays
b. Quantity of deliveries on Tuesdays.
c. Quantity of deliveries on Wednesdays.
d. Quantity of deliveries on Thursdays.
e. Quantity of deliveries on Fridays
f. Quantity of deliveries on Saturdays.
g. Quantity of deliveries on Sundays.
Characteristics of the replacement cycle.
1.1 Frequency of product purchase.
2.1.1 Quantity of annual replacement.
1.2 Stock level.
a. Average daily stock.
b. Inventory turnover.
c. Annual average replacement lot.
Market features
1.2.1 Sale volume.
a. Average daily sale.
1.2.2 Promotions and price decisions
a. Number of promotion days per year.
b. Average price.
1.2.3 Competitive intensity
a. Number of supermarkets near the store.
b. Number of hypermarkets near the store.

Source: the author

4. RESULTS

Regression analysis

As previously described, the independent variables selected were detailed in Table 3. To avoid problems with differences in measurement units of different variables, the data were standardized. To validate the results, both the method of adding forward integration and backward elimination, as well as the stepwise method were performed and similar results were obtained.

The final regression is shown in Table 4. The data indicate that five independent variables are significant for predicting the annual rate of store stockout. The independent variables were ranked in order of decreasing significance (t tests) with statistical error probability very close to zero (Sig).

Table 4 - Multiple regression report

Dependent variable: Annual stockout rate

Independent variable	Coefficient Standardized	T	Sig.
Number of promotion days per year	-0.445	-5.857	0.000
Inventory turnover	0.355	5.412	0.000
Distance between deliverer and the store	-0.320	-4.294	0.000
Type of supplier x1	0.326	3.733	0.000
Number of replacements on Wednesdays	0.158	2.432	0.017
Type of supplier x2	0.138	2.056	0.042

Variance analysis report

Variance analysis

	Sum of the squares	DF	Average^2
Regression	0.146	6	0.024
Residual	0.101	106	0.001
Total	0.247	112	

F = 25.627 Significance of F = 0.000

R^2 = 0.592

R^2 adjusted = 0.569

Standard error of the estimate = 0.031

Source: the author

The independent variables selected have no problems of multicollinearity (VIF <1, the tolerance index> 1, condition index <3 and variance proportion <1), so that each variable explains different portions of the variation in the stockout rate. The correlation matrix also indicated no incidence of multicollinearity. The analysis of residuals indicated: absence of serial autocorrelation (Durbin-Watson = 2.0) and the presence of a normal distribution (Komogorov-Smirnov). It has also been found that residues are homoscedastic, that is, the variance of the residuals is constant over the spectrum of variables. Together, these results corroborate the assumptions of regression and that the explained variations and the inference tests are valid.

In general, the model is significant. The F value of 25.627 exceeds the critical value of 2.96 for the type I error probability of 0.01. Consequently, the chance of the results being explained by chance is zero.

The final model can explain about 56.9% (R^2 adjusted) of the variations which occur in the stores' annual stockout rate, a relatively high coefficient of determination for an exploratory study.

The regression model resulting from the process was:

Stockout rate = -0.445 Number of promotions

+0,355 Inventory turnover

-0.320 Distance between deliverer and the store

+0.158 Number of replacements on Wednesdays

+0.326 Type of supplier x1

+0.138 Type of supplier x2

Based on the final regression model, one can draw the following conclusions:

- **Quantity of promotions:** The changes in the number of promotions per year are responsible for the most relevant explanations of the expected variations in stockout rate. Once it is realized that empirical verification does not confirm the impact of promotions, as found in similar international studies on stockout rate (Corsten and Gruen, 2003). This retailer increased the number of days of promotion in the year, reducing the rates instead of increasing stockout rates, since the coefficient of this variable is negative. This unexpected effect may be justified by the employee's focus/greater attention to retail and supplier replacements in cases of beer sales.

- **Inventory turnover:** The independent variable is also important to explain stockout rate in stores. Stores which have high stock turnover tend to have higher stockout rates. This effect can be explained by the increasing number of occurrences of stockouts over time.

- **Distance between deliverer and the store**: The variable distance between the deliverer (external supplier or DC) is a significant explanatory variable. If the distance between the store and the deliverer is longer, the store tends to have a lower stockout rate than a store closer to the deliverer. Greater distance represents more logistic challenges in restocking the store and the delivery people tend to be more helpful. This result was also unexpected, contrary to the results found in developed countries where the greater the distance, the greater the stockout rate (Khalid 2008). This can be explained by the employees' focus/greater attention to retail and supplier replacements in cases of more distant stores.

- **Number of replacements on Wednesdays:** The delivery day of the week at the store is usually not a variable used in practice to predict stockout rate in a store. But, even so, its influence was assessed in the model. The result indicated that deliveries on Wednesdays are related to a higher stockout rate. The lowest stockout rate coincides with deliveries on Sundays.

- **Type of supplier:** The supplier type, a variable which identifies if the supplier of the store is an outside vendor or the retailer's distribution center, is a significant explanatory variable. The result indicated that the stores that had internal supplier deliveries showed lower stockout rates.

Table 5 presents the hypotheses proposed and informs the results reached.

Hypotheses	Result	Conclusion
H1: The stores served by the DC possess a lower stockout rate than the stores supplied directly by the supplier	Yes: (Beta = 0.326, sig=0.000). Yes: (Beta = 0.138, sig=0.042).	Hypothesis supported
The stores that have closer delivery drivers (DC or supplier) have lower stockout rates than the more distant stores.	No: (Beta = -0.320,sig=0.000)	Significant hypothesis, but not supported.
H3: The frequency of delivery per day in a store affects stockout rates	Yes: (Beta=0.158, sig=0,017).	Hypothesis supported*
H4: The stores which have higher inventory turnover have greater stockout rates and risk	Yes: (Beta=0.355, sig=0.000).	Hypothesis supported
H6: The stores with lower sales volumes have higher stockout rates than stores with higher sales volume.	No: Not significant	Not significant
H6: The stores with lower sales volumes have higher stockout rates than stores with higher sales volume.	No: Not significant	Not significant
H7: Making promotions increases stockout rates in the stores	Yes: (Beta = -0.445, sig=0.000).	Hypothesis supported
H8: The stores which have higher number of competitors in their area have higher stockout rates..	No: Not significant	Not significant

*Wednesday is the day with the worst performance

Cluster analysis

Before starting the cluster analysis, an analysis of data from 113 stores for the five variables used in cluster analysis was performed in order to identify possible outliers (Fávero et al., 2009). For this, profile diagrams were generated using the data with standardized score Z, there were no outliers that needed to be excluded.

After assessing the presence of outliers, we performed a correlation analysis, as shown in Table 6, where it is possible to identify that each variable investigated has a low rate of correlation with the others, and may therefore be the basis for the application of cluster analysis. (Hair et al. 2009).

Table 6 – Results of Pearson's correlation

	inventory turnover	total annual stockout %	Distance between the deliverer and the store	Number of days of promotion per year	Number of replacements on Wednesdays
inventory	1	0.486	-0.037	-0.205	0.262

turnover					
Total annual stockout %	0.486	1	-0.446	-0.307	0.341
Distance between the deliverer and the store	-0.037	-0.446	1	-0.183	-0.128
Number of promotion days per year	-0.205	-0.307	-0.183	1	-0.069
Number of replacements on Wednesdays	0.262	0.341	-0.128	-0.069	1

Source: the author

Looking at Table 6, we can see that the variable which presents the highest values for Pearson's correlation is the inventory turnover with the annual inventory stockout rate, showing a correlation rate of 0.486, representing a low relationship between the variables.

Hierarchical Analysis

Before performing the analysis the data were standardized using the transformation z-scores according to the procedure suggested by Milligan and Cooper (1988).

To perform the hierarchical analysis, the squared Euclidean distance was selected as the similarity measure for it is the most commonly used measure of similarity between two objects (Hair et al., 2009).

According to Hair et al. (2009), for the validation of cluster solutions, it is important to apply clustering methods and compare the alternative solutions. We used two types of connections to define the number of clusters in the hierarchical method: Mean link (Between Groups) and Ward's method.

When performing a hierarchical analysis using mean links and Ward's method, it was found that although procedures have been used for grouping different hierarchical methods, both present the suggestion of forming three groups.

The results for the cluster number was consistent with Lehmann (1979), who reports the appropriate number of clusters should range from n/30 to n/60, n being the sample size. In this case, the interval between groups was 1.88 to 3.76, and it is possible to conclude that the number of three clusters corroborates with the literature.

Non-Hierarchical Analysis

The analysis of non-hierarchical K-means was carried out in Table 7. It can be seen that all variables have significant differences between groups (sig <0.05). You can also check that the most representative variable in differentiating the groups was the number of repayment to the 4th (F = 80.791) and inventory turnover (F = 58.098).

Table 7 – Final solution for the non-hierarchical K-means analysis

	Final cluster center			Mean Values			ANOVA					
	Cluster			Clusters								
Variables	1	2	3	1	2	3	Mean square of the cluster	df	Root mean square	df	F	Sig.
Inventory turnover	1.89891	-0.31404	0.43246	87.5	43.9	58.6	28.767	2	0.495	110	58.098	0.000
Distance between deliverer and the store	-0.31993	0.08479	-0.39524	269.1	657.6	196.8	1.695	2	0.987	110	1.717	0.018
Number of promotion days per year	-0.70866	0.07408	0.27459	104.8	149.6	161.1	3.853	2	0.948	110	4.064	0.020
% of annual stockout	1.38977	-0.25302	0.55085	18%	10%	14%	16.833	2	0.712	110	23.637	0.000
Number of replacements on Wednesdays	0.19950	-0.28152	2.55835	5.4	3.6	14.2	33.318	2	0.412	110	80.791	0.000
Cluster members	**13**	**91**	**9**									

Source: the author

In order to perform the interpretation of the groupings according Hair (2009) it is important to generate the profile of groups, as shown in Figure 4.

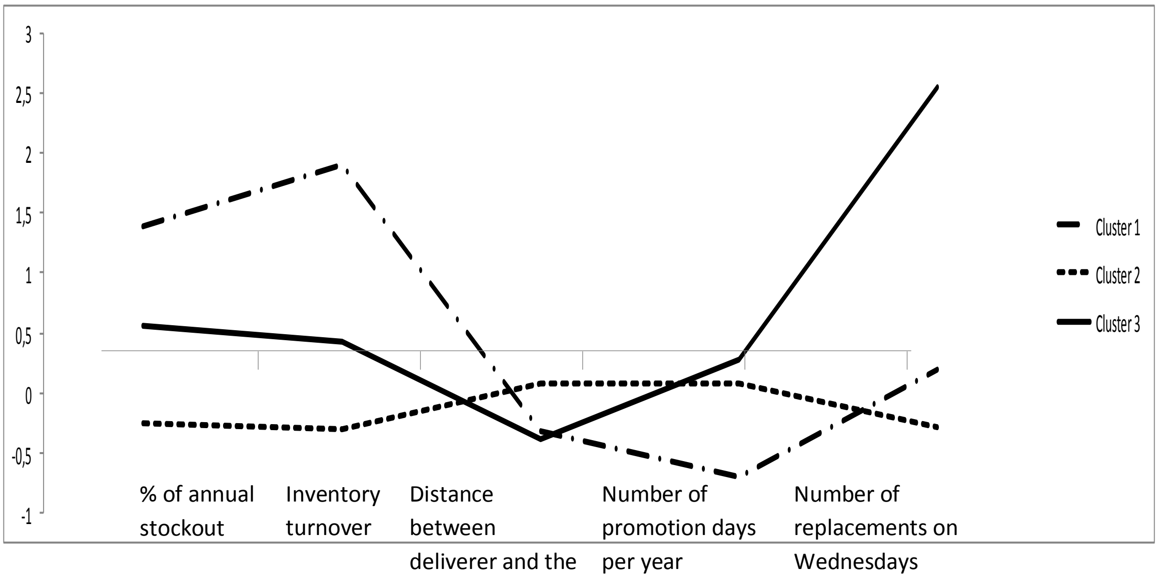


Figure 4 - Profile of clusters for the five variables with standardized z-scores values

Source: the author

The three groups formed considerable differences in the behavior of their variables, as can be seen in Figure 5.

- Cluster 1 can be called **"group of stores close to the deliverer with high inventory turnover rates and few promotions per year."** This group showed, as its main differentials when compared with the other groups, high inventory turnover, low number of promotions in the year and the worst performance of stockout rates with an average rate of 18%.

- Cluster 2 can be called **"cluster of stores far from the deliverer with low inventory turnover."** This cluster presented, as points of differentiation when compared with the other clusters, a large distance between the store and the deliverer (external or internal supplier), low inventory turnover, few inventory replacements on Wednesdays and a better average stockout rate of 10%.

- The third cluster can be called **"group of stores close to the deliverer with high rates of restocking on Wednesdays and high number of promotions per year".** This group showed intermediate results for inventory turnover rate and annual stockout rate. It comprised the stores which are closer to the deliverer (internal or external supplier) and stores that had the highest replacement rate on Wednesdays.

Analyzing Figure 4, one can see that the cluster which has the best performance (10% stockout rate) is the cluster 2, the "cluster of stores far from the deliverer and low inventory turnovers", and the one that shows the worst performance (18% of stockout) is cluster 1, "cluster of stores close to the deliverer, with a high inventory turnover and few promotions in the year."

This agglomeration has 13 stores and, apparently, the retailer and the supplier have a greater attention to the supply of more distant stores. Mainly the stores located in the state of Rio de Janeiro showed worse stockout results, as shown in Table 8.

Table 8: List of stores from cluster 1

State	Total of stores	Stockout rate in each store	Kind of supplier
Goiás	1	14.8%	External supplier
Paraná	1	12.9%	External supplier
Rio de Janeiro	5	19.7%	External supplier
		21.6%	External supplier
		23.3%	External supplier
		25.2%	External supplier
		26.3%	External supplier
Rio Grande do Sul	1	18.6%	CD RS
São Paulo	5	12.6%	CD SP
		13.4%	CD SP
		14.5%	CD SP
		15.3%	External supplier
		16.2%	CD SP

Source: the author

The data in Table 9 also shows that the larger stockout problems are associated with the external supplier, as the brewery itself is responsible for the supply of these stores, but this claim is premature because the problem can also be caused by poor management of the retailer's ordering process. This analysis shows some actions which might be taken by the retailer.

Conclusions

This work aimed to identify the factors which affect the stockout of an item of high turnover in a large retailer in the Brazilian market. The results revealed that the causes of stockout cannot be generalized, i.e., the results found in developed countries (Corsten, and Bharadwaj Gruen, 2002) do not necessarily coincide with the problems experienced in the Brazilian market (Vasconcellos et al. ; 2009).

The study revealed that the history of a database contains information relevant to the identification of factors which cause stockout in retailers. This information is useful both for retailers and manufacturers as well as for researchers interested in the subject. The lessons learned in this study are valuable, because it deals with a major retailer in the domestic market. It was found that retailers have a lot of data but little information for managing decision making.

It was identified an average annual stockout rate of 11.5% for the product, can of Skol beer 350 ml, and the worst annual stockout rate was 26.3%, while the best stockout rate was 2.2%.

In the regression analysis, we were able to explain 56.9% (adjusted R^2) of the variations which occur on an annual stockout rate of the stores through five variables, and cluster analysis confirmed the existence of three groups of hypermarkets with stockout rates of different inventories. . The cluster called a "Retail stores close to the deliverer, with high inventory turnovers and fewer promotions in the year" presenting the worst performance with 18% stockout rate, the second cluster called "Retail store away from the deliverer and low inventory turnover" showed the best performance with an annual inventory stockout rate of 10%.

This result was unexpected, exactly because the retail's stores closest to the DCs or external suppliers showed the worst results, revealing that the macro problem for this item should not be the logistic infrastructure, but the process itself. These results conflict with those of studies in developed countries. Corsten, and Bharadwaj Gruen (2002) state that the main problem of stockout occurs within the framework of retailer's logistics, while in this case the problem may be in the suppliers, which is more consistent with the results found by Vasconcellos et al. (2009).

Limitations

One of the limitations of this study was the use of a single product, Skol beer in 350 ml cans., Although considered the fourth best selling beer in the world, in the case of an item of high inventory turnover and of strategic importance for both the retailer and the beer manufacturer, it is not possible to generalize these results for other items sold in a major retailer.

Another limitation is the method of estimating the stockout rate based on a database of sales and inventory. This method cannot identify if the stock available in the store is on the shelf or storage area of the store, which would require a physical audit to ascertain the availability of stock on the shelves, a procedure which was not part of the retailer's daily routine.

A third limitation is the fact of the entire analysis (113 hypermarkets) having been performed on a single retail chain, where some conclusions can be associated with the management model and the current processes in this group and, therefore, cannot simply extend the results to other companies.

References

AASTRUP,J.; KOTZAB,H.(2009), "Analyzing out-of-stock in independent grocery stores: an empirical study". *International Journal of Retail & Distribution Management*,Vol.37.

ACNIELSEN. (2004), "Ruptura: Causas and impactos na cadeia de abastecimento and no comportamento do consumidor", *RESENTATION HELD AT ECR BRAZIL CONFERENCE, São Paulo,* Alegre. Bookman

CHAOUCH, B.,A.(2001), "Stock levels and delivery rates in vendor-managed inventory programs", *Production and Operation Management*, Vol.10.

CORSTEN, D; GRUEN, T. W.; BHARADWAJ,C. (2002), "Retail Stockouts: A Worldwide Examination of Extent, Causes and Consumer Responses", *In: The Food Marketing Institute and CIES* - The Food Business Forum.

CORSTEN, D.; GRUEN, T. (2003), "Desperately seeking shelf availability: An examination of the extent, the causes, and the efforts to address retail out-of-stock", *International Journal of Retail & Distribution Management*, Vol. 31, No.11/12.

EMMELHAINZ, L.; EMMELHAINZ, M.; STOCK, J.(1991), "Logistics implications of retail stockouts". *Journal of business logistics*, Vol.12.

Eroglu, C., Williams, B. D., & Waller, M. A. (2011). Consumer-driven retail operations. *International Journal of Physical Distribution & Logistics Management, 41*(5), 420-434.

FÁVERO,L.P.; BELFIORE,P.; SILVA, F.L.; CHAN, B.L. (2009), "Análise de dados. Modelagem multivariada para tomada de decisões". *Rio de Janeiro: Elsevier*.

FISHER, M. L. (1997) "What is the right Supply Chain for your product?", *Harward Business Review*, P 105-116. Mar-Apr.

GIMENÉZ, C.; VENTURAK.E. (2003), "Supply chain management as a competitive advantage in the Spanish grocery sector*". The International Journal of Logistics Management*, Vol4.

GRANT, D. B.;FERNIE,J.(2008), "Exploring out-of-stock and on-shelf availability in non grocery, high street retailing", *International Journal of Retail & Distribution Management*,Vol.36,.

GRANT, D. B.;FERNIE,J. (2009), "Optimizing on-shelf availability for customer service and profit", *Journal of Business Logistics*,Vol.30.

HAIR, J.F.; ANDERSON,R.E.; TATHAM,R.L.;BLACK,W.C.; BABIN,B.J. (2009), "Análise multivariada de dados". *São Paulo, Elsevier.*

HARDGRAVE, B.; LANGFORD, S.; WALLER, M.; MILLER, R. (2008), "Measuring the impact of RFID on out of stock at Wal-Mart*". University of Minnesota- MIS Quarterly Executive* ,Vol.7, No.4, Dec.

KAIPIA, R.; TANSKANEN,K. (2003), "Vendor managed category management – an outsourcing solution in retailing". *Journal of Purchasing & Supply Chain*, Vol9.

KHALID, U. (2008), "Determination of drivers of stock-out performance of retail stores using data mining techniques". *Master of engineering in logistics at the MIT.*

KUCUK, U. (2004), "Reducing the out-of-stock costs in a developing retailing sector", *Journal of International Consumer Marketing,* Vol.16.

LEHMANN, D. R.(1979), "Market Research Analysis", *Homewood IL; Richard D. Irwin*.

MARQUI, A.; ALCÂNTARA, R.; CHRISTOPHER, M. (2010), "Using the systematic literature review procedure to identify the root causes of out-of-stock in retail supply chains", *EUROMA*

MILLIGAN, G. W.; COOPER, M.C. (1988), "A Study of Variable Standardization", *Journal of Classification*, Vol. 5, pp181-204.

MORGAN,C.; DEWHURST,A. (2008), "Multiple retailer supplier performance: an exploratory investigation into using SPC techniques", *International Journal of Production Economics,* Vol111.

PECKHAM ,J.O.(1963), "The consumer speaks", *Journal of Marketing.*

PERO,M.; ROSSI,T.; NOE,C.; SIANESI,A.(2010), "An exploratory study of the relation between supply chain topological features and supply chain performance", *International Journal of Production Economics*, Vol.123.

PIBERNIK,R, (2006), "Managing stock-outs effectively with order fulfillment systems", *Journal of manufacturing technology management*, Vol7.

PRAMATARI, K.; MILIOTIS,P.(2008), "The impact of collaborative store ordering on shelf availability", *Supply chain management*, Vol.13.

PRAMATARI, K., EVGENIOU,T., DOUKIDIS,G.(2009), "Implementation of collaborative and-supply-chain initiatives: an initial challenging and final success case from grocery retailing", *Journal of Information Technology*, Vol.24.

VASCONCELLOS, L. H. R.; SAMPAIO, M.(2009), "The stockouts study: an examination of the extent and causes in the Sao Paulo supermarket sector", *ANPAD*.

WALLER,M., TANGARI, A.,WILLIAMS,B. (2008), "Case pack quantity's effect on retail market share: an examination of the backroom logistics effect and the store-level fill rate effect", *International Journal of Physical Distribution Management*, Vol. 38.

Increasing Value Generation using a Hierarchical Simulation-Based SCOR Framework

John Crowe[56] and Amr Arisha[57]

Abstract

We are part of extraordinary times, global recession coupled with increased competition; high costs and decreasing demand have changed the dynamics of supply chain management (SCM). In response, many organizations have fast-tracked changes to corporate-level strategies to reduce costs and maintain profit margins and have not considered the long-term impact these decisions have on more operational-level SCM activities. This has resulted in a renewed focus on customer value and the economic and behavioral systems of the supply chain, or more accurately, the value chain. The Supply Chain Operations Reference (SCOR) model increases the integration organizations have within their supply chains and increases alignment between different hierarchical strategies. Simulation techniques, in particular discrete-event simulation (DES) and system dynamics (SD) are proven techniques in improving SCM corporate and operational decision making processes. This paper presents a framework that integrates SCOR with DES-SD modeling approaches in order to improve the performance of inventory management in a leading tire distribution center in Ireland. This integration shows an effective method to evaluate order strategies, enhance throughput and increase value generation within supply chain networks.

Keywords: *Supply Chain Management, Value Chain, SCOR, Simulation, System Dynamics*

1. Introduction

This is an era marked by an unprecedented global recession and a high level of uncertainty within markets. Coupled with cost reduction pressures and rapidly changing customer requirements, strategic management has evolved requiring more agile planning and lean control techniques. Through this evolution, there is recognition of the need for decision-making tools and new approaches to the arrangement of the supply chain (SC) that optimizes value, both for the customer and supply chain partners. The variations in product-orders, multi-suppliers, and parallel processes have increased the level of risk in SC's and make SC management (SCM) a major challenge. To complicate planning activities further, increased global competitiveness and innovations in technology have decreased the life cycle of many products. Demand uncertainty, in particular, has become an increasingly important factor. To accurately hedge against demand uncertainty, efficient inventory management controls are needed in SC operations.

SCM is a vast management concept, with many interpretations and definitions. Although the concept itself was only introduced in early 1980 by Oliver and Webber, cited in Jüttner et al. (2007), it was not until the mid 1990's that it came to prominence globally. SCM can be defined as the strategic management of upstream (suppliers) and downstream (customers) relationships in order to create enhanced value to the final consumer at less cost to the SC as a whole (Christopher, 1998). At its basic

[56] 3S Group – College of Business, Dublin Institute of Technology, Ireland, +353 1 4023041, john.crowe@dit.ie
[57] 3S Group – College of Business, Dublin Institute of Technology, Ireland, +353 1 4023197, amr.arisha@dit.ie

level, a SC is made up of multiple actors, multiple flows of items, information, and finances, and is sometimes described as looking like an 'uprooted tree' (Lambert and Pohlen, 2001). The end goal of SCM is value creation, both for end consumers; in the form of reliable high quality products and pre/after-sales services, and for SC partners; in the form of increased turnover and profits (Mentzer et al., 2001, Mentzer, 2004, Murman, 2002). Such value creation in the SC is more commonly known as the value chain (VC).

1.1 Value Chain Improvement

In recent years, decision makers have realized that competition is no longer enterprise versus enterprise, but SC versus SC (Li et al., 2005, Christopher, 2000), or more appropriately, VC versus VC. In addition, the global recession has disturbed the fundamental concepts of international business. To keep competitive, organizations have had to drastically revise and implement cost cutting strategies to their VC operations to sustain profits. This is not an easy task. VCs are very dynamic, and each network node has its own customers' and suppliers' management strategies, partnerships, demand arrival process and demand forecast methods, inventory control policies and item mixtures (Longo and Mirabelli, 2008), with many challenges to overcome including; complexity, uncertainty, risk, visibility, collaboration, cost and sustainability to name a few. The dynamic and complex nature of VC systems imply that there is very high probability that cost driven decisions to change VC strategies will fail with huge financial consequences (Tobail et al., 2011). Pitta, Franzak, and Little (2004) state that other decisions other than cost need to be considered to add value to the VC. They are: relationships, interactivity, customer retention, and customization. Analytical models such as mathematical programming are very useful tools in understanding SC dynamics. This is noted by Hae and Han (2000), who add that when an analytic solution cannot give measurable performance indicators simulation should be used. Simulation offers a more thorough, measurable analysis of the systems data including the examination of parameter variability, operational uncertainty, and the accurate estimation of probability distributions that statistically fit the data sets (Arisha and Young, 2004).

To be truly sustainable and value adding, organizations need to transcend the boundaries of their own SC operations and develop relationships with their suppliers' suppliers and their customers' customers (Barratt, 2004). For this reason, business process orientation concepts of reengineering, benchmarking and process measurement have been integrated into a cross-functional framework commonly known as a process reference models. With regards to SCM, the most commonly used models are the Supply Chain Councils (SCC) Supply Chain Operations Reference (SCOR) model and the Council of Supply Chain Management Professionals' SCM Process Standards. The objective of this paper is develop a hierarchical simulation-based framework integrated with the benefits of using process reference models such as SCOR in managing sustainable, competitive VC's. To achieve this, Section 2 will give a background overview of the SCOR model, generally and from the perpective of VC. This is followed by a detailed discussion on integrating SD and DES into a hybrid simultion model for value gernation in hierarchiacal systems such as in VC's in Section 3. Section 4 gives a profile of the case study industry; tire distribution, and the case study company. Data collected on this company will then be used in Section 5 to build an accurate SD-DES simuation model of the TDC system that will be analyzed in Section 6 before conslusions and future work are discussed in Section 7.

2. Supply Chain Operations Reference Model

The concepts of the VC or SCM are not recent additions to management philosophy. Many experts including Michael Porter and W. Edwards Deming have created process frameworks that embrace whole system value creation (Bolstorff and Rosenbaum, 2007). The purpose of the SCOR model is to provide the ability to describe process architecture in a way that makes sense to key SC partners and give a better understanding of whole system value creation. It is especially useful for describing value/demand/supply chains that cut across multiple departments and organizations, providing a common language for managing such processes (SCC, 2010). The SCOR model contains four main sections: (1) Performance: Standard metrics to measure process performance: (2) Processes: Standard descriptions of management processes and a framework of process relationships; (3) Practices: Management practices that produce best-in-class performance; and (4) People: Training and skills requirements aligned with processes, best practices, and metrics. The foundations of the framework developed in this paper are built on the first two sections of the SCOR model, performance metrics and processes. The SCOR Performance section is separated into two hierarchical groups: (1) strategic and qualitative performance attributes such as; responsiveness, reliability, agility, cost and asset management; and (2) operational and quantitative performance metrics such as on-time delivery, average cycle time, invoice accuracy etc. Performance metrics are used to quantify and measure the higher-level strategic attributes.

The SCOR Process section is the core SCM knowledge base for the development of the hierarchical simulation-based framework, and is divided into three hierarchical levels. Zhou et al. (2011) summarize each level very efficiently. Level 1 consists of five strategic supply chain processes: Plan (P), Source (S), Make (M), Deliver (D), and Return (R). Level 2 of the SCOR model describes core processes. Level 3 specifies the best operational practices of each process. The P component includes the processes that balance aggregate demand and supply to develop a course of action which best meets sourcing, production, and delivery requirements. The S component includes the processes that procure goods and services to meet planned or actual demand. The M component is comprised of the processes that transform product to a finished state to meet planned or actual demand. The D component includes all processes which provide finished goods and services to meet planned or actual demand. The R component includes all processes that provide accurate returns of unwanted and poor quality finished goods, product recalls and equipment.

3. Comparison of System Dynamics and Discrete-Event Simulation

As noted earlier, simulation is a widely used analytical modeling technique within the field of SCM. Two of the most-established approaches are that of SD and DES (Pidd, 2004). System dynamics methodology is best suited to problems associated with continuous processes where feedback significantly affects the behavior of a system, producing dynamic changes in system behavior. SD is a system thinking approach to modeling that is not data-driven, targeting executive-level decision makers (Rabelo et al., 2007). DES models, in contrast, are better at providing a detailed analysis of systems involving linear processes and modeling discrete changes in system behavior (Sweetser, 1999). DES is mostly applied at operational-levels for planning and scheduling activities (Venkateswaran et al., 2004). A very accurate review of the fundamental differences between SD and DES is given by Lane (2000); Table 1 presents an overview of these differences.

Table 1. Fundamental differences between SD and DES (Lane, 2000)

	System Dynamics	**Discrete-Event Simulation**
Perspective	Holistic; emphasis on dynamic complexity	Analytic; emphasis on detail complexity
Resolution of models	Homogenized entities, continuous policy pressures, and emergent behavior	Individual entities, attributes, decision, and events
Data sources	Broadly drawn	Primarily numerical
Problems studied	Strategic	Operational
Model elements	Physical, tangible, judgmental, information links	Physical, tangible, and some informational
Human agents	Executive policy implementers	Decision makers
Model outputs	Understanding behavior, location of key performance indicators, effective policy levers	detailed performance measures across a range of parameters, decision rules, and scenarios

3.1 Why integrate SD and DES modeling?

When modeling a complex system, it is sometimes very difficult to define the boundaries of a model that appears to be a closed loop with its external environments (Brailsford et al., 2010). This is often the case with hierarchical levels of the VC. Similar kinds of uncertainties occur at different hierarchical levels of organizations, yet they are nearly always handled independently at each level. Integrating SD and DES can be very effective in studying the impact interaction between each level has on the system (Venkateswaran et al., 2004). Hybrid simulation integrating both SD and DES can create valuable synergies. By integrating each technique hierarchically, "both paradigms symbiotically enhance each other's capabilities and mitigate limitations by sharing information" (Chahal and Eldabi, 2008), which is very attractive to VC managers. The hierarchical nature of a hybrid SD-DES simulation model can support VC decision-making process by being able to combine the aggregate and strategic aspects of the system with the very detailed operational-levels, in a way that recognizes the different needs along the management hierarchy (Rabelo et al., 2005).

3.2 Synergizing SCOR with SD-DES Model

The SCOR model can be a powerful value management and decision-making tool. Once a complex management process such as SCM is captured in standard process reference model form, it can be measured, managed, and controlled (SCC, 2010). However, Bolstorff and Rosenbaum (2007) quite cleverly state that "*for all its strengths and potential, the SCOR model is still just a noun-a-series (or glossary) of definitions for processes, metrics and leading practices*". They continue by saying that simply having the dictionary is not enough and to change the nouns into verbs, effective management, business process engineering and problem-solving techniques are needed. Integrating SCOR with simulation has been used very effectively, especially DES to achieve this (Venkateswaran et al., 2004, Persson, 2011, Jin et al., 2006). Despite the huge potential in using a hybrid SD-DES driven SCOR model, there has been no record of it in literature. This alone is a key reason for synergizing SCOR with SD-DES modeling in this paper.

4. CASE STUDY – Tire Distribution Industry

Intensive global competition, reductions in brand loyalty, increasing tire life spans, high costs of raw materials, and decreasing demand due to recession have reduced tire distributors' profit margins. Market variety creates a high demand on several categories of tires which vary in size and type. Tire supply and manufacturing is seen as a much easier process than other automotive components, as it needs a relatively small number of commodity raw materials such as natural and synthetic rubbers. Nevertheless, its distribution network is considered complex as a direct result of globalization. The case studied in this paper focuses on the order processing system at a leading brand name tire distribution center (TDC) in Dublin, Ireland. To add value for customers, SC strategies were revised in order to provide short order cycle times with a minimum of incurred cost. TDC is an Irish-based distribution center for one of the biggest brand names in the global tire market. It supplies tires for a wide variety of customers ranged between individual customers to large-scale companies which in turn impact the variety of customer orders regarding item quantities and types. In order to keep customer satisfaction high, the company's response to its customers has to be fast, accurate, on-time, with low costs. The company also provides the proper capacity of equipment, labor and storage spaces to prevent operations bottlenecks and improve item flow. However, many SC and operational challenges have arisen that prompted the company to think about applying a process reference model to their SC structure. SCOR has been recommended as a reference guide for TDC to follow to increase SC transparency, visibility, collaboration and effectiveness along their VC.

4.1 TDC Problem Definition

The diversity in customer types causes a wide variation in the customer demand regarding to tire quantities and types. To maintain customer loyalty and value, the company aims to respond speedily to customers' demands in an accurate manner with the least possible cost, following the SCM strategy of responsiveness. The company mainly faces challenges in ordering accuracy. Monthly forecasting plans are generated based on extensive analysis of the market conditions, competitors' positions, future customer contracts and stock keeping unit (SKU) consumption rates. Applying such a process for more than 200 different SKUs requires considerable time and effort, particularly when one considers that 75% of all orders received in 2011 were for 10 SKU's or under (Figure 1). In an attempt to cope with these challenges, the company decided to increase the lot sizes of its replenishment orders and regularly schedule them in longer time intervals. Although this policy has prevented stock-out situations and reduced item unavailability rates (a key requirement of a responsive SC), this has resulted in considerably long order cycle times as well as high inventory costs.

Figure 1. TDC customer order frequency distribution for 2011

5. PROPOSED FRAMEWORK

Structuring, planning, collaborating, analyzing and improving are all key factors in managing a successful VC. The powerful analytical and mitigating benefits both SD and DES have in understanding and aligning the hierarchical levels of the VC are evident. The hierarchical simulation-based framework developed in this paper is illustrated in Figure 2. It incorporates the structure, knowledge base and SCM expertise of the SCOR model with the analysis and evaluating strengths of SD-DES simulation. TDC data will be used to describe the framework in more detail.

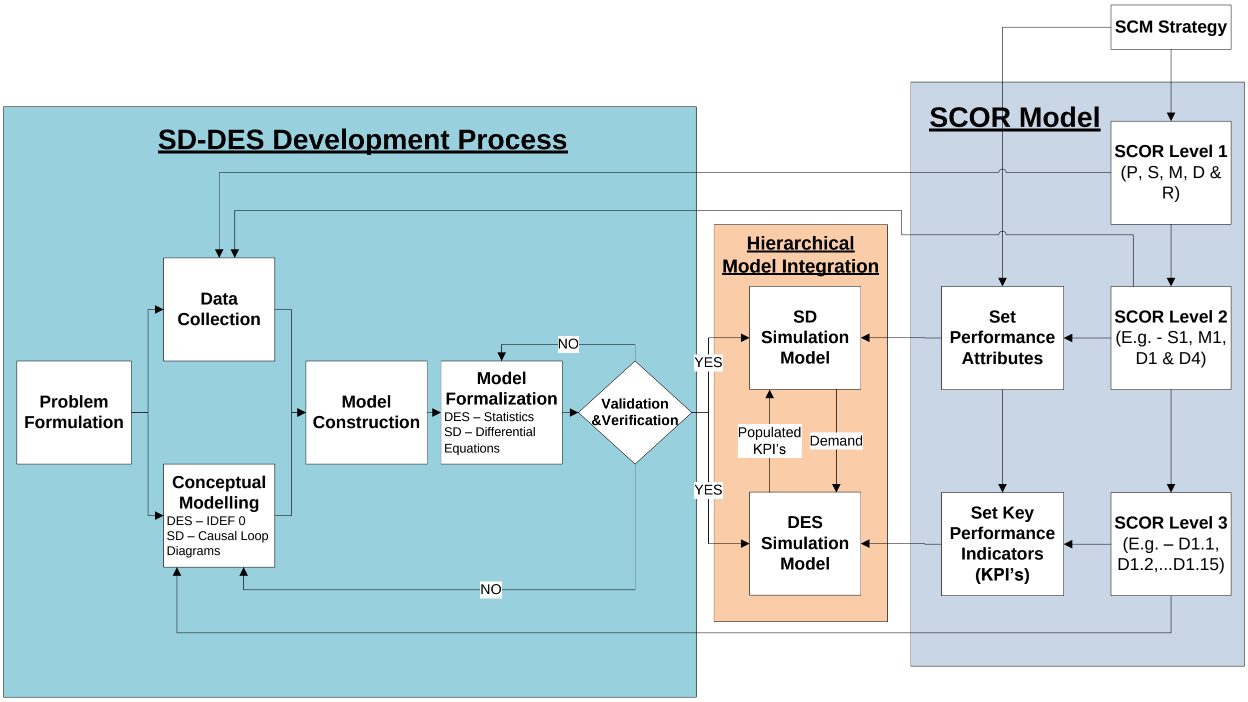


Figure 2. Hierarchical Simulation-Based SCOR Framework

5.1 SCOR Model

According to the SCOR process, SCM is defined by five key integrated processes; PLAN (P), SOURCE (S), MAKE (M), DELIVER (D), and RETURN (R). There are four strategic hierarchical process levels; this paper focuses on the first three levels of TDC's SCOR model.

5.1.1 TDC SCOR Level 1

SCOR Level 1 processes are the core management processes that are put in place to achieve the overall SC strategy of an organization. TDC's VC strategy is that of agility and responsiveness in the distribution of tires to several customer categories in the Irish market. For this reason, the company follows the SCOR SC model which is inventory driven, has high fill rates and short turnarounds, and is called Make-to-Stock (MTS). As a distribution service provider the company's core strategic value management processes center on PLAN, SOURCE and DELIVER, (and RETURN which is beyond the scope of this paper).

5.1.2 TDC SCOR Level 2

SCOR Level 2 categorizes and configures the sub-processes of Level 1. Using a thread diagram Figure 3 shows the TDC VC from a SCOR perspective, focusing on the Level 1 category most important to the company, PLAN and DELIVER. In the TDC SCOR model, thread diagrams are relationship maps that focus on the material flow (D, R), material strategy (M, S) and planning processes (P) (Bolstorff and Rosenbaum, 2007). The TDC SCOR thread process focuses on the material flow (D), material strategy (M, S) and planning processes (P). The thread diagram disaggregates the MTS model further into level 2 processes, which are explained in Table 2.

Table 2. TDC SCOR Level 2 Processes

Level 2 Process	Code	Core Activity
Plan Source	**P2**	Aggregate Planning
Plan Make	**P3**	Aggregate Planning
Plan Deliver	**P4**	Aggregate Planning
Source Stocked Product	**S1**	Procurement
Source Make-to-Order Product	**S2**	Procurement
Make-to-Stock	**M1**	Production Planning
Make-to-Order	**M2**	Production Planning
Deliver Stocked Product	**D1**	Distribution Planning
Deliver Make-to-Order Product	**D2**	Distribution Planning
Deliver Retail Product	**D3**	Distribution Planning

There are two main inputs to the process, first, the source of supply from TDC's regular supplier, which produces and holds product in stock for customers such as TDC to order periodically. The regular supplier sources raw material to produce tires (S1), makes-to-stock for future customer orders (M1) and distributes customer orders to TDC within a lead time of 10 days (D1). Supplier number two is a backup supplier TDC uses when there are shortages in supplier 1 inventory, peaks in demand, or when an expedited order is needed. Although the lead time is 3 days less than the regular supplier, the backup supplier works under a make-to-order plan, a more expensive order process.

TDC's procurement department executes the S1 and S2 processes, while D1 (deliver to motor shop/repair garage) and D4 (deliver to retailer) are generic warehouse functions that receive, store, pick, load and deliver, along with information and capital flows. P2, P3 and P4 are the planning activities that support the movement of material and information along TDC's SC. SD modeling will be used to recreate the planning, sourcing and, distribution functions represented in Level 2.

5.1.3TDC SCOR Level 3

Level 3 processes describe the steps performed to execute the processes of Level 2. The sequence in which these processes are executed influences the performance of the Level 2 processes and the overall VC. The example used in this framework is that of TDC D1, or delivered stocked item to customer. Figure 4 shows the hierarchical breakdown of level 2 process D1 into its level 3 sub-processes, D1.1 to D1.15. These are generic activities within any distribution function of any organization, ranging from process customer order inquiry, to storage, order picking and invoicing. DES modeling will be used to create this operational level view of TDC's SC.

5.2Data Collection

One of the key factors that affect the quality of the simulation results is the input data (Ismail et al., 2010). System understanding and process analysis using qualitative and quantitative data collection methods were used in the analysis stage through the collection of TDC primary data. Several field visits, interviews, ERP data collection and process analysis sessions were conducted in order to frame an understanding about the main parameters and generate a list of SCM activities of the studied SC. Secondary data collection in the form of a review of current literature supports the process analysis phase.

Data required for the SD model development was mainly to gain a strategic level understanding of the internal and external influences on the behavior of TDC's more-strategic Level 1 and 2 SCOR processes.

This was done using interviews with senior management and focus groups. A more-tactical, operational level of data collection was introduced to collect data for Level 3 process D1.

5.3 Conceptual Models

Conceptual modeling is a presentation of the sequences of system processes, procedures and resources and shows the relationship between a system's objects, such as customers and products, and their status during the systems process (Mahfouz et al., 2010). Many modeling methods have been developed, studied, and reviewed by academic experts (Aguilar-Savén, 2004, Shen et al., 2004). To develop the hierarchical simulation-based framework, it was important to choose the best fit conceptual models for each simulation technique used.

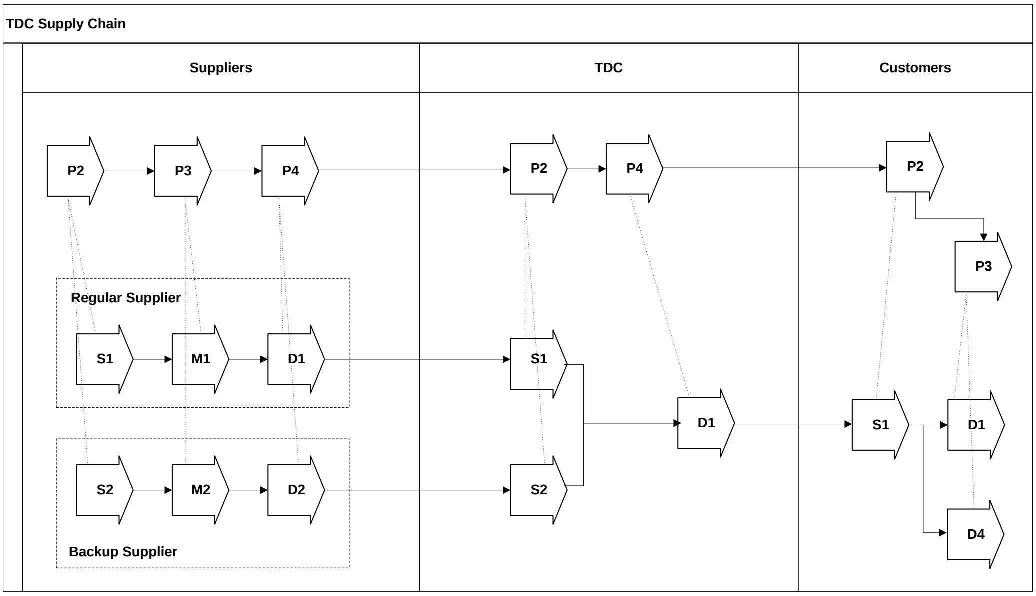
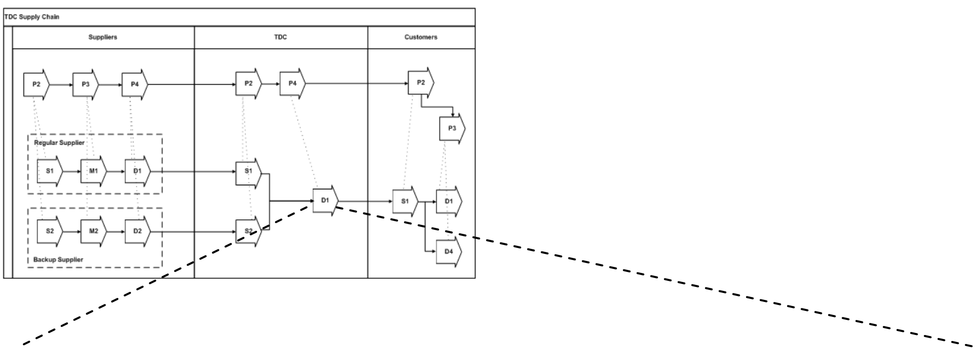


Figure 3. Thread diagram of TDC SC – SCOR Level 2.



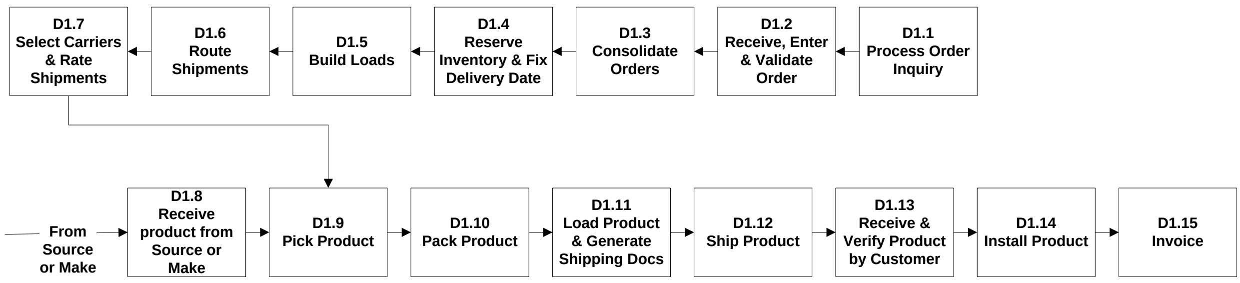


Figure 4. Deliver stocked product (D1) - SCOR Level 3 process.

5.3.1Conceptual Model of TDC SCOR Level 2 Processes

As illustrated in the thread diagram in Figure 3 and Table 2, Level 2 processes at TDC are at a high hierarchical level, incorporating senior management decision-making processes. The type of simulation modeling technique used to recreate this process will directly influence the choice of conceptual model used. Using SD suggests that the objective of the simulation model is to study and understand the underlying behavior of TDC SC and the influencing factors (feedback mechanisms) each parameter, decision and performance measure have on each other.

The causal loop diagram depicted in Figure 5 shows the feedback processes that affect the customer order process and inventory accumulation at TDC. The diagram is formed of two types of feedback loops: balancing feedback loops and reinforcing feedback loops. An example of a balancing loop is the loop connecting the inventory and ship to customer processes. The + inventory and – shipments explain that whatever happens to inventory, the opposite or negative happens to shipments. That is, if shipments increase then inventory decreases. An example of a reinforcing loop is that between forecasted orders and inventory. The + inventory and + forecasted orders show that the same behavior occurs in this relationship, that is if forecasted supplier orders increase, inventory in TDC's warehouse increases. The behaviors depicted in the feedback loops are the core blueprints for building SD models.

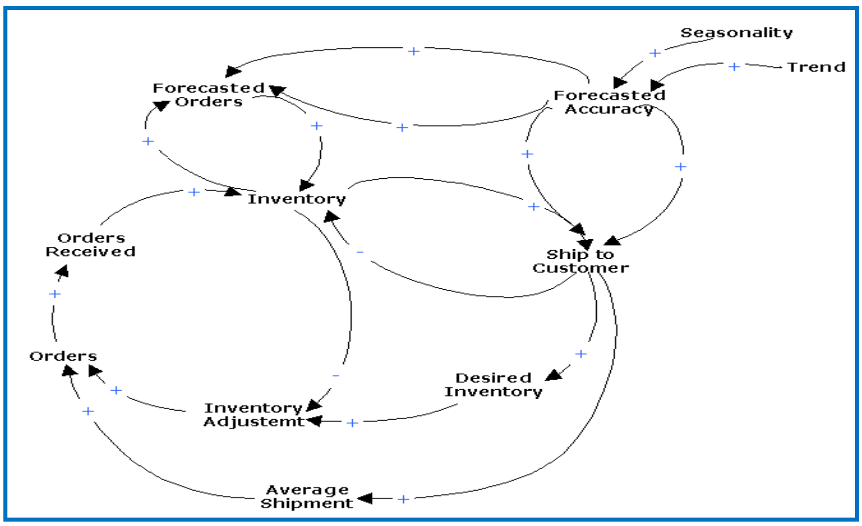


Figure 5. Causal Loop Diagram of TDC SCOR Level 2 Process

5.3.2 Conceptual Model of TDC SCOR Level 3 Processes

Figure 4 in Section 5.1.3 clearly maps the process requirements for TDC's Level 3 process D1. In this process view of D1, information, resource, and material flows are represented, making it a complex process to model and capture all details needed to create an accurate 'As Is' simulation. Taking into account the complexity of the D1 system and its multiple input, output, controls, and mechanisms, integrated definition for functional modeling (IDEF0) is a perfect match for modeling such intricate systems (Mahfouz et al., 2011). IDEF0 allows users to understand the sequence of system functions. An activity block which is the basic unit for IDEF0 describes the main function of the process using ICOMs (Input, Control, Output and Mechanism), which are represented by horizontal and vertical arrows, as illustrated in Figure 6. Each activity block shown in Figure 6 incorporates SCOR Level 3 processes D1.1–D1.15. For example, activity block A1, customer order management, depicts D1 sub-processes D1.1, D1.2, and D1.3. The hierarchical nature of IDEF0 means that all activity blocks can be filtered down another level to gain more detail for the simulation model-building phase.

5.4 Simulation Models

The simulation models created for TDC SCOR processes are very detailed and extensive. The aim of this paper is to introduce a SC value generating framework integrating SCOR with SD-DES simulation; therefore it goes beyond the objectives of this paper to describe the simulation models in detail. An overview of the models is as follows.

5.4.1 SD Model

Based on the causal loop diagram, the SD model was built using four primary blocks: levels, flows, auxiliaries, and constants. Levels are accumulators that give a snapshot view of reality. Their values highlight how the system is doing at any given point in time. Flows are action variables, creating dynamics when they accumulate in levels. They feed levels with a rate of material or information flow. Auxiliaries are used to aid in the formulization of flow rates, level and other auxiliaries. They are algebraic computations used in conjunction with differential equations used in the model. Constants are similar to auxiliaries but remain static over the course of the simulation run. The inventory variable is the only level used in the model, while customer orders/shipments and forecasted supplier orders are flows. The remaining variables were used as auxiliaries and constants to construct the differential equations. The model was run for a period of 1 year, with multiple replications (warm up period showed 10 runs for each experiment is a statistically valid selection).

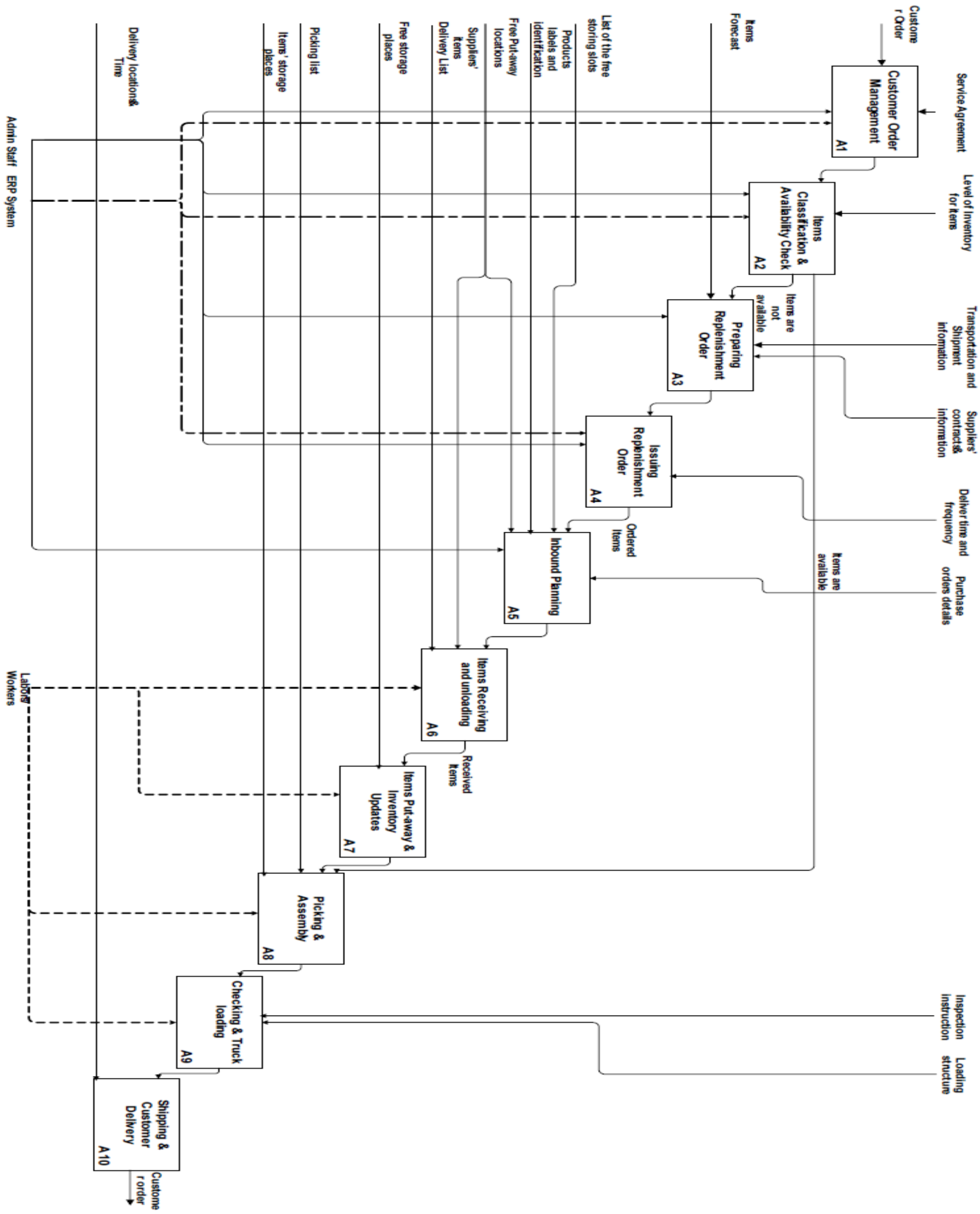


Figure 6. IDEF0 Model of TDC SCOR Level 3 Process D1

5.4.2 DES Model

A DES simulation model based on the IDEF0 conceptual model shown in Figure 6 was developed. The model assumptions are (1) no returnable items are modeled, (2) the resource availability rates are based on data collected from managers, and (3) the model focuses on the generic features (Figure 4 and 6) of the distribution activities. For the model to reach its steady-state condition, the warm-up period was found to be 2 weeks. Every simulation run represents one year of actual timing. Each experiment result is an average of 10 independent replications. The DES model of the distribution processes has used a generic simulation package and customized it with Java and XML technologies.

Excel sheets are the link between the two simulation models. Each model runs independently of each other and data is transferred via input and output Excel sheets generated by the SD and DES models. Forecasted demand created in the SD model is transferred to the DES model as customer order input. Cycle time, average inventory, and late jobs are the variables transferred back to the SD model to measure the SCOR performance attribute Responsiveness.

6. Results Discussion

The uncertain nature of customer demands and suppliers' lead time makes it difficult to select the best system process parameters that can achieve high level of customer satisfaction (i.e. short cycle time and no late orders) while achieving the goals set out in the VC. After discussions with TDC managers, it was agreed that to generate value through increased agility and responsiveness the models would run under four scenarios (Table 3): (1) base scenario- no change in current system; (2) scenario 1- change forecasting technique to triple exponential smoothing (Snyder and Shen, 2011) incorporating trend and seasonality in demand predictions; (3) scenario 2– Increase frequency of forklift maintenance to optimize order picking rate; and scenario 3 – Customers Segmentation, which is splitting customers into a Pareto grouping by their contribution to TDC sales.

The parameter change in the forecasting technique in the SD model has had a significant impact on the SCOR Level 3 performance metrics chosen to represent VC responsiveness. Factoring seasonality and trend into the demand forecast has decreased order cycle time and average inventory by 47% and 14%, respectively. This suggests that the use of triple exponential smoothing has increased the forecasting accuracy of demand, resulting in increased availability of SKU's, less wait time for back orders, and higher inventory turnover. The large decrease in late jobs of 61% needs more investigation, but reflects the increased accuracy between forecasted and customer orders. On the other hand, management's suggestion that decreasing the probability of breakdowns through applying regular maintenance services in fixed intervals did not materialize, suggesting that equipment breakdowns do not have a significant impact on order fulfillment at present. If management implemented these measures using random estimates and experience alone, it would be a costly mistake to make. There were no significant changes in VC performance when the hybrid simulation was run under scenario 3, customer segmentation. Cycle time and average inventory remained static because order and supply rates remained the same as the base line; it was only the order fulfillment priority that changed. The number of late jobs increased by 30% as there was a delay in lowest priority customers receiving their orders. In terms of value generation, this increase was balanced by the on-time order fulfillment of customers with larger order volumes.

Table 3. Main effect of Level 2 Scenario change on Level 3 performance metrics

			Results	
	Process Parameter	**Cycle time (days)**	**No of Late Jobs**	**Average Inventory (All SKU's)**
Baseline –	No Changes	28.75	3.67	18020.07
Scenario 1 -	Change Forecasting Technique	15.34	1.42	15467.23
Scenario 2 -	Decrease Equipment Breakdowns by 50%	27.26	3.32	17547.34
Scenario 3 -	Customer Segmentation	27.67	4.78	18067.1

7. Conclusion

We are part of extraordinary times, where global recession coupled with increased competition, high costs and decreasing demand has changed the dynamics of supply chains. In response, many organizations fast-tracked changes to reduce costs and maintain profit margins, not considering the long-term impact these decisions have on operational-level SCM activities and overall value generation. The Supply Chain Operations Reference (SCOR) model increases the control organizations have on their VC's and increases alignment between different hierarchical strategies. Simulation techniques, in particular DES and SD are very effective in decreasing poor SCM corporate and operational decision making.

This paper presents a novel framework that integrates SCOR with SD-DES simulation modeling to improve the VC performance of hierarchical SCM decision-making with respect to inventory management and order processes. Using TDC as a case study, it was found that conceptual modeling techniques such as IDEF0 and causal loop diagrams complement the process modeling methods used by SCOR. The integration of SD and DES gives companies a powerful analytical tool to support the knowledge base gained by using SCOR. This integration appears to be an effective method to; evaluate order strategies and performance, enhance throughput rates, and increase value generation.

A full hierarchal SD-DES model of the entire SCOR reference model, using generic processes is a future research work. The next phases in the model advancement will include: the development of a performance index to assess and grade the success of using SCOR in any SC; and more in-depth collection of corporate-level data, evaluating the alternatives from the simulation results against other qualitative factors using analytic hierarchy process (AHP).

Acknowledgements

The authors wish to thank the Irish Research Council for Science, Engineering, and Technology (IRCSET) for contributing to the funding of this research project. The authors would also like to thank their colleague Dr. Amr Mahfouz for his assistance in the simulation model development phase of the framework.

8. References

AGUILAR-SAVÉN, R. S. 2004. Business process modelling: Review and Framework. *International Journal of Production Economics,* 90**,** 129-149.

ARISHA, A. & YOUNG, P. Intelligent simulation-based lot scheduling of photolithography toolsets in a wafer fabrication facility. Simulation Conference, 2004. Proceedings of the 2004 Winter, 5-8 Dec. 2004 2004. 1935-1942 vol.2.

BARRATT, M. 2004. Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: An International Journal,* 9**,** 30-42.

BOLSTORFF, P. & ROSENBAUM, R. G. 2007. *Supply chain excellence: a handbook for dramatic improvement using the SCOR model*, Amacom Books.

BRAILSFORD, S. C., DESAI, S. M. & VIANA, J. Towards the holy grail: Combining system dynamics and discrete-event simulation in healthcare. Simulation Conference (WSC), Proceedings of the 2010 Winter, 5-8 Dec. 2010 2010. 2293-2303.

CHAHAL, K. & ELDABI, T. Applicability of hybrid simulation to different modes of governance in UK healthcare. Simulation Conference, 2008. WSC 2008. Winter, 7-10 Dec. 2008 2008. 1469-1477.

CHRISTOPHER, M. 1998. *Logistics and supply chain management: Strategies for reducing cost and improving service,* London, Financial Times Publishing.

CHRISTOPHER, M. 2000. The agile supply chain: competing in volatile markets. *Industrial marketing management,* 29**,** 37-44.

ISMAIL, K., ABO-HAMAD, W. & ARISHA, A. Integrating balanced scorecard and simulation modeling to improve Emergency Department performance in Irish hospitals. Winter Simulation Conference (WSC), Proceedings of the 2010, 5-8 Dec. 2010 2010. 2340-2351.

JIN, D., HONGWEI, D., CHANGRUI, R. & WEI, W. IBM SmartSCOR - A SCOR Based Supply Chain Transformation Platform Through Simulation and Optimization Techniques. Simulation Conference, 2006. WSC 06. Proceedings of the Winter, 3-6 Dec. 2006 2006. 650-659.

JÜTTNER, U., CHRISTOPHER, M. & BAKER, S. 2007. Demand chain management-integrating marketing and supply chain management. *Industrial Marketing Management,* 36**,** 377-392.

LAMBERT, D. & POHLEN, T. 2001. Supply chain metrics. *International Journal of Logistics Management,* 12**,** 1-20.

LANE, D. 2000. You just don't understand me: Modes of failure and success in the discourse between system dynamics and discrete event simulation.

LI, S., RAO, S. S., RAGU-NATHAN, T. S. & RAGU-NATHAN, B. 2005. Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management,* 23**,** 618-641.

LONGO, F. & MIRABELLI, G. 2008. An advanced supply chain management tool based on modeling and simulation. *Computers & Industrial Engineering,* 54**,** 570-588.

MAHFOUZ, A., ALI HASSAN, S. & ARISHA, A. 2010. Practical simulation application: Evaluation of process control parameters in Twisted-Pair Cables manufacturing system. *Simulation Modelling Practice and Theory,* 18**,** 471-482.

MAHFOUZ, A., SHEA, J. & ARISHA, A. Simulation based optimisation model for the lean assessment in SME: A case study. Simulation Conference (WSC), Proceedings of the 2011 Winter, 11-14 Dec. 2011 2011. 2403-2413.

MENTZER, J. T. 2004. *Fundamentals of supply chain management: Twelve drivers of competitive advantage*, Sage Publications, Inc.

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**,** 1-25.

MURMAN, E. M. 2002. *Lean enterprise value: insights from MIT's lean aerospace initiative*, Palgrave Macmillan.

PERSSON, F. 2011. SCOR template—A simulation based dynamic supply chain analysis tool. *International Journal of Production Economics,* 131**,** 288-294.

PIDD, M. 2004. *Computer Simulation in Management Science,* UK, Wiley.

PITTA, D. A., FRANZAK, F. J. & LITTLE, M. W. 2004. Maintaining positive returns in the value and supply chain: applying tomorrow's marketing skills. *Journal of Consumer Marketing,* 21**,** 510-519.

RABELO, L., ESKANDARI, H., SHAALAN, T. & HELAL, M. 2007. Value chain analysis using hybrid simulation and AHP. *International Journal of Production Economics,* 105**,** 536-547.

RABELO, L., HELAL, M., JONES, A. & HYEUNG-SIK, M. 2005. Enterprise simulation: a hybrid system approach. *International Journal of Computer Integrated Manufacturing,* 18**,** 498-508.

SCC. 2010. SCOR 10 Web Overview. Available: http://supply-chain.org/f/SCOR-Overview-Web.pdf [Accessed 02/12/2011].

SHEN, H., WALL, B., ZAREMBA, M., CHEN, Y. & BROWNE, J. 2004. Integration of business modelling methods for enterprise information system analysis and user requirements gathering. *Computers in Industry,* 54**,** 307-323.

SNYDER, L. V. & SHEN, M. Z.-J. 2011. *Fundementals of Supply Chain Theory,* New Jersey, Wiley.

SWEETSER, A. A comparison of system dynamics (SD) and discrete event simulation (DES). 1999.

TOBAIL, A., CROWE, J. & ARISHA, A. Learning by gaming: Supply chain application. Simulation Conference (WSC), Proceedings of the 2011 Winter, 11-14 Dec. 2011 2011. 3935-3946.

VENKATESWARAN, J., YOUNG-JUN, S. & JONES, A. Hierarchical production planning using a hybrid system dynamic-discrete event simulation architecture. Simulation Conference, 2004. Proceedings of the 2004 Winter, 5-8 Dec. 2004 2004. 1094-1102 vol.2.

YOUNG HAE, L. & SOOK HAN, K. Optimal production-distribution planning in supply chain management using a hybrid simulation-analytic approach. Simulation Conference, 2000. Proceedings. Winter, 2000 2000. 1252-1259 vol.2.

ZHOU, H., BENTON, W. C., SCHILLING, D. A. & MILLIGAN, G. W. 2011. Supply Chain Integration and the SCOR Model. *Journal of Business Logistics,* 32**,** 332-344.

The Effects of Research and Development Expenditures on Financial Performance of Manufacturing Firms: A Study on Istanbul Stock Exchange

İbrahim Onur Oz[58], *Güldem Cerit*[59]

Abstract

The effects of Research and Development (R&D) activities on firm performance have been a long discussion in the literature. Especially, the firm expenditures for innovation have been taken into consideration as a way to increase profitability for the long term. On the other hand, R&D expenditures before, during and after recessions are essential to sustain competitive advantage of the firms. In the light of these arguments, the current study aims to investigate the influence of R&D expenditures on sales, gross profit, operating and net income of 154 manufacturing firms at Istanbul Stock Exchange for 2006-2011 periods through panel data analysis. The effects of R&D activities on the growth of sales and net income are also analyzed. The authors humbly believe that this study will also be helpful to see the profitability effect of R&D expenditures before and after the financial crisis of 2008.

Key Words: Research and development, financial performance, manufacturing firms, Istanbul Stock Exchange

Introduction

The Research and Development (R&D) expenditures are accepted as one of the endogenous factors of growth for firms' sales, assets and profitability due to their contribution to innovation process (Geroski et al.,1993; Mudambi and Swift, 2011). Especially, the innovation process and the patents as outputs of the process have positive effects on the profitability of the firms.

R&D expenditures were also strategically important for firms as the amount going to be spent would be a cash outflow. That's why, the increase or the decrease of R&D expenditures are also important during crises. Despite the fact that R&D expenditures decreases during the recessions, the recommended time of boosting R&D expenditures is the span of crises (Barlevy, 2005). On the other hand, the decrease in R&D expenditures during crises could not be a suitable approach to each country, since countries, such as Turkey and Hungary has increased level of R&D outlays when compared with other Eastern European countries during 2008 financial crisis for their export oriented firms (Correa and Lootty, 2011). It is obvious that countries may have distinct approaches to R&D expenditures; moreover, countries may support R&D expenditures as well. For instance, in Turkey, 5576.article of corporate tax law about the support of R&D outlay was altered in 2008. Since that time, the R&D expenditures have been 100% tax deductible which was 40% before 2008.

[58] Izmir University of Economics, Turkey, +902324889872, onur.oz@ieu.edu.tr
[59] Dokuz Eylul University, Turkey, +902324534992,gcerit@deu.edu.tr

The accounting process of R&D expenditures is also crucial for the companies. Especially, International Financial Reporting Standarts (IFRS), due to their principles based structure, states that companies can expense their R&D expenditures during the research stage of the product, and they can capitalize the related R&D expenditures during the development stage. This approach is totally different than Generally Accepted Accounting Principles (GAAP), also known as US GAAP, indicating that the R&D expenditures must be expensed when they occur without any separation depending on the stages of R&D. These two approaches are strategically different than each other and would let companies select one of the ways to manage their net income.

All in all, above argument shed light on the importance of the issue R&D expenditures are vital for companies to define their strategies in terms of increasing sales, profitability and managerial decision making during recessions.

1. Literature Review

The effects of Research and Development on firm performance have been analyzed in the literature approximately for the last six decades. One of the very first studies was the Nelson's 1959 work indicating the motivation behind the R&D expenditures as profit. He claimed that the need for R&D was to increase innovation, one of the main drivers of the firm profitability. The literature also entails the studies which are about positive association between profit and R&D outlay. These examine the possible effects of R&D expenditures on sales (Branch, 1974; Menjon and Merino, 2012), patents (Nelson and Winter, 1977; Griliches, 1984), market value (Chauvin and Hirschey, 1993), and employee growth (Coad and Rao, 2008).

R&D expenditures were represented as one of the key determinants of market value of the firms, manufacturing and nonmanufacturing, by (Chauvin and Hirschey, 1993). That's why, they concluded that research and development as intangible assets were important for firm valuation. Additionally, the stock value of the firms should have reflected their R&D capital (Chan et al., 2001). The association between the volatility return and R&D intensity was found significant, despite the fact that there was not significant distinction between the stock performances of the firms doing R&D and not.

The R&D expenditures have been taken into consideration as a strategic outlay for the firms. Especially, recession periods were investigated to see whether firms alter their R&D behavior. Gary and Sridhar in 2011, found that firms continue their R&D expenditures during crises depending on their market share, financial leverage, and product market profile. The effects of R&D on the firm profitability during crises were examined by Srinivasan and Lilien in 2009. The two researchers indicated that R&D expenditures impact firm profitability during crises for business to business, and business to consumer firms without having any affect on their service counterparts. The amount of R&D expenditures during recessions, on the other hand, should have been increased to sustain the competitiveness among firms (Barlevy,2005). In fact, governments should have provided necessary funding for the firms during recessions.

The internationalization of R&D process for firm profitability was another point in literature that firms with more internationalized R&D centers had more profits than the firms just doing domestic R&D. Furthermore, the aim of diversified and internationalized R&D was to increase the level of knowledge while increasing the level of production and sales. This increased level of sales and knowledge provided companies to reach higher levels of profitability than those whose R&D processes just covered fewer countries or domestic ones (Peters and Schmiele, 2011).

2. Data And Methodology

2.1 Data

The research entailed listed manufacturing firms on Istanbul Stock Exchange (ISE) in the period 2006-2011. All the necessary accounting numbers were combined from Public Disclosure Form and Istanbul Stock Exchange Websites. The firms with missing data were excluded from the sample and the last form of the sample included 760 firm year observations.

2.2 Model

This study examined the effects of lag year R&D expenditures on sales revenue, gross, operating, and net profit of ISE listed manufacturing firms for 2006-2011 period.

To see the effect of R&D expenditures on sales we established our models as;

$$SRt= \beta 0 + \beta 1RD(t\text{-}1) +\varepsilon \qquad (1)$$

$$GPt= \beta 0 + \beta 1RD(t\text{-}1) + \varepsilon \qquad (2)$$

$$OPt= \beta 0 + \beta 1RD(t\text{-}1) + \varepsilon \qquad (3)$$

$$NPt = \beta 0 + \beta 1RD(t\text{-}1) +\varepsilon \qquad (4)$$

SRt is the Sales Revenue at time *t* and RD(t-1) is the Research and Development expenditure at time *t-1*. GPt is the Gross Profit at time *t* while OPt is the Operating Profit and NPt is the Net Profit.

2.3 Methodology

Panel data analysis was used to see the combined effects of variables in different years for each firm; additionally, it overcomes the possible multicollinearity effects of ordinary least square model (OLS). Panel data analysis let us see more heterogeneous observations in the calculation sample as well (Baltagi, 1995; Gujarati, 2003).

The effects of R&D and marketing expenditures on sales revenue and net income were also investigated by (Yucel and Kurt, 2001), they found the effects of advertising expenses on sales significant but not for the R&D for the ISE 100 firms in 2001. That may be due to lack of observations as the sample was composed of ISE 100 firms without holdings for only the year 2001. On the other hand, present study explained the lag year effect of R&D expenditures on Sales and following Gross, Operating and Net Profit dependent variables. We humbly believe that our study contributes to literature that the R&D effects on Sales revenue and Profit can better be seen by lag year approach.

3. Findings

3.1 Panel Data Analysis OLS

It is found on tables that lag year R&D expenditures had positively significant effect on the sales revenue when the data was run over the Panel Data Analysis. The similar significant results were also found for the R&D expenditures and Gross, Operating and Net Profits between 2006 and 2011. A dummy variable was put into the year 2008 to see whether crises had an impact on R&D expenditures but no significant relationship was found.

3.2 Simple Linear Regression Analysis

When the results were calculated over the simple linear regression, it was founded that the significance levels were decreased for the years 2007 and 2008 for Sales Revenue. Likewise, the R&D expenditures in year 2006 did not have a significant effect on Net and Operating Profits. The effect of R&D expenditures on Sales Revenue, and Gross Profit were found significant in 2007, and in 2008 R&D expenditures had significant effect on Sales Revenue, Gross Profit and Operating Profit. In 2009 and 2010, the previous year's R&D expenditures had significant effect on Sales Revenue, Gross, Operating and Net Profits for ISE Manufacturing Firms.

4. Result

It is found for the years 2006 to 2011 that R&D expenditures have significant effect on the sales revenue, operating profit and the net income of the manufacturing firms' in Istanbul Stock Exchange.

5. Conclusion

The authors humbly believe that the lag year effect of the R&D expenditures for the manufacturing firms would be helpful for the companies to control their long term strategic research and development expenditures. It is found that the research and development expenditures have a positive effect on the sales revenue with a strong positive coefficient. Interestingly, different than the literature (Kurt and Yucel, 2003), there is also positive coefficient, not as strong as sales revenue, between R&D expenditures and operating and net income for the years 2006 to 2011 depending on the panel data analysis. This may be due to the lag year effect of R&D expenditures on Operating and Net Income and shows that the R&D expenditures may explain the long term positive increase of profit.

Further research may cover the industry level effects of R&D expenditures for the manufacturing firms.

APPENDIX

Effect of R&D(t-1) on Sales (t) Between 2006-2011

Random-effects GLS regression				Number of obs	=	758
Group variable: firm				Number of groups	=	153
R-sq: within	= 0.0108			Obs per group: min	=	3
between	= 0.1145			avg	=	5.0
overall	= 0.0836			max	=	5
Random effects u_i ~ Gaussian				Wald chi2(1)	=	10.44
corr(u_i, X)	= 0 (assumed)			Prob > chi2	=	0.0012

Sales Revenue (t) |	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
R&D(t-1) |	18.2891	5.659226	3.23	0.001	7.197217	29.38097
_cons |	8.48e+08	2.16e+08	3.92	0.000	4.24e+08	1.27e+09
sigma_u |	2.624e+09					
sigma_e |	7.521e+08					
rho |	.92407911	(fraction of variance due to u_i)				

Effect of R&D(t-1) on Gross Profit(t)

Random-effects	GLS regression			Number of obs	=	758
Group variable:	firm			Number of groups	=	153
R-sq: within=	0.0076			Obs per group: min	=	3
between=	0.2598			avg	=	5.0
overall=	0.1703			max	=	5
Random effects	u_i ~ Gaussian			Wald chi2(1)	=	11.48
corr(u_i, X)	= 0 (assumed)			Prob > chi2	=	0.0007
Grossprofit (t) |	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
R&D(t-1) |	2.350402	.6936636	3.39	0.001	.9908464	3.709958
_cons |	1.36e+08	2.34e+07	5.79	0.000	8.97e+07	1.82e+08
sigma_u |	2.78E+08					
sigma_e |	90793915					
rho |	.90380993	(fraction of variance due to u_i)				

Effect of R&D(t-1) on Operating Profit (t)

Random-effects GLS regression				Number of obs	=	758
Group variable: firm				Number of groups	=	153
R-sq: within = 0.0228				Obs per group: min	=	3
between = 0.1360				avg	=	5.0
overall = 0.0811				max	=	5
Random effects u_i ~ Gaussian				Wald chi2(1)	=	32.33
corr(u_i, X) = 0 (assumed)				Prob > chi2	=	0.0000
Operatingprofit(t) |	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
R&D(t-1) |	4.655224	.8186764	5.69	0.000	3.050647	6.2598
_cons |	4.90e+07	1.04e+07	4.71	0.000	2.86e+07	6.94e+07
sigma_u | 1.139e+08						
sigma_e | 1.250e+08						
rho | .45335571 (fraction of variance due to u_i)						

Effect of R&D(t-1) on NetProfit (t)

Random-effects GLS regression				Number of obs	=	758
Group variable: firm				Number of groups	=	153
R-sq: within = 0.0234				Obs per group: min =		3
between = 0.1345				avg =		5.0
overall = 0.0901				max =		5
Random effects u_i ~ Gaussian				Wald chi2(1)	=	28.67
corr(u_i, X) = 0 (assumed)				Prob > chi2	=	0.0000

Netprofit(t)		Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
R&D(t-1)		2.811874	.525139	5.35	0.000	1.782621	3.841127
_cons		3.71e+07	8696598	4.27	0.000	2.01e+07	5.42e+07

sigma_u | 1.008e+08
sigma_e | 74891732
rho | .64436328 (fraction of variance due to u_i)

Effect of 2006 R&D Expenditures on Sales of 2007

Source	SS	df	MS		
				Number of obs =	72
Model	1.8938e+19	1	1.8938e+19	Prob > F	= 0.0033
Residual	1.4332e+20	70	2.0474e+18	R-squared	= 0.1167
				Adj R-squared	= 0.1041
Total	1.6225e+20	71	2.2853e+18	Root MSE	= 1.4e+09

sales_2007		Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
r_d2006		72.46299	23.8256	3.04	0.003	24.94433	119.9817
_cons		6.53e+08	1.81e+08	3.61	0.001	2.92e+08	1.01e+09

Effect of 2007 R&D Expenditures on Sales of 2008

Source	SS	df	MS		
				Number of obs =	73
Model	2.12E+19	1	2.1211e+19	Prob > F	= 0.0030
Residual	1.59E+20	71	2.2382e+18	R-squared	= 0.1178
				Adj R-squared =	0.1053
Total	1.80E+20	72	2.5017e+18	Root MSE	= 1.5e+09

sales_r~2008 |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
r_d_exp~2007 |	124.0975	40.31156	3.08	0.003	43.71849	204.4764
_cons |	5.94e+08	2.01e+08	2.96	0.004	1.94e+08	9.94e+08

Effect of 2008 R&D Expenditures on Sales of 2009

Source	SS	df	MS		
Model	5.58E+19	1	5.5844e+19	Number of obs =	78
Residual	9.18E+19	76	1.2085e+18	Prob > F	= 0.0000
				R-squared	= 0.3781
				Adj R-squared =	0.3699
Total	1.48E+20	77	1.9180e+18	Root MSE	= 1.1e+09

sales_2009	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d	60.88708	8.956771	6.80	0.000	43.04812	78.72603
_cons	5.20E+08	1.30e+08	4.01	0.000	2.62e+08	7.79e+08

Effect of 2009 R&D Expenditures on Sales of 2010

Source	SS	df	MS		
Model	1.34E+20	1	1.3419e+20	Number of obs =	81
Residual	9.31E+20	79	1.1779e+19	Prob > F	= 0.0011
				R-squared	= 0.1260
				Adj R-squared =	0.1150
Total	1.06E+21	80	1.3310e+19	Root MSE	= 3.4e+09

sales2010	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d	116.8632	34.62462	3.38	0.001	47.9446	185.7818
_cons	9.14E+08	4.11e+08	2.23	0.029	9.64e+07	1.73e+09

Effect of 2010 R&D Expenditures on Sales of 2011

Source	SS	df	MS		
Model	2.11E+20	1	2.1090e+20	Number of obs=	79
Residual	2.04E+21	77	2.6514e+19	Prob > F	= 0.0061
				R-squared	= 0.0936
				Adj Rsquared=	0.0819
Total	2.25E+21	78	2.8878e+19	Root MSE	= 5.1e+09

sales2011	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2010	117.759	41.75335	2.82	0.006	34.61743	200.9005
_cons	1.36E+09	6.17e+08	2.20	0.031	1.27e+08	2.59e+09

Effect of 2006 R&D Expenditures on 2007 Net Profit

Source |	SS	df	MS	Number of obs =	152
Model |	6.85E+15	1	6.8510e+15	Prob > F =	0.5654
Residual |	3.10E+18	150	2.0643e+16	R-squared =	0.0022
				Adj R-squared =	-0.0044
Total |	3.10E+18	151	2.0552e+16	Root MSE =	1.4e+08

netprof~2007 |	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2006 |	1.326328	2.302302	0.58	0.565	-3.222803	5.875459
_cons |	5.07E+07	1.20e+07	4.21	0.000	2.69e+07	7.45e+07

Effect of 2006 R&D Expenditures on 2007 Gross Profit

Source	SS	df	MS	Number of obs =	152
Model	3.08E+17	1	3.0775e+17	Prob > F =	0.0477
Residual	1.16E+19	150	7.7215e+16	R-squared =	0.0259
				Adj R-squared =	0.0194
Total	1.19E+19	151	7.8742e+16	Root MSE =	2.8e+08

grosspr~2007	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2006	8.889414	4.45271	2.00	0.048	.0912798	17.68755
_cons	1.12E+08	2.33e+07	4.80	0	6.56e+07	1.58e+08

Effect of 2006 R&D Expenditures on 2007 Operating Profit

Source	SS	df	MS	Number of obs =	152
Model	1.83E+16	1	1.8294e+16	Prob > F =	0.4433
Residual	4.64E+18	150	3.0963e+16	R-squared =	0.0039
				Adj R-squared =	-0.0027
Total	4.66E+18	151	3.0879e+16	Root MSE =	1.8e+08

operati~2007	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2006	2.167369	2.819626	0.77	0.443	-3.403946	7.738684
_cons	6.16E+07	1.47e+07	4.18	0	3.24e+07	9.07e+07

Effect of 2007 R&D Expenditures on 2008 Gross Profit

Source	SS	df	MS			
Model	7.67E+17	1	7.6659e+17		Number of obs =	152
Residual	1.43E+19	150	9.5202e+16		Prob > F =	0.0052
					R-squared =	0.0509
					Adj R-squared =	0.0446
Total	1.50E+19	151	9.9648e+16		Root MSE =	3.1e+08
gross_p~2008	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2007	21.89113	7.714531	2.84	0.005	6.647945	37.13431
_cons	1.09E+08	2.66e+07	4.10	0	5.64e+07	1.62e+08

Effect of 2007 R&D Expenditures on 2008 Operating Profit

Source	SS	df	MS			
					Number of obs =	152
Model	1.67E+16	1	1.6670e+16		Prob > F =	0.2164
Residual	1.62E+18	150	1.0816e+16		R-squared =	0.0102
					Adj R-squared =	0.0036
Total	1.64E+18	151	1.0855e+16		Root MSE =	1.0e+08
operati~2008	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2007	3.228107	2.600261	1.24	0.216	-1.909763	8.365978
_cons	2.72E+07	8967867	3.03	0.003	9453752	4.49e+07

Effect of 2007 R&D Expenditures on 2008 Net Profit

Source	SS	df	MS			
					Number of obs =	152
Model	3.44E+16	1	3.4390e+16		Prob > F =	0.0267
Residual	1.03E+18	150	6.8623e+15		R-squared =	0.0323
					Adj R-squared =	0.0259
Total |	1.06E+18	151	7.0446e+15		Root MSE =	8.3e+07
net_pro~2008	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2007	-4.63663	2.071195	-2.24	0.027	-8.729115	-.54415
_cons	2.27E+07	7143205	3.18	0.002	8581213	3.68e+07

Effect of 2008 R&D Expenditures on 2009 Gross Profit

Source	SS	df	MS			
					Number of obs =	153
Model	2.14E+18	1	2.1389e+18		Prob > F =	0.0000
Residual	1.17E+19	151	7.7513e+16		R-squared =	0.1545
					Adj R-squared =	0.1489
Total	1.38E+19	152	9.1075e+16		Root MSE =	2.8e+08
gross_profit2009	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2008	11.66573	2.22078	5.25	0	7.277916	16.05354
_cons	9.49E+07	2.30e+07	4.13	0	4.95e+07	1.40e+08

Effect of 2008 R&D Expenditures on 2009 Operating Profit

Source	SS	df	MS			
Model	1.55E+17	1	1.5516e+17		Prob > F	= 0.0192
Residual	4.18E+18	151	2.7703e+16		R-squared	= 0.0358
					Adj R-squared =	0.0294
Total	4.34E+18	152	2.8541e+16		Root MSE	= 1.7e+08
					Number of obs =	153
operating 2009	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2008	3.141976	1.327636	2.37	0.019	.5188344	5.765118
_cons	4.42E+07	1.37e+07	3.22	0.002	1.70e+07	7.14e+07

Effect of 2008 R&D Expenditures on 2009 Net Profit

Source	SS	df	MS		Number of obs	153
Model	2.58E+17	1	2.5788e+17		Prob > F	0
Residual	1.46E+18	151	9.6404e+15		R-squared	0.1505
					Adj R-squared	0.1449
Total	1.71E+18	152	1.1274e+16		Root MSE	98000000
net_profit_t2009	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2008	4.050637	.7831874	5.17	0	2.503216	5.598058
_cons	2.38E+07	8107604	2.94	0.004	7808300	3.98E+07

Effect of 2009 R&D Expenditures on 2010 Gross Profit

Source	SS	df	MS		Number of obs	152
Model	4.54E+18	1	4.5422e+18		Prob > F	0
Residual	1.18E+19	150	7.8699e+16		R-squared	0.2779
					Adj R-squared	0.273
Total	1.63E+19	151	1.0826e+17		Root MSE	280000000
gross_p~2010	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2009	20.73875	2.729809	7.60	0	15.34491	26.1326
_cons	8.76E+07	2.36e+07	3.71	0	4.09E+07	1.34E+08

Effect of 2009 R&D Expenditures on 2010 Operating Profit

Source	SS	df	MS		Number of obs =	152
Model	8.11E+17	1	8.1069e+17		Prob > F	= 0.0000
Residual	3.10E+18	150	2.0675e+16		R-squared	= 0.2072
					Adj R-squared =	0.2019
Total	3.91E+18	151	2.5907e+16		Root MSE	= 1.4e+08
operati~2010	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2009	8.761437	1.399172	6.26	0	5.996805	11.52607
_cons	3.63E+07	1.21e+07	3.00	0.003	1.24e+07	6.02e+07

Effect of 2009 R&D Expenditures on 2010 Net Profit

Source	SS	df	MS		Number of obs	152
Model	5.41E+17	1	5.4078e+17		Prob > F	0
Residual	2.02E+18	150	1.3472e+16		R-squared	0.2111
					Adj R-squared	0.2059
Total	2.56E+18	151	1.6964e+16		Root MSE	1.2E+08
net_pro~2010	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2009	7.155817	1.129433	6.34	0	4.924164	9.387469
_cons	3.11E+07	9775105	3.18	0.002	1.18E+07	5.04E+07

Effect of 2010 R&D Expenditures on 2011 Gross Profit

Source	SS	df	MS		Number of obs =	149
Model	7.71E+18	1	7.7071e+18		Prob > F	= 0.0000
Residual	1.89E+19	147	1.2887e+17		R-squared	= 0.2892
					Adj R-squared =	0.2844
Total	2.67E+19	148	1.8007e+17		Root MSE	= 3.6e+08
gross_p~2011	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2010	21.81995	2.821512	7.73	0	16.24398	27.39591
_cons	1.21E+08	3.04e+07	4.00	0	6.14e+07	1.81e+08

Effect of 2010 R&D Expenditures on 2011 Operating Profit

Source	SS	df	MS		Number of obs =	149
Model	1.28E+18	1	1.2751e+18		Prob > F	= 0.0000
Residual	7.65E+18	147	5.2045e+16		R-squared	= 0.1429
					Adj R-squared =	0.1370
Total	8.93E+18	148	6.0310e+16		Root MSE	= 2.3e+08
operati~2011	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2010	8.87535	1.793077	4.95	0	5.331811	12.41889
_cons	6.38E+07	1.93e+07	3.31	0.001	2.57e+07	1.02e+08

Effect of 2010 R&D Expenditures on 2011 Net Profit

Source	SS	df	MS		Number of obs	149
Model	6.02E+17	1	6.0184e+17		Prob > F	0
Residual	4.02E+18	147	2.7326e+16		R-squared	0.1303
					Adj R-squared	0.1244
Total |	4.62E+18	148	3.1208e+16		Root MSE	1.7E+08
net_pro~2011	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_d2010	6.097447	1.299252	4.69	0	3.529821	8.665073
_cons	4.59E+07	1.40e+07	3.29	0.001	1.83E+07	7.36E+07

REFERENCES

Aghion, Philippe, Peter H. March 1996. Research and Development In The Growth Process, *Journal of Economic Growth*, pp. 49-73.

Barlevy, G. Nov. 2005. "Why do not Recessions Encourage More R&D Spending", *Essays on Issues Chicago FED Letter,* No. 220,

Branch, Ben. Sep.- Oct. 1974. Research and Development Activity and Profitability: A Distributed Lag Analysis, *Journal of Political Economy*, Vol. 82, No. 5. pp.999-1011.

Brown, William H. August 1957. Innovation In The Machine Tool Industry, *Quarterly Journal of Economics*, Vol. 71, No. 3, pp. 406-425.

Chan, Louis K. C., Josef L., and Theodore S. Dec. 2001. The Stock Market Valuation of Research and Development Expenditures, *The Journal of Finance*, Vol. LVI, No. 6, pp.2431-2456.

Chauvin, Keith W., Mark, H. Winter, 1993. Advertising, R&D Expenditures and the Market Value of the Firm, *Financial Management*, Vol. 22, No. 4 pp. 128-140.

Coad, A., Rekha,R. March 2010. Firm Growth and R&D Expenditure, *Economics of Innovation and New Technology*, Vol. 19, No. 2, pp. 127-145.

Correa, P., Mariana l., "R&D Decisions During The Crisis: Firm Level Evidence For Selected Eastern Countries", *World Bank Group, Enterprise Note*, No. 21.

Geroski, P., Steve M., John V. N. Summer, 1993. The Profitability of Innovating Firms, *The RAND Journal of Economics*, Vol. 24, No. 2, pp. 198-211.

Grabowski, Henry G., Dennis C. M. Autumn, 1978. Industrial Research and Development, Intangible Capital Stocks, and Firm Profit Rates, *The Bell Journal of Economics*, Vol. 9, No. 2, pp. 328-343.

Mudambi, R., Tim, S. 2011. Proactive R&D Management and Firm Growth: A Punctuated Equilibrium Model, *Research Policy*, Vol. 40, pp. 429-440.

Nelson, R. 1959. The Economics of Invention: A Survey of Literature*, The Journal of Business*, Vol. 32, No.2.

Pandit, S., Charles E. W., Tzachi Z. January 2011. The Effect of R&D Inputs and Outputs on the Relation between the Uncertainty of Future Operating Performance and R&D Expenditures, *Journal of Accounting, Auditing and Finance*, Vol.26, No.1, pp.121-144.

Peters, B., Anja S. January 2011. The Contribution of International R&D to Firm Profitability *Centre for European Economic Research,* Discussion Paper No: 11-002.

Srinivasan, R., Gary L. L., Shrihari, S. May 2011. Should Firms Spend More on Research and Development and Advertising During Recessions? *Journal of Marketing,* Vol. 75. pp. 49-65.

Srinivasan, R., Gary L. L. *2009.* R&D Advertising and Firm Performance in Recessions, *ISBM Report.*

Yucel, T., Guluzar, K. August 2003. The Effects of Advertising and Research & Development Expenditures on Firm Profitability, "*Iktisat Isletme ve Finans Dergisi*" pp. 18-24.

Challenges and Opportunities of Implementing Cooperation in R&D and Value-Chain

Alberto de la Calle [60], *Esther Alvarez*[61], *Jalal Ashayeri*[62]

Abstract

This paper reviews common practices of value chain analysis in manufacturing and identifies challenges and opportunities for developing and implementing a partnership in R&D and Value Chain. This is carried out by examining the trends, the research and studies done globally on collaboration/cooperation in the area. The idea is to present a holistic view and discuss mechanisms that allow designers, producers, processors, buyers, sellers, and consumers — separated by time and space — to gradually add value by designing the right products, and delivering products and services as they pass from one link in the chain to the next. Value chain concept adopted here is different than the one popularized by Michael Porter. Since our adopted concept can be easily diffused into a wide array of activities and is very close to the practice of supply chain, it constitutes an important concept complementing other development approaches already discussed in the literature. The findings suggest that although many papers can be found addressing this issue, the major coordination problems are not well-described.

Keywords: R&D, Value Chain, Cooperation, Coordination

1. Introduction

The speed at which technology advances and increased competition are sources of instability and uncertainty for businesses. In order to reduce the volatility of the variables that are part of the environment, companies seek to deploy their strategies to anticipate or at least to adapt, as quickly as possible, to the changes. Today, any chain cannot be the most outstanding in all the upstream and downstream activities and therefore must be somehow integrated to maximize the use of all available resources to adapt to the competitive environment of mass customization in order to enhance market competitiveness.

Throughout the time there has been a change in the competitive paradigm of the products offered. Traditionally, the features and functionality of a product were enough to determine the degree of interest and demand position occupied by the product over its competitors. However, there have been adding new elements such as after-sales service, delivery time, the products' design, the customization degree which complement the traditional product price, quality and functionality. Many of these parameters are out of the control of an isolated company in the supply chain. Thus, the ability to adapt to change depends not only on the ability of the company itself but the adaptability of its upstream suppliers and downstream customers to new circumstances.

[60] Universidad de Deusto, Spain, +34 944139000, acalle@deusto.es
[61] Universidad de Deusto, Spain, +34 944139000, esther.alvarez@deusto.es
[62] Tilburg University, Netherlands, +31 13 466 2176, j.ashayeri@uvt.nl

In business management the necessary transcendence of individuality has led in recent times the importance of concepts such as value chain, extended enterprise and supply chain. The popularity of these concepts is shown both from the business, as the academic fields. The first group because of the number of meetings and forums as well as initiatives that develop business cooperation as a teaser and the second by the number of investigations conducted in recent years.

This field of study is of special interest because it goes beyond the traditional objective of managing the supply chain, to be more efficient operationally. It seeks for the improvement of the overall performance of the chain.

It is commonly accepted that a substantial part of the innovation processes occur between the interactions of the members of the same chain. It makes companies wonder how resources and capabilities of their suppliers and customers can be used to create greater value on their products and services. The improvement of collaboration will be essential for a more effective and efficient chain, which definitively will face in better conditions the customer needs.

Advances in production technologies and information and communication systems are basic towards meeting the needs of customers. In this way the customer focus has gone from being a differentiating strategy to a minimum requirement to compete. The need to meet their requirements and expectations, leading the company to substitute products for new or improved versions even before reaching their maximum sales level.

There is widespread consensus that innovation is a key element in industrial development and is widely accepted for determining competitiveness. The company can reach new heights through competitive markets with the launch of new and improved products, either through process improvement resulted in a higher productivity factor. The innovation is now embedded into the business agenda of most organizations, i.e. new ways of understanding the products, production processes, organizational management, marketing, etc.

For many years companies have based their innovations development using their own resources. On the one hand, it implies a strong dependence of their abilities. On the second hand it supposes to start from a narrowed vision limited to the characteristics of the surrounding environment. Additionally, the reactive nature of the strategies in response to the competitors' actions or changes in the markets means that companies see their competitive capability bounded by their own business strategies.

Innovation in collaboration with suppliers and customers is emerging as a business strategy that can break the limitation of resources and expertise to respond with greater accuracy to the needs of the markets. However, this strategy is not immune to the fears inherent to collaboration. In order to achieve efficient collaboration companies must overcome different barriers: the possibility of losing power, the risk to third parties to benefit from the relationship, the equivalence in the level of commitment from all parties, the responsibility in the decision-making, etc.

Although innovation and collaboration are claimed as forces by which the company can generate new value for customers, the work done so far do not shed enough light on the trinomial: innovation-collaboration-added value.

This research focuses on how to improve the performance of the innovative capacity of the company from taking advantage of the collaborative strategy that could be implemented with its suppliers and customers. Section 2 discusses briefly the research objectives. Section 3 presents the contemporary literature on cooperation and collaboration in R&D and value chain. Section 4 summarizes face to face findings. Finally, Section 5 presents conclusions and the need for a holistic view and mechanisms that allow designers, producers, processors, buyers, sellers, and consumers — separated by time and space work together.

2. Research Objectives

The environment in which the company operates is becoming increasingly complex and dynamic. The variables that companies can consider to plan and deploy their business strategies are characterized by their huge number of items and the volatility of their values. In this context, companies are in a continuous re-formulation of business strategies that enable them to sustained growth over time.

In a supply chain there is at least the minimum buyer-seller relationship, i.e. the negotiation for setting volume and purchase price, transaction of goods... The collaborative strategy aims to go beyond the reduction of transaction costs, to focus on developmental characteristics for delivering greater value to customers. Thus, the company and its relationship with its supply chain are emerging as an interesting scenario to study how the development of collaborative strategies affect the innovation performance, how it influences both on business performance and on customer perception.

The collaboration is based on the premise that all parties make profit. This is the win-win philosophy. However, reality throws some figures to show the difficulty of doing so. According to some studies, the failure rate of alliances is very high, around 70% (Faems et al, 2005).

There are many obstacles to launching and sustaining a strategy of collaboration: trust, organizational design, the difficulty to align internal processes, the disparity or lack of infrastructure, the presence of major power centers in the chain, etc. Other kind of barrier lie in the collaboration understanding. Failure to understand it in the same way implies misunderstandings, conflicts and ultimately the end of relationships.

Since 80s, when companies made important investments in its operational effectiveness, many supply chain initiatives have been proposed. Methodologies as developed by Chrysler and its suppliers in the SCORE (Supplier Cost Reduction Effort); Wal-Mart proposals as the CPFR methodology (Collaborative Planning, Forecasting and Replenishment) developed in collaboration with the Voluntary Inter-industry with Commerce Standards Association, the VMI methodology (Vendor Managed Inventory), or the ECR methodology (Efficient Consumer Response); and the methodology proposed by the Supply Chain Council SCOR model with (Supply Chain Reference model Operations) and the subsequent adaptation of this methodology to develop new products, named DCOR (Design-Chain Operations Reference Model).

In short, there are many dark spots that should be studied. Given the potential, the company's relationship with its supply chain is displayed as a field of study that can shed light on many challenges and opportunities. This research proposes the development of a model that allows businesses to maximize their potential for innovation through the implementation of collaboration strategy. To help achieve this goal, we set the following objectives:

- Define a common framework of understanding to identify and analyze the concepts that are part of the model: collaborative strategies, innovation processes and business results.
- Discuss approaches to the definition of strategies related to the value chain according to the business context in which the company operates.
- Identify the factors that influence the decision to launch collaborative strategies in the supply chain.
- Determine the relationship and influence of internal and external supply chain factors which affects the innovation capability of the firm.

To reach the above objectives, a thorough literature study is carried out briefly outlined in the next section.

3. Literature Investigation

The result of the literature research has been presented in the following table framework. Depending on the topic and obvious key words covering the broader value of collaboration relevant literature is investigated. The discovered scientific papers assist us to understand better how the value proposition of can be broadened to R&D activities and to manage the whole value chain.

Besides this top-down approach goes from general key phrases to specific scientific papers. This literature research discussion is also supported by additional direct interaction with professionals, which is presented in the following discussions.

The literature survey shows that successful value chains currently create more value by developing more new products. However, many of our collaborative activities are still at an early stage and have not yet begun to deliver in terms of hard economic measures. The feedback **from** the value chain and relationships that have been built between R&D and the rest of the chain are clear indicators of collaboration success. Through reported collaboration to date from the summary table can be noted that:

- Establishing collaboration is an effective way of improving quality and innovation of products as well as reducing development lead-times and cost in a value chain.
- Collaboration in the value chain needs to be formed on the basis of technical competencies and mutual exchange of knowledge, where knowledge sharing then is important key success factor.
- Competencies of separate organizations participating in collaboration within the value chain need to be linked via cross-company various infrastructures. Therefore, the communication means are highly a determinant factor.
- Early and intense integration of strategic value chain collaborators facilitates the successful delivery of goals within the value chain.
- At early stages of the collaboration process technological competencies have to be measured and compared with partners in the chain.
- The boundaries of responsibilities between collaborating parties need to be clearly defined to deliver a successful outcome within the value chain.
- Strategic and long term thinking for the whole value chain increases the chance of successful collaboration.
- On top of all there is the need for a leader to coordinate all stakeholders within the value chain.

Moreover, this literature shows that there is always a strong support for a deep integration of strategic partners early in their R&D activities across the value chain to facilitate the successful delivery of competitive products of quality, short development time, and cost. This is due to more coordination of R&D research activities funneled faster towards the needs of ultimate customers and reducing the risk of producing an unwanted product.

Table 1. Main Literature Findings

	Paper	Paper objective	SCM practices concepts	Performance concepts	Sample and Main Methods	Findings	Observations
1	Fawcett et al (2011)	It evaluates the how's underlying the effective deployment of Information Technologies (IT) in winning SC business models	(a) Information sharing culture (b) Supply chain connectivity (c) Supply chain collaboration	(a) Customer satisfaction (b) Operational performance (c) Profitability (d) Growth	702 / Structural equations modeling	The results show that investments in IT make their greatest competitive contribution when they enable a dynamic SC collaboration capability.	
2	Cao and Zhang (2011)	The objective is to uncover the nature of supply chain collaboration and explore its impact on firm performance based on a paradigm of collaborative advantage.	(a) Information sharing (b) Goal congruence (c) Decision synchronization (d) Incentive alignment (e) Resource sharing (f) Collaborative Communication (f) Joint Knowledge Creation	(a) Collaborative advantage: process efficiency, offering flexibility, business synergy, quality, innovation (b) Firm performance: Growth of sales, Return on investment and profit margin on sales.	211/ Structural equation modeling	The results indicate that supply chain collaboration improves collaborative advantage and indeed has a bottom-line influence on firm performance, and collaborative advantage is an intermediate variable that enables supply chain partners to achieve synergies and create superior performance.	
3	Wong et al (2011)	This paper extends prior supply chain research by building and empirically testing a theoretical model of the contingency effects of environmental uncertainty on the relationships between three dimensions of supply chain integration and four dimensions of operational performance.	(a) Internal integration (b) Supplier integration (c) Customer integration (d) Environmental uncertainty	(a) Organizational performance: delivery, production cost, product quality, production flexibility.	151 / Structural equations modeling	The results offer evidence of the purported impacts of supply chain integration on various operational performance outcomes.	Thailand's automotive manufacturing plants.
4	Allred et al (2011)	This research employs a multi method approach to evaluate collaboration's influence on operational and firm performance.	(a) Supplier orientation (b) Customer orientation (c) Collaboration capability (d) Environmental uncertainty	(a) Satisfaction (b) Productivity (c) Business performance: Profitability and Growth	980 / Structural equations modeling and qualitative method (case study data-interviews to 109 managers.	The results show that collaboration, as a dynamic capability, mediates the conflict resulting from functional orientations, and improves performance.	
5	Lin et al (2010)	This paper investigates the effects of various dimensions of customer relationship management (CRM) on innovation capabilities..	(a) Information sharing (b) Customer involvement (c) Long-term relationship (d) Joint problem solving (e) Technology based CRM	(a) Innovation capability: five most frequently studied innovation capabilities: product, process, marketing, service and administrative innovation.	107 / Regression analysis.	The findings suggest that not all CRM activities contribute to innovation programs, which clearly indicates the need for applying other mechanisms, such as supplier integration, to form a complete innovation program.	Computer industry in Taiwan

6	Hernández-Espallardo et al (2010)	This paper aims to examine how effective different governance mechanisms are in promoting knowledge transfer, learning and performance in SC.	(a) Governance: Relationship-specific assets, Social enforcement, output control, behavior control (b) Learning: Knowledge sharing routines, learning	(a) Performance	219 /Structural Equations modeling	This paper finds that from more influential to less, social mechanism of governance, hostages and behavioral control favor knowledge sharing, leaning and performance in SC. Output control exerts a negative influence on learning in SC.
7	Charterina and Landeta (2010)	It analyses with relational resources and capabilities are determinant in fostering innovations and to what extent these innovations are relevant in achieving superior business results.	(a) Contracts (b) Interdependence (c) Knowledge sharing routines (d) Investment in relation specific assets (e) Resource and capabilities complementary efforts	(a) Innovativeness (b) Business performance: increase in turnover, profit margins and brand recognition.	106 / Structural Equations modeling	The results confirm the existence of customer-supplier relationships, which generally begin from contracts, and are based on trust and resource interdependence, tends to encourage the exchange of knowledge, specialized resources and idiosyncratic investments. It is also observed that the more committed firms are to the relationship, the greater the resulting increase in their innovatinveeness.

Table 1. Main Literature Findings – continued

8	Wiengarten et al (2010)	It seeks to report the results of a study examining the importance of information quality for the efficacy of collaborative supply chain practices	(a) Information quality (b) Information sharing (c) Incentive alignment (d) Joint decision making	Operational performance	152 / Regression analysis	The research illustrates that the impact of collaborative supply chain practices on performance varies significantly depending on the quality of information that is exchanged throughout the supply chain.	German manufacturing firms at various tiers within the automotive industry supply chain.
9	Rosenzweig (2009)	It investigates how various product and market characteristics may influence the nature of the expected positive relationship between e-collaboration and performance. It is based on suppliers' perceptions.	e-collaboration: collaborative product design, forecasting, production and logistics planning.	(a) Operational performance: order fulfillment cycle time, order fill rate, forecast accuracy. (b) Business performance: customer retention rate, sales volume growth and profitability.	50 /Structural Equation Modeling	The results indicate that the greater the extent of internet-enabled , collaborative activities conducted with key customers, the better a manufacturer's performance. High levels of perceived environmental munificence, but not market variability and product complexity level, diminish the positive effect of e-collaboration on operational performance.	
10	Prajogo et al (2008)	This paper aims to explore the extent to which four elements of the value chain (marketing, R&D, procurement and operations) are associated with product quality and product innovation	(a) Customer focus (b) R&D management (c) Process management (d) Supplier management	(a) Product quality (b) Product innovation	194 / Structural equations modeling	The findings suggest that the elements of the value chain differ in their association with product outcomes. Customer focus and process management are related to product quality, but surprisingly while research and development is related to product innovation, customer focus is not. Supplier focus is related to both product quality and innovation.	Australian firms.
11	Tian and Chai (2007)	Proceedings of the 25th International Conference of the System Dynamics Society and 50th Anniversary Celebration July 29 – August 2, 2007 --- Boston	This research tries to prove the rationality of the three dimensional thought and provides modeling method in theory.			The three dimensional systems thinking though becomes to a comprehensive and objective method to construct the causal model of a system.	
12	Walters and Rainbird (2007)	This is a conceptual paper. It tries to briefly review earlier contributions to partner/cooperative innovation with the aim of evaluating the application of the concept to the increasingly popular virtual/ value chain business model.	(a) Partner/cooperative innovation	The value chain organization model as a value creating system.	Examples of partnership innovation (cases description)	Partner/cooperative innovation combines elements of process and product innovation management within a "network structure" to create a product-service response that neither partner could create using its own resources.	The partner provides a a model that facilitates the evaluation of the "total efficacy" of partner/cooperative innovation alternatives. The findings need further validation through empirical data analysis in appropriate industrial settings.

13	Li et al (2007)	This paper examines the relationships between supplier development efforts and buyer competitive advantage from the buyer's perspective, and seeks to understand how specific supplier development efforts may impact on a buyer's operational performance.	(a) Asset specifity (b) Joint action (c) Performance expectation (d) Trust	(a) Market responsiveness (b) Operational effectiveness	147 / Structural equations modeling	The results indicate that each effort of supplier development has a different effect on different dimensions of buyer competitive advantage. Specifically, we found that joint actions and trust appear to be the two most critical elements to enhance the operational effectiveness of a buyer, while asset specificity improves the market responsiveness of a buyer slightly. However, supplier development efforts like increasing supplier performance goals and recognizing supplier progress do not appear to be an effective means and thus should be practised with caution.

Table 1. Main Literature Findings – continued

14	Jeong and Hong (2007)	It examines how customer orientation can be applied in the interactive supply chain system infrastructure.	(a)Information sharing (b)Operational practices: lean systems, postponement, time-based management. (c) Customer management: long term relationship building, satisfaction improvement, complaint management	Supply chain performance outcomes: (a) Informational outcomes (b) Operational outcomes. (c) Customer outcomes.	Literature review	It highlights the importance of supply chain management as a crucial aspect of change management. It also indicates that it is a more critical success factor than any other type of value chain practice. Networks should not focus too narrowly on implementing practices, without first building shared organizational and value chain mental models and attitudinal practices.
15	Narasimhan et al (2006)	It is to create and describe a typology of SCM strategies using the notion of alignment between corporate and functional level strategies.	(a) Corporate SCM initiatives: SC integration, Information sharing, JIT capability, supplier and customer relationship and geographic proximity. (b) Functional SCM initiatives: Emphasis on customer objectives, flexibility, strength of supplier linkage, product design/development, quality control, functional JIT capability, customer orientation, customer oriented logistics, customer service/satisfaction	Firm's performance: financial performance, customer satisfaction, market performance.	411/ (a) Exploratory Factor Analysis (b) Correlation analysis	Based on the results, six SCM strategy typologies are suggested. Through them it was possible to identify two key issues for the development of an effective SCM strategy: (1) The concurrent pursuit of efficient supply chain integration and productive supplier relationship. (2) The pursuit of either geographic proximity of suppliers and customers or electronic linkage with suppliers and customers through advanced information systems and technologies.
16	Li et al (2006)	It tries to empirically test a framework identifying the relationships among SCM practices, competitive advantage and organizational performance.	(a) Strategic supplier partnership (b) Customer relationship (c) Level of information sharing (d) Quality of information sharing (e) Postponement	(a) Organizational Performance: market and financial performance (b) Competitive advantage: Price/cost, quality, delivery dependability, product innovation and time to market.	196/ Structural equation modeling	The results indicate that higher levels of SCM practice can lead to enhanced competitive advantage and improved organizational performance. Also, competitive advantage can have a direct, positive impact on organizational performance.

17	Martinez and Perez (2006)	This paper analyzes the relationship between the dimensions of SC flexibility and business performance in a sample of Spanish automotive suppliers.	(a) Flexibility (b) Environmental uncertainty (c) Technological complexity (d) Mutuality (e) Interdependence (f) Supplier dependence	Firm performance	126/ Linear regression	The results indicate a positive relation between a superior performance in flexibility capabilities and firm performance. On the other hand, flexibility capabilities are enhanced in supply chain with higher environmental uncertainty, technological complexity and mutual understanding but with lower commitment.	Automotive sector
18	Kim (2006)	This study examines the causal linkages among SCM practice, competition capability, the level of SC integration and firm performance.	(a) Level of SC integration: Company's integration with suppliers, Cross functional integration within a company, Company's integration with customers (b) Level of SCM practice: Technical, Structural and logistical initiatives.	(a) Competition capability: cost leadership, customer service, innovative marketing technology, differentiation (b) Firm performance: customer satisfaction, market and financial performance.	623 / Structural equations modeling	The results show that, in small firms, efficient SC integration may play a more critical role for sustainable performance improvement, while, in large firms, the close interrelationship between the level of SCM practices and competition capability may have more significant effect on performance improvement. It is also concluded that, in early stage, the emphasis on systemic SC integration may be more crucial. Once SC integration has been implemented, it may be advisable to focus on SCM practice and competition capability.	

Table 1. Main Literature Findings – continued

19	Vereecke and Muylle (2006)	It empirically tests the relationship between supply chain collaboration and performance improvement	(a)Collaboration with supplier (b)Collaboration with customer	Firm performance: cost, delivery, quality, flexibility, procurement, time to market.	374 / Linear statistical models (correlation and analysis of variance)	The empirical findings support the claim for a concerted approach to collaboration both with suppliers and customers in order to reach maximum performance improvement benefits. Separate collaboration efforts means only minor performance improvements.	Based on the engineering/ assembly industry across 11 European countries.
20	Espitia and Lopez (2005)	The aim of this paper is to clarify how the SCM impact on business performance implementation, taking into account the effects of regional location	It characterizes SCM through four dimensions: (a) Product design (b) The use of flexible production systems (c) Supplier collaboration agreements (d) Customer collaboration agreements.	Return on Sales	52 / Regression analysis	The results show the SCM impact on business performance depends on the geographical location. The competitive advantages related to the different SCM performance of Spanish regions.	
21	Corsten and Kumar (2005)	It attempts to achieve three objectives: First, it proposes a comprehensive scale to measure collaborative Efficient Consumer Response (ECR) initiative. Second the effects of ECR adoption on supplier outcomes are examined. Finally it tries to determine whether the effects of collaborative ECR relationships are similar for large versus small manufacturers and branded versus private-label suppliers.	(a) Transactional specific investments (b) Cross functional teams (c) Incentive systems	Supplier outcomes: Economic performance, perceived equity, capability development.	266/ Structural equation modeling	The results demonstrate that whereas ECR adoption has a positive impact on supplier economic performance and capability development, it also generates greater perceptions of negative inequity on the part of the supplier. However, retailer capabilities and supplier trust moderate some of these main effects.	
22	Wong et al (2005)	It seeks to explore SCM practices and identify practical and theoretical gaps in toy supply chains.	(a) SC performance (b) Product differentiation (c) Lead time management (d) Postponement and customization (e) Inventory and cost management (f) Information sharing and coordination (g) Buyer-seller relationships (h) Distribution and logistics	(a) Level of provided supply responsiveness (b) Level of provided market mediation allowance.	11 / Qualitative analysis	The study concludes that there are three main SCM practices for toy retailers in terms of ordering behaviors (one-off, JIT and mixed model), and one dominated SCM practice for toy manufacturers (Traditional mass production or push-models. It highlights that SCM know-how is not yet capable of managing such levels of volatility and seasonality.	A longitudinal and in-depth case study to international toy manufacturer, which includes qualitative semi-structured interviews and questionnaire to 11 European toy retailers.

			(i) Retail strategy (j) SCM initiatives					
23	Kim and Oh (2005)	Supply chain management: An international Journal	It is focused on manufacturers and suppliers who engage in strategic relationships for quality improvement and new product development.	Based on seven modules: (a) Resource allocation (b) Quality improvement (c) New product development (d) Market demand module (e) Pricing (f) Operations (g)Profit			It shows that sharing the decision making process has indeed a significant impact on the collaboration performance. The paper puts forth that the supply chain partners could expect better performance from their collaboration when both of their perspectives are accommodated equally.	

Table 1. Main Literature Findings – continued

24	Corsten and Felde (2005)	It examines the conditions under which the proposed benefits of collaboration between a firm and its suppliers will occur.	(a) Supplier collaboration (b) Trust (c) Dependence	(a) Innovation (b) Purchasing cost reduction (c) Financial performance	135 / Structural Equation Modeling	The results demonstrate that supplier collaboration has a positive effect on buyer performance both in terms of innovative capability and financial results. As expected, trust and dependence play an important role in supplier relationships.	It is based on a single country (Switzerland) multi-industry study.
25	Chen et al (2004)	The research is based on the premise that strategic purchasing can engender sustainable competitive advantage by enabling firms to: (a) foster close working relationships with a limited number of suppliers; (b) promote open communication among SC partners; and (c) develop long-term strategic relationship orientation to achieve mutual gains.	(a) Strategic purchasing (b) Communication (c) Limited number of suppliers (d) long-term strategic relationship orientation	(a) customer responsiveness (b) Financial performance	221 / Structural equation modeling	The results provide a robust support to the links between strategic purchasing, supply management, customer responsiveness and financial performance of the buying firm.	
26	Narasimhan and Kim (2002)	It tries to examine how the interaction between supply chain integration strategy and competitive strategy (product and market diversification) impacts performance.	(a) Company integration with suppliers (b) Internal integration across the supply chain; (c) Company's integration with customers	Firm performance: (a) Sales growth and (b) market share growth; (c) Profitability;	623/ Structural Equation Modeling	The results imply that in order to pursue sustainable performance growth beyond performance stability obtained simply by dispersing the risks and administrative burdens due to diversity, complexity of product and International market diversification, the linkage of systematic SC integration with diversification strategies is indispensable.	
27	Tan el al (2002)	It describes a survey effort to study contemporary SCM and supplier evaluation practices. It also relates these practices to firm performance.	(a)Supply chain integration (b)Information sharing (c) Supply chain characteristics (d) Customer service management (e) Geographical proximity (f) JIT capability	Supplier evaluation practices: (a) Product and delivery assessment (b) Capacity assessment (c) Information assessment	101 / Factor analysis.	The study reveals that SCM practices could be categorized into six constructs, addressing various aspects of supply and materials management issues, ranging from the broad based supply chain integration to more specific ones.	
28	Tan et al (1999)	It presents details of a survey carried out to determine whether particular quality management, supply base management, and customer relations practices can impact corporate performance.	Total quality management practices Supply base management practices: Customer relations practices	Firm performance: market share, return on total assets, average production costs, overall customer service levels, product quality and four items more.	313 / Regression analysis	The results support and confirm that all three major components of a SC, suppliers, manufacturers and customers must be effectively integrated in order to achieve financial and growth objectives. The results also highlight the fact that SCM initiatives alone cannot improve profitability and market share. With product life cycles shrinking, firms must unceasingly pursue new markets, new technologies and improve cost and delivery performance.	
29	Tan et al (1998)	It examines the relationship between SCM	(a) Specific purchasing practices:	Firm performance: market	313/ Regression	The results provide empirical evidence that selected purchasing	

		practices, supplier performance and company performance.	ten practices. (b) Specific customer relation practices: seven practices.	share, return on total assets, average production costs, overall customer service levels, product quality and four items more.	analysis.	practice and customer relation practices are strongly associated with the perceived financial and market success of firms responding to this survey.

4. In-depth Interviews

In-depth interviews were carried out with managers of five Spanish manufacturing companies. All companies are well positioned in their different sectors and are compromised with customer and supplier integration.

Table 2. Characteristics of companies that were included in the study

	Sector	Supply chain position	Nº of employees
Company A	Automotive	OEM	3,380
Company B	Furniture	OEM	316
Company C	White line	OEM	6,900
Company D	Metal	Tier 1	148
Company E	Metal	Tier 1	42

The interviews lasted on average 2 hours. CEOs and top managers were the people selected to be interviewed due to their whole vision of the company. The aim was to get information about the interaction between the value chain members (specifically customer and supplier integration) and its impact on R&D. The main conclusions are described below:

- The environmental uncertainty was appreciated as high by all managers. The three main reasons were: Supplier and customer disputes (Companies B, C), entrance of new competitors (A, B, C), dramatically decrease of internal demand (all companies). Also the European and National policies for recovering products and material at the end of their life was mentioned by all companies as a source of uncertainty due to continuous changes.
- The response to the environmental uncertainty comes from the companies' strategic plans: Innovation, internationalization, diversification and environmental sustainability were the four strategies mentioned by all companies.
- Although all the companies highlighted their customer orientation compromise, customer integration level was different in all cases: company visits (A, B and D), product testing (C, E), Vendor Managed Inventory (B, C and D). In relation to specific R&D process customers are mainly involved in the idea generation and prototype testing processes (all companies).
- Supplier involvement differs a bit from one company to another: From the supply chain perspective Just in Time (JIT) is carried out by companies A, B, C and D and inventory control is developed using Vendor Managed Inventory (VMI) in companies A and C. Regarding the R&D process the supplier involvement is focused on the concept and prototype development. The R&D units of companies and strategic suppliers usually work together in order to avoid duplicities and to take advantage of work in the same place (not to waste time).

The companies were also asked about the clues for a successful collaboration with customers and suppliers. The main responses were the following: the need of long term agreements, trust, to share risks and benefits, to share information (Companies D and E share inventory information but not their production plans) and employees' compromise. The barriers to collaboration were also gathered: power asymmetries in the value chain and property rights of developed innovations. The position and size of each company in the value chain are important characteristics for encouraging the rest of the chain to adopt standards and integration of technologies for information and communication (ICTs). In this sense, companies A and C due to their economies of scale are able to involve the rest of the chain in the adoption of some standards regarding management (the use of common Enterprise Resource Planning- ERP systems, quality reports and information exchange) and also from the supply chain perspective (batch size, transportation characteristics and frequency).

According to managers, the collaboration impact is appreciated mainly in innovation and internationalization strategies:

- Innovation: they reduced time to market, innovation development costs and increased the success rate in launching new products.
- Internationalization: Strategic suppliers (of companies A, B, C, D) are invited to follow them in the internationalization challenge.

There is a new trend of integrating suppliers into the eco-design approach (especially in company C). This fact involves the generation and development of new ideas and prototypes taking into account an environmental friendly approach of the designed products. International and national policies are getting more and more aware about the energy consumption and the impact of the product life in the environment, so especially for the automotive and household appliances companies have to take care about their products with respect to International legislation.

5. Conclusions

This inductive research study has proposed that a collaborative value chains can improve the competitiveness of R&D activities. It argues for a holistic and strategic view towards R&D activities requires:

1. an early involvement of key suppliers;
2. an open sharing of knowledge between the partners through proper platforms;
3. a long-term orientation towards collaborative relationships that also contains R&D units;
4. an involvement of multiple cross-functional interfaces and clearly defined responsibilities; and
5. an existence of a knowledgeable leader within the value who manages the interfaces between the collaborative partners.

In addition, a contingency approach is needed; there is no way of the "one fits all" regarding collaboration strategy within the value chain.

The framework is based on a set of validated suggestions that are grounded in sound interviews with five companies in Spain. These suggestions were confronted with existing literature and resulted in highlighting the needs for a collaborative R&D process which is going to be further validated through an expert focus group in other industrial settings.

References

Allred, C. R., Fawcett, S. E., Wallin, C. & Magnan, G. M. 2011. A Dynamic Collaboration Capability as a Source of Competitive Advantage. *Decision Sciences*, 42: 129–161.

Cao, M. & Zhang, Q. 2011. Supply chain collaboration: Impact on collaborative advantage and firm performance. Journal of Operations Management*, 29(13): 163-180.*

Charterina, J., Landeta, J. 2010. The pool effect of dyad-based capabilities on seller firms' innovativeness, *European Journal of Innovation Management*, 13 (2): 172-196.

Chen, I.J. & Paulraj, A. 2004. Towards a theory of supply chain management: the constructs and measurements. *Journal of Operations Management*, 22(1): 119-150.

Corsten, D. & Felde, J. 2005. Exploring the performance effects of key-supplier collaboration: An empirical investigation into Swiss buyer-supplier relationships. International Journal of Physical Distribution & Logistics Management*, 35 (6): 445-461.*

Corsten, D. and Kumar, N. 2005. Do Suppliers Benefit from Collaborative Relationships with Large Retailers? An Empirical Investigation of Efficient Consumer Response Adoption, Journal of Marketing, 69(3): 80-94.

Faems, D., Van Looy, B. & Debackere, K. 2005. Interorganizational collaboration and innovation: toward a portfolio approach. *Journal of Product Innovation Management,* 22: 238 250.

Fawcett, s. E., Wallin, C., Allred, C., Fawcett, A. M. & Magnan, G. M. 2011, Information technology as an enabler of supply chain collaboration: a dynamic-capabilities perspective. *Journal of supply chain management*, 47: 38–59.

Jeong, J. S. & Hong, P. 2007. Customer orientation and performance outcomes in supply chain management. *Journal of Enterprise Information Management*, 20(5): 578-594.

Kim, S.W. 2006. The effect of supply chain integration on the alignment between corporate competitive capability and supply chain operational capability. *International Journal of Operations & Production Management*, 26(10): 1084-1107.

Kim, B. & Oh, H. 2005. The impact of decision-making sharing between supplier and manufacturer on their collaboration performance, *Supply Chain Management*, 10(3): 223-236.

Li, S., Ragu-Nathan, B., Ragu-Nathan, T.S. & Rao, S.S. 2006.The impact of supply chain management practices on competitive advantage and organizational performance. Omega, *34(2): 107-124.*

Li, W., Humphreys, P.K., Yeung, A.C.L. & Cheng, T.C.E. 2007. The Impact of Specific Supplier Development Efforts on Buyer Competitive Advantage: An Empirical Model. *International Journal of Production Economics*, 106(1): 230-247.

Lin, R.J., Chen, R.H. & Chiu K.K. 2010. Customer Relationship Management and Innovation Capability: An Empirical Study. *Industrial Management & Data Systems*, 110 (1): 111-133.

Martinez Sanchez, A. & Perez Perez, M. 2007. La flexibilidad de la cadena de suministro: un estudio empírico en la industria de automoción. Cuadernos de Economía y Dirección de la Empresa*, 26: 123-148.*

Hernández-Espallardo, M., Rodríguez-Orejuela, A. & Sánchez-Pérez, M. 2010. Inter-organizational governance, learning and performance in supply chains. *Supply Chain Management: An International Journal,* 15 (2): 101-114.

Narasimhan, R. & Kim, S.W. 2002. Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms. *Journal of Operations Management,* 20(3): 303-323.

Narasimhan, R., Talluri, S. & Mahapatra, S. K. 2006. Multiproduct, multicriteria model for supplier selection with product life-cycle considerations. *Decision Sciences*, 37(4): 577-603.

Prajogo, D. I., McDermott, P. & Goh, M. 2008. Impact of value chain activities on quality and innovation. International Journal of Operations & Production Management*, 28(7): 615-635.*

Rosenzweig, E.D. 2009. A contingent view of e-collaboration and performance in manufacturing. Journal of Operations Management*, 27(6): 462-478.*

Tan, K.C., Kannan, V.R., Handfield, R.B., 1998. Supply chain management: supplier performance and firm performance. *International Journal of Purchasing and Material Management*, 34 (3): 2–9

Tan, K.C., Kannan, V.R., Handfield, R.B. & Ghosh, S. 1999. Supply chain management: an empirical study of its impact on performance. *International Journal of Operations and Production Management*, 19(10): 1034-1052.

Tan, K.C., Lyman, S.B., Wisner, J.D., 2002. Supply chain management: a strategic perspective. *International Journal of Operations and Production Management*, 22(6): 614–631.

Tian, F. & Chai, Y. 2007. *A supply line with integrated plans and strategies.* Proceedings of the 25th International Conference of the System Dynamics Society and 50th Anniversary Celebration. July 29- August 2, Boston. 1-10: 1989-1994.

Vereecke, A. & Muylle, S. 2006. Performance improvement through supply chain collaboration in Europe. International Journal of Operations and Production Management.*, 26(11): 1176-1198.*

Walters, D. and Rainbird, M. 2007. Cooperative innovation: a value chain approach. *Journal of Enterprise Information Management*, 20 (5), 595-607.

Wiengarten, F., Humphreys, P., Cao, G., Fynes, B. & McKittrick, A. 2010. Collaborative supply chain practices and performance: exploring the key role of information quality. Supply Chain Management: An International Journal*, 15(6): 463-473.*

Wong, C.Y., Arlbjørn, J.S. & Johansen, J. 2005. Supply chain management practices in toy supply chains. *Supply Chain Management: An International Journal*, 10(5):367-378.

Wong, C.Y., Boon-itt, S. & Wong, C.W.Y. 2011. The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance. Journal of Operations Management*, 29(6): 604-615.*

Implications of Product Substitutability in Supply Chain Network Downsizing Optimization

Ning Ma[63], Jalal Ashayeri[64], Renata Sotirov[65]

Abstract

This paper discusses an optimization model for understanding the managerial implications of product substitutability in downsizing a multi-product supply chain facing bankruptcy risks, where multi-functional production facilities are shared for producing a group of substitutable products. The proposed mixed integer programming model incorporates a general formulation of demand substitution, which allows arbitrary demand diversion and arbitrary replacement rates between products under investigation. The new product substitution formulation enables considering uneven substitutions for supply chain network design and therefore it extends currently used substitution approaches. We show the new product substitution formulation is efficient for the here-described downsizing applications by following series of tests on product substitution cases. The numerical analysis also demonstrates that new substitution formulation could increase the profitability when compared with the downsizing situation without it.

Keywords: Supply chain network, Downsizing, Product line, Substitution

1. Introduction

Contemporary problems in world economy seem to be continued for years to come. However, unlike in past, today supply chains are global and the crisis are scattered all over the world. Since market fluctuation accumulates and amplifies over the supply chain network, large transnational firms suffer enormous impact and faces bankruptcy risks in the extreme cases. Downsizing, deemed as one of the most effective rescue means, has been widely applied by companies for rightsizing their supply chain networks. A careful application of supply chain downsizing not only improves business stability, but also restores company profitability. Therefore, we propose a mathematical model that addresses downsizing problem and represents a correct strategic framework for analyzing and guiding the downsizing decision process. In what follows, we first briefly discuss the meaning of supply chain downsizing, and then we explore the up-to-date downsizing literature relevant to this study.

In much of the current literature on supply chain management, downsizing has been frequently recognized as personnel reduction. However, downsizing here refers to the supply chain network reconfiguration operations that reduce the resource and the size of a supply chain for improving its business performance. It often results in reduction of supply chain entities (e.g., supplier, production and distribution centers, and customers), production facilities, material flow, and/or production output.

[63] Tilburg University, the Netherlands, +31 13 466 8748, n.ma@uvt.nl
[64] Tilburg University, the Netherlands, +31 13 466 3280, j.ashayeri@uvt.nl
[65] Tilburg University, the Netherlands, +31 13 466 3178, r.sotirov@uvt.nl

Ashayeri et al. (2012) define a supply chain downsizing problem (SCDP) under bankruptcy. Compared with classical supply chain network design problems, the problem has following five unique features:

- The SCDP under bankruptcy optimizes the closure of operation centers and the reduction of production capacities. While selling redundant facilities contribute cash generation, extra investment for adding new facilities to a supply chain network is unavailable because of financial constraint.
- By allowing reselection of customer and disregard of unprofitable demands, the SCDP under bankruptcy only allocates sufficient production capacity to demands which generate earnings.
- A multi-period planning is adopted for taking into account the execution time of downsizing decisions and expected demand changes.
- Cash flow is continuously observed for each planning period such that smooth daily operation and successful debt payment are not hindered.
- Robustness of profitability to uncertainties from operations, markets, and government policies is ensured.

In order to solve the newly defined SCDP under bankruptcy, Ashayeri et al. (2012) present a downsizing mixed integer programming (MIP) model. The model looks for the downsizing solution that maximizes the utilization of investment resources and guarantees successful debt payments. The further developed robust counterparts (see Ben-Tal et al. (2009)) deal with uncertainties of demands and exchange rates. The numerical results confirm the validity of the proposed approach in delivering effective downsizing plans for cash release, profit generation and variation reduction, which leads to higher and sustainable economic value of an existing supply chain network. (For related conference papers, see Ashayeri et al. (2010) and Ma (2011).)

Note that production output reduction, as one of the downsizing option, can result from the reduced production volume and reduced product types. This paper extends the SCDP under bankruptcy to a multi-product case, where additional options to cut certain product types are also included. Comparing with that of Ashayeri et al. (2012), the here described SCDP under bankruptcy has following extra features:

- More than one product exists and generates non-unique marginal profit depending on network configuration.
- Multi-functional machines, representing alternative liquidities in case of capacity contraction, are shared for manufacturing products of different types with various output rates.
- Products are substitutable with each other.

Reduction in product types and other downsizing decisions may interact with each other, which influences the financial performance of the downsized supply chain (see Figure 1). In particular, a reduced number of product types may result in reduced production volume and unsatisfied demand. The causal diagram shows that on one side, the decline of production volume may release production capacity. While redundant capacities are sold for cash generation, the rest are reallocated for manufacturing the remaining product types. The reallocation of production capacity usually involves a supply chain redesign, which results in a reconfigured network. Hence, cost structures for satisfying demands may be varied. The figure shows also on the other side, the substitution of unsatisfied demands suggests shifted demands of the remaining products. Depending on how available capacities are reallocated, demand satisfaction may contribute to revenue generation.

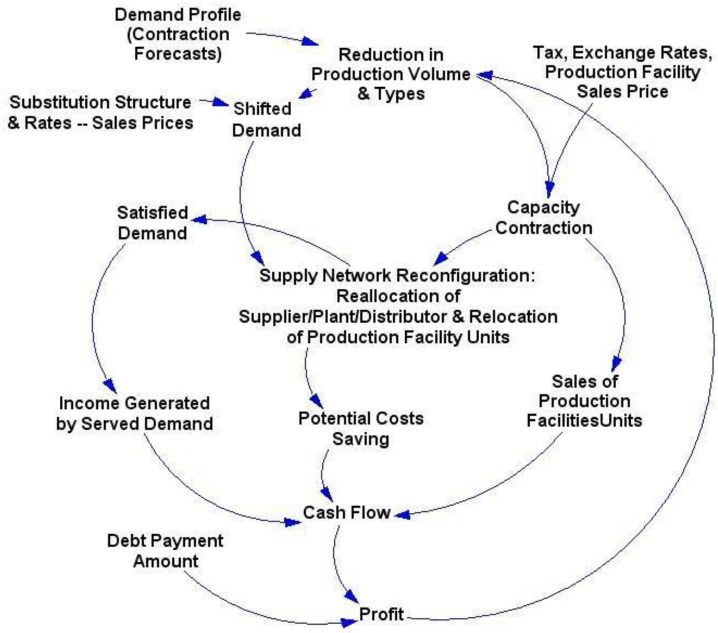


Figure 1. Causal relation of product substitution and downsizing

We organize the rest of the paper as follows. In Section 2 we derive the general formulation of demand substitution, which is incorporated into the multi-product downsizing MIP model in Section 3. The general formulation of demand substitution relate the commonly used substitution rate to the replacement rate of products and to the demand diversion of customers, which makes the proposed MIP model the first MIP formulation that allows uneven substitutions of products for network design. Numerical results in Section 4 demonstrate the validity of the downsizing MIP model for product type reduction. In Section 5, we give concluding remarks. This paper is a short version of Ma et al. (2012).

2. Demand substitution

Demand substitution is often considered by assortment problems, lot-sizing problems with substitution, or capacity investment and planning decisions. Assortment problem, as defined by Pentico (2008), involves the decision of the sizes or qualities of the final products. Demands for an unavailable size can be filled with products of another size. The transformation of available products into desired size involves convention costs. Lang (2010) discusses extensively about lot-sizing problems with substitution. The substitution under consideration can refer to the replacement of demands for un-stocked finished products or to the flexible bill-of-material related to parts and semi-finished products. The literature on economics side capacity investment and planning decisions investigates the impacts of demand substitution on product pricing and on the value of production flexibility. For example, Karakul and Chan (2008) present an analytical study of the influence of product substitutability on the joint pricing and procurement decisions of two different products. Lus and Muriel (2009) concern the optimal investment mix in flexible and dedicated capacities and find that the optimal investment in manufacturing flexibility tends to decrease as the products become more substitutable. On operation research side, Eppen et al. (1989) present a scenario-based MIP model for General Motors capacity planning. To the best of our knowledge, this is the only paper that considers demand substitution for capacity planning using MIP. While assuming that products of General Motors are substitutable, authors require that the replacement rate between any two products is always equal to one and that all diverted demand need to be satisfied. However, in general, unprofitable demands may be disregarded and the replacement rate does not have to be always equal to one. For example, when a 200 grams chocolate pack is unavailable, the demand can be satisfied by two 100 grams chocolate packs. Here, the replacement rate is 2. In this section, we present a general formulation of demand substitution, which allows downsizing MIP model to consider uneven substitution for network design.

The demand quantity of a product relies on the number of customers and their average purchase quantity. The change of demand quantities caused by demand substitution also depends on the diversion of customer from one product to another as well as the replacement rate between the two substitutable products. Let $i,k \in \{1,\ldots,I\}$ be the index of a product type. Our generalized substitution matrix, $Y \in R^{I\times I}$, is defined as

$$Y := \begin{pmatrix} S_{11}H_{11} & S_{12}H_{12} & \ldots & S_{1I}H_{1I} \\ S_{21}H_{21} & S_{22}H_{22} & \ldots & S_{2I}H_{2I} \\ \vdots & \vdots & \ddots & \vdots \\ S_{I1}H_{I1} & S_{I2}H_{I2} & \ldots & S_{II}H_{II} \end{pmatrix}.$$

The substitution rate $Y_{ik} := S_{ik}H_{ik}$ specifies the change of demand quantity of product i when demand of one unit of product k is not satisfied.

S_{ik} and H_{ik} stand for the replacement rate and the demand diversion rate from product k to product i respectively. Without loss of generality, we assume that products of the multi-product SCDP under consideration cannot be separated into independent subgroups where substitution only happens inside each subgroup. In the case that there are two or more mutually independent subgroups of substitutable products, each of the group of products can be studied independently. We define $S := e(e^{-1})^T$, where $e \in R_+^I$ and $(e^{-1})_i := e_i^{-1}$. Here, e_i stands for the replacement rate of the numeraire product to product i. The matrix S has the following properties:

- $S_{ik} > 0, \forall i,k \in \{1,\ldots,I\}$
- $S_{ii} = 1, \forall i \in \{1,\ldots,I\}$
- $S_{ik}S_{ki} = 1, \forall i,k \in \{1,\ldots,I\}$
- $S_{ik} = S_{il}S_{lk}, \forall i,k,l \in \{1,\ldots,I\}$.

There may be a list of products that can fulfill the same demand of a customer. Without loss of generality, we assume that in case $H_{ik} > 0$ for some $i,k \in \{1,\ldots,I\}$, a fraction H_{ik} of unsatisfied customers of product k take product i as their second choice. H has the following properties:

- $H_{ik} \in [0,1], \forall i,k \in \{1,\ldots,I\}$
- $H_{ii} = 0, \forall i \in \{1,\ldots,I\}$
- $\sum_{k=1}^{I} H_{ki} \leq 1, \forall i \in \{1,\ldots,I\}$.

Note that a group of products may require a combined usage. Hence, their demands are interdependent. An unsatisfied demand of one of the products brings down demands of other products, and an increased demand of one of them also brings up the demands of other products. By considering these products as one united product, our proposed formulation can take into account of the demand correlation between products.

3. MIP model for downsizing a multi-product supply chain

Since unsatisfied demand can be diverted to another similar product in the market, a downsized supply chain of multiple substitutable products may face a shifted demand. It is of crucial importance for companies to downsize in accordance with the demand changes. In this section, we present the concept MIP model for solving a multi-product SCDP under bankruptcy, which incorporates the general formulation of demand substitution.

The proposed downsizing model considers downsizing a supply chain network over a multi-period planning horizon, which consists of three levels of entities, which are suppliers, production and distribution centers. The supply chain is privately owned by a transnational manufacturing company. The company produces more than one product. The products are substitutable with each other. The manufacturing processes at production centers are conducted using multi-functional machines. While multi-functional machines of various types are used for producing different ranges of products, their output rates differ depending on the product-machine match. Suppliers conduct subcontracted works and provide production centers with parts and semi-finished products. Distribution centers are located at geometrically different regions and collect local demands.

The objective function of our downsizing MIP model maximizes the sum of discounted net profit values over the planning horizon. Constraints are explained as follows:

1. Constraint set 1 allows the total supply of product i to differ from its expected demand at a distribution center in a certain period.

   (total supply of product i from plant) + (unsatisfied demand of product i) – (oversupply of product i) = (expected demand of product i at distribution center)

2. Constraint set 2 requires the oversupply of product i being bounded by the diverted demand from other products.

   (over-supply of product i) ≤ $\sum_k (Y_{ik} \cdot$ *unsatisfied demand of product* k $)$

3. Constraint set 3 requires that the total supply of raw material in a period to a production center is greater or equal to its demand.
4. Constraint set 4 requires the total demand of raw material in a period at a supplier not to be more than the capacity of that supplier.
5. Constraint set 5 requires the production volume of end product at a production center not to excess the production capacity of that production center in that period. Note that in case there is a production facility set up in a period, a portion of its production capacity is lost.
6. Constraint set 6 balances production capacity between periods.
7. Constraint set 7 identifies whether the production capacity at a production center is changed in a period. In case that the production capacity is changed, a fixed adjustment cost is charged.
8. Constraint set 8 identifies whether a production center has positive production capacity. In case that there is positive production capacity at a production center, the production center operates and is charged with a fixed operation cost.
9. Constraint set 9 identifies whether a distribution center operates in a period. In case that the distribution center operates, a fixed operation cost is charged.
10. Constraint set 10 calculates the revenue of a production center in a period.
11. Constraint set 11 calculates the revenue of a distribution center in a period. Note that we need to allow revenues of production and distribution centers to be either positive or negative in correspondence with tax charges of positive revenues in objective.
12. Constraint set 12 guarantees that distribution and production centers are not reopened after closing.

13. Constraint set 13 ensures that all production and distribution centers are operating at the beginning of the production process.

Based on the formulation of constraint sets 1 and 2, we conclude the following properties of our multi-product downsizing MIP model:

a) When the substitution matrix Y satisfies that $S_{ik} = 1, \forall i,k \in \{1,\ldots,I\}$, the sum of unsatisfied demands is always larger than the sum of diverted demands for all distribution center and period.

b) When the substitution matrix Y satisfies that $S_{ik} = 1, \forall i,k \in \{1,\ldots,I\}$, the total supply of products to a distribution center in a period is less than its total demand.

c) When the substitution matrix Y satisfies that $S_{ik} \geq 1$ for some $i,k \in \{1,\ldots,I\}$, the total diverted demand can be larger than the total unsatisfied demand at a distribution center. But the difference is always less than α-1 times of the total demand at the distribution center in a period, where α represent the largest replacement rate in S.

d) When the substitution matrix Y satisfies that $S_{ik} \geq 1$ for some $i,k \in \{1,\ldots,I\}$, the total supply of products to a distribution center in a period is less than α times of its total demand.

Following these properties, we know that total supply of products is bounded by the worst case, where all demands are substituted according to the largest substitution rate.

4. Numerical results

In this section, we discuss the test results of our downsizing MIP model with one generated downsizing case. Table 1 specifies the general features of the downsizing case. There are two PFU types, four product types, seven production centers, 20 distribution centers, and in total 63 PFUs. Three of the product types, denoted by “A”, “B”, “C”, are substitutable. The profit trade-offs of the three products follow a preference of A to B, and B to C. We test the case with 14 substitution matrices (SuMs), where we gradually increase the substitution rates. We list the SuMs 1 to 14 in the appendix at the end of this paper. Section 4.1 presents the test results of SuMs 1 to 7 where replacement rates are always equal to one, and Section 4.2 presents the test results of SuMs 8 to 14 which represent general substitution situations.

Table 1. Information of the generated case

# of PFU types	# of product types	# of PFUs	# of prod. center	# of dist. center	Profit trade-off of substitutable products
2	4	63	7	20	A>B>C

For illustration purposes, we explain the substitution relationship represented by SuM 5. It suggests that unsatisfied demands of product B are equally divided and diverted to product A and C, and unsatisfied demands of product A are diverted to product B, while unsatisfied demands of product C are lost.

4.1 Numerical results of demand substitution (replacement rate equals to 1)

In Table 2, we present the downsizing solutions of the generated case with SuMs 1 to 7. Since one PFU type is used for producing C, while the other one is used for producing A, B, and the product type whose demand cannot be substituted, we refer the first PFU type as the dedicated PFU, and the second PFU type as the flexible PFU. The columns two to seven of Table 2 specify the downsizing results: the number of PFUs sold and moved for both PFU types, the number of production centers closed, the number of distribution centers closed, and the output TDNP of each test. The last three columns of Table 2 present the demand fulfillment rates (in percentage) of the three products relative to their original demand. Based on the demand fulfillment rate, we can identify where demands are diverted to.

Table 2. Test results of SuMs 1 to 7

Tests	# of PFUs sold		# of PFUs moved		# of prod. center closed	# of dist. center closed	TDNP	Demand fulfillment (%)		
	Flex.	Dedi.	Flex.	Dedi.				A	B	C
No Sub.	2/44	1/19	0	0	0	0	590551	100	100	99
SuM 1	2/44	1/19	0	0	0	0	590551	100	100	99
SuM 2	1/44	1/19	0	0	0	0	603434	77	122	99
SuM 3	9/44	1/19	0	0	0	0	652504	181	23	99
SuM 4	8/44	1/19	0	0	0	0	665226	159	44	99
SuM 5	7/44	0/19	0	0	0	0	618035	102	64	125
SuM 6	0	16/19	6/44	0	0	0	784051	240	50	19
SuM 7	0	16/19	6/44	0	0	0	784051	240	50	19

The downsizing solution considering no demand substitution, listed in row 1 of Table 2, suggests that there are two of the 44 flexible PFUs and one of the 19 dedicated PFUs are sold respectively. It further shows that no PFU is transferred among production centers. All demands of product A and B are satisfied, while only one percent of demands of product C are lost. Note that the lost demands in this case are not profitable. While SuM 1 suggests no profit improvement and the same downsizing solution as if demand cannot be substituted, SuM 2 suggests reducing production volume of product A and diverting 23% demands of A to B. Note that the profitability of products depends on the network configuration and material follows. Although A is more preferable than B according to Table 1, the diverted demands of A to B in SuM 2 indicate that B can generate a higher profit than A under certain network configuration. SuM 3 suggests reducing production of B and diverting 77% demands of B to A. SuM 4, allowing equal substitution between A and B, suggests a combined downsizing results of SuM 2 and 3, which diverts demands both from A to B and from B to A. We refer to this diversion pattern as two-way diversion. While the same two-way diversion happens also with SuM 5 to 7, their suggested major demand diversions are consistent with the corresponding substitution relationships. With SuM 5, the unsatisfied demand of product B is divided equally between product A and C. The test results suggest diverting demands of product B to both A and C. Since both SuMs 6 and 7 allow demands divert freely among A, B, and C, the test results suggest diverting demands of both B and C to A.

While the demand diversion of SuMs 1 to 7 sounds reasonable, we can see that the TDNP increases along with the increased substitution rates from SuMs 1 to 7, which indicates possible profit improvement when considering demand substitution for downsizing.

Comparing the last row with the first row of Table 2, we can also sport that the selling of dedicated PFUs increases significantly from one to 16 and that the number of flexible PFUs reallocated also increases from zero to six. The selling of flexible PFUs, however, decreases from two to zero. This suggests that flexible PFUs are more likely to be reserved after downsizing when products become more substitutable.

4.2 Numerical results of demand substitution (replacement rate can be larger than one)

Here, we extend our test of the generated case with general substitution matrices, where the replacement rates between products are:

$$S = \begin{pmatrix} 1 & 2 & 2 \\ 0.5 & 1 & 1 \\ 0.5 & 1 & 1 \end{pmatrix}$$

This means that e = [1; 0.5; 0.5], and an unsatisfied customer who needs one unit of product B or C will demand for two units of product A for exchange. By adopting the same diversion matrix H of SuMs 1 to 7, we obtain a set of general substitution matrices, SuMs 8 to 14. We list test results in Table 3.

Table 3. Test results of SuMs 8 to 14

Tests	# of PFUs sold		# of PFUs moved		# of prod. center closed	# of dist. center closed	TDNP	Demand fulfillment (%)			SBR
	Flex.	Dedi.	Flex.	Dedi.				A	B	C	
No Sub.	2/44	1/19	0	0	0	0	590551	100	100	99	0
SuM 8	2/44	1/19	0	0	0	0	590551	100	100	99	0
SuM 9	2/44	1/19	0	0	0	0	590551	100	100	99	0
SuM 10	0	1/19	10/44	1/19	0	0	878211	310	0	99	0.71
SuM 11	0	1/19	10/44	1/19	0	0	878211	310	0	99	0.71
SuM 12	9/44	0/19	0	0	0	0	705902	196	9	126	0.36
SuM 13	0	10/19	11/44	1/19	0	0	1205288	477	1	23	0.9
SuM 14	0	10/19	11/44	1/19	0	0	1205288	477	1	23	0.9

Note that A is the most profitable product. By increasing the replacement rate from B and C to A, product A obtains a stronger trade-off position and demand diversion from B and C to A becomes more profitable. We can see that the results in Table 3 indicate a clear pattern of demand diversion, where two-way diversion no longer happens. Demands of B and C are diverted to A in SuM 10 to 14, while demands of A are never diverted to B and C. Besides, when comparing test results of SuM 10, 11, 13, and 14 with the results of no demand substitution, the increased amount of demand fulfillment of product A is always twice as much as the decreased amount of demand fulfillment of product B and C. This is due to the doubled replacement rate between product A and product B (and C).

Comparing with Table 2, we can also note that an increased number of PFUs are reallocated among production centers and a decreased number of PFUs are sold in Table 3. This is due to the doubled production volume when demands are diverted to product A.

We define substitution balance ratio (SBR) of a distribution center in certain period to be equal to the total unsatisfied demand divided by α-1 times of the total demand of that period. According to the property (c) of our downsizing MIP model, SBR should never be more than 1. We list the largest SBR in the column 12 of Table 3 for each test, all of which are less than 1.

5. Conclusion

Here we developed an understanding of the basis for a supply chain network re-configuration problem and its various dimensions under demand substitution. In this paper, we analyzed demand substitution impacts on supply chain downsizing decisions through a carefully formulated new downsizing MIP model.

While the multiproduct downsizing MIP optimizes the supply chain network configuration in accordance with demand contraction forecast, it also takes into account demand adjustments in case of demand substitution. The novel formulation of demand substitution relates substitution rate to demand diversion and replacement rate, and enables the downsizing MIP to consider uneven substitution for network design. While numerical results confirm the validity of our proposed MIP model in assisting companies to reshape their supply chain network, the generalized formulation of demand substitution is also proven to be valuable for careful reduction of product type and helping companies to target a more profitable and sustainable market.

6. References

Ashayeri, J., Ma, N., Sotirov, R., 2012. Supply chain downsizing under bankruptcy: A robust optimization approach. Preprint.

Ashayeri, J., Ma, N., Sotirov, R., 2010. Creating Sustainability through Robust Optimization of Supply Chain Downsizing. Proceedings of the *International Conference on Value Chain Sustainability* (ICOVACS 2010), 159-165, Valencia: Political University of Valencia.

Ben-Tal, A., Ghaoui, L., Nemirovski, A., 2009. *Robust Optimization*. Princeton Series in Applied Mathematics, Princeton University Press.

Eppen, G.D., Martin, R.K., Schrage, L., 1989. A scenario approach to capacity planning. *Operations Research* 37, 517 – 527.

Freeman, S.J., Cameron, K.S., 1993. Organizational downsizing: A convergence and reorientation framework. *Organization Science* 4, 10 – 29.

Karakul, M., Chan, L., 2008. Analytical and managerial implications of integrating product substitutability in the joint pricing and procurement problem. *European Journal of Operational Research* 190, 179-204.

Lang, J.C., 2010. *Production and Inventory Management with Substitutions*. Springer.

Lus, B., Muriel, A., 2009. Measuring the impact of increased product substitution on pricing and capacity decisions under linear demand models. *Production and Operations Management* 18, 95–113.

Ma, N., Ashayeri, J., Sotirov, R., 2012. Product Line Pruning and Supply Chain Network Downsizing. Working paper.

Ma, N., 2011. A Robust Approach to Supply Chain Downsizing Problem. Proceedings of the *International Conference on Value Chain Sustainability* (ICOVACS 2011), 208-214, Leuven: KU Leuven, Center of Industrial Management.

Pentico, D.W., 2008. The assortment problem: A survey. *European Journal of Operational Research* 190, 295–309.

Appendix: Substitution matrices

SuM 1

$$Y = \begin{bmatrix} 0 & 0 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 2

$$Y = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 3

$$Y = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 4

$$Y = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 5

$$Y = \begin{bmatrix} 0 & 0.5 & 0 \\ 1 & 0 & 0 \\ 0 & 0.5 & 0 \end{bmatrix}$$

SuM 6

$$Y = \begin{bmatrix} 0 & 0.5 & 1 \\ 1 & 0 & 0 \\ 0 & 0.5 & 0 \end{bmatrix}$$

SuM 7

$$Y = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

SuM 8

$$Y = \begin{bmatrix} 0 & 0 & 0 \\ 0.25 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 9

$$Y = \begin{bmatrix} 0 & 0 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 10

$$Y = \begin{bmatrix} 0 & 2 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 11

$$Y = \begin{bmatrix} 0 & 2 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

SuM 12

$$Y = \begin{bmatrix} 0 & 1 & 0 \\ 0.5 & 0 & 0 \\ 0 & 0.5 & 0 \end{bmatrix}$$

SuM 13

$$Y = \begin{bmatrix} 0 & 1 & 2 \\ 0.5 & 0 & 0 \\ 0 & 0.5 & 0 \end{bmatrix}$$

SuM 14

$$Y = \begin{bmatrix} 0 & 0 & 2 \\ 0.5 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

The Evaluation of Online Shopping Behaviour of Generation Y

Cansu Yildirim[66] *and A. Guldem Cerit*[67]

Abstract

Increasing usage of Internet affected both consumers and organisations. On one hand, a growing number of consumers prefer buying diversified products through online shopping channels. On the other hand, organisations have to adapt themselves to this innovation in order to grow and stay competitive. In that sense, they need to be adaptive to the new changes in the marketplace. This means, organisations should include creativity, adaptation and innovation in their business and corporate strategies. However, although organisations have been trying to attract new consumers and to retain existing ones through this innovative channel, consumers are sometimes prone to resist innovations such as online shopping. Thus, the aim of this study is to evaluate the online shopping behaviour of generation Y, also called as the Net Generation, and understand whether the consumers are accepting or resisting online shopping. A field study is realized among students, academic and administrative staff of a university in order to measure the behaviours of different samples comparatively.

Keywords: online shopping behaviour, generation Y, consumer resistance, business strategy

Introduction

The everyday life of each individual is experiencing a transformation due to the current developments in technology (Rubin, 2011). Especially, the developments of information and communication technologies are aids for forming the modern life (Kilian, Hennigs, & Langner, 2012). These evolvements bring out the occurrence of Internet that changes both the life and habits of individuals regarding searching for information and/or entertainment, etc. (Correa, Hinsley, & Gil de Zuniga, 2010).

One of these inevitable changes for individuals is the alternative way of purchasing goods which is online shopping (Laohapensang, 2009). The growth of online shopping mediums has aroused interest on both practitioners and consumers (Osman, Yin-Fah, & Hooi-Choo, 2010). On one hand, Internet along with other technological mechanisms such as IPads, IPhones and Androids let retailers conduct their businesses without an actual presence in, for example, foreign countries which may generate competitive advantage for retailers in a competitive marketplace (Kim & Kim, 2010). On the other hand, this change also affected the consumer. Traditionally, consumers have been going to the stores which are considered to be the most convenient. However, with the emergence of online shopping, the obligation of visiting a store in order to purchase something has been eliminated. Consumers started to search the information regarding the product and/or service they want from the Internet and purchase these products and/or services via a direct interaction with an online store (Park & Kim, 2003).

[66] Izmir University of Economics, Sakarya Cad. No: 156, Balcova, Izmir, Turkey, Tel:90 232 488 9874, Faks:0(232) 488 8197, e-mail: cansu.yildirim@ieu.edu.tr, begum.kaplan@std.ieu.edu.tr

[67] Dokuz Eylul University e-mail: Dokuz Eylül University, Maritime Faculty, Tinaztepe Campus, Buca Izmir Turkey, Phone: +90 232 453 4992, e-mail gcerit@deu.edu.tr

The interest coming from both practitioners and consumers also affected the researchers. Online shopping behaviour has become an emerging research area which, for instance, produced over 120 articles in 2001 (Cheung, Zhu, Kwong, Chan, & Limayem, 2003). Several researchers (i.e.: Bellman, Lohse, & Johnson, 1999; Cheung, Zhu, Kwong, Chan, & Limayem, 2003; Constantinides, 2004) have studied the change in consumers' behavioural patterns towards online shopping and the predictors of online purchasing.

Nevertheless, despite the growing interest for online shopping, according to a study 8,5 % of 136 participants claimed that they have never used internet to search for or purchase a product and/ service online (Sorce, Perotti and Widrick, 2005). This demonstrated that some of the consumers have been actually showing some resistance towards online shopping. Moreover, another study declares that still 30 % of consumers who enter an online store exit without purchasing anything (Schaffer, 2000). This means there are other aspects of online shopping behaviour to study in order to understand the behaviour of resistance and the reasons behind the leaving without buying anything. Although there are some studies citing the barriers of online shopping such as security concerns (Laohapensang, 2009) and suggesting factors such as service quality to consider for the success of the e-commerce or the online shopping store (Santos, 2003;Kim & Kim, 2010), these studies were conducted in either far east (i.e.: Thailand or Korea) or in the United States. Thus, the purpose of this study is to clarify the factors affecting online buying behaviour and the effect of web-site quality on online purchasing behaviours' of Turkish consumers. Besides, the results of this study aim to shed a light for practitioners of online shopping channels in order to increase consumers' adaptation to online shopping.

Online shopping

The use of the Internet as a shopping and purchasing medium has been increased unexpectedly (Limayem, Khalifa & Frini, 2000). With the growth of Internet almost 20 years ago, online shopping would become another way of buying goods (Laohapensang, 2009). This brings out opportunities for both businesses and also consumers.

On one hand, the World Wide Web (WWW) helps businesses to search for new markets that otherwise cannot be attained, and this makes Electronic Commerce (EC) one of the most important ways of doing business (Limayem, Khalifa & Frini, 2000). Organisations realized the usage of Internet will make the electronic market global that gives a chance to the companies to reach current and future customers through Web-based businesses instead of traditional retail stores (Limayem, Khalifa & Frini, 2000). Moreover, the low entry barriers of Internet increase its attractiveness as a distribution channel (Melewar and Smith, 2003). For organisations, this strategy of enhancing business scope through employing online shopping channels is attractive since it aids to deliver several aspects of global marketing strategies of an organisation such as branding and building loyalty (Czinkota and Ronkainen, 1990) which in turn may have a positive impact on market share. Thus, general consensus in literature suggests that "*the Internet is just too influential for growth-oriented merchants to ignore"* (Melewar and Smith, 2003, p. 363).

On the other hand, the quick spread of e-commerce in recent years caused an increase in the samples of experienced e-shoppers i.e. individuals who often make purchases on the internet (Hernández, Jiménez & Martín, 2011) since it enables them to purchase goods from anywhere in the world and as the barriers to the flow of information has been removed especially with the emergence of social media (Rehmani and Khan, 2011). Furthermore, using Internet provides consumers with new communication channels which enables them to develop relationships with organisations (Melewar and Smith, 2003; Mangold and Faulds, 2009). A different study claims that consumers view Internet as a convenient medium for shopping since it provides convenience, ease of research, good deals and wider selection alternatives; respectively. (Delafrooz, Paim & Khatibi, 2009).

Rudolph, Rosenbloom and Wagner (2004) list the advantages of online shopping for consumers as follows:

- 7/24 availability,
- Interactivity,
- Powerful and cheap ways of searching information regarding products or services

- Instant physical distribution of intangible goods (e.g: music, movies, PC games, etc.)
- Customization of the transactional surroundings (e.g: Web-site)
- Virtual communities which enables users to communicate.

Thus, as Alba, Lynch, Weitz, Janiszewski, Lutz, Sawyer & Wood (1997) stated Internet shopping had altered both the way people purchase things (i.e.: the daily lives of individuals) and also the entire retailing business (i.e.: the way retailers operate).

Online shopping behaviour

Traditionally, consumers preferred to go to stores to check first-hand and then purchase goods they want; the distinctive characteristic of online shopping provides consumers with an option of not going to a store, and of making their own decisions depending on what they see on the internet (Laohapensang, 2009). As the author states, in today's world, consumers have the options to choose either indirect shopping (using the internet or mail order catalogues), or direct shopping from a store (Laohapensang, 2009).

However, as for the motivations for online shopping, there have been contradicting ideas in the literature. On one hand, some researchers (Childers, Carr, Peck and Carson, 2001; Sorce, Perotti and Widrick, 2005) claim that the motivations are similar to the motivations of traditional shopping. These researchers declare that the hedonic (shopping for fun) and utilitarian (shopping with a goal) motivations of shopping is also applicable for online shopping. Hedonic shoppers look for a product and/or service specific online shopping experience, whereas utilitarian shoppers search for convenience, information, selection and the control over the shopping experience (Sorce, Perotti and Widrick, 2005). On the other hand, others (Cheung, Zhu, Kwong, Chan and Limayem, 2003; Delafrooz, Paim & Khatibi, 2009) state that for consumers, the motivations to purchase online differs from the motivations of purchasing traditionally. In either way, in order to create effective interactions, it is important to understand consumers' needs and factors that influence their behaviours and intentions when shopping online (Delafrooz, Paim & Khatibi, 2009).

Moreover, the effect of demographics on online shopping behaviours is one of the most studied concepts (Cheung, Zhu, Kwong, Chan, Limayem, 2003; Zhou, Dai & Zhang 2007). Factors such as age, gender or income affected consumers' technological behaviour, and in recent years, with the spread of the internet and e-commerce, the importance of these characteristics has also progressed (Hernández, Jiménez & Martín, 2011). For instance, while Zhou, Dai and Zhang (2007) claim that income is one of the main factors that determines the online shopping tendency, Bellman, Lohse and Johnson (1999) declare that the most important factor that affects the decision of purchasing online is the previous behaviour regarding former online purchases. In another study, Degeratu, Rangaswamy and Wu (2000) state that individuals who have a higher "opportunity cost of time" are more likely to shop online in order to save time, and are also less price sensitive than other households with the same demographics. Another study conducted by Zhou, Dai & Zhang (2007) examines the effect of gender on online shopping and finds out that male consumers are more likely to shop online and spend more money online compared to female consumers. Furthermore, several studies investigate the relationship between age and online shopping behaviour (Sorce, Perotti and Widrick, 2005; Zhou, Dai & Zhang, 2007; Hernández, Jiménez & Martín, 2011). For instance, Hernández,Jiménez & Martin (2011) claim that it is not the age that prevents the finalizations of an internet transaction, but the lack of user experience which has generally occurred for older individuals.

In summary, motivations of online shopping may vary, however they might be broadly classified as hedonic and utilitarian. Moreover, these motivations may be affected by several factors such as age and income.

The perceived risk of online shopping

As it may be understood from the above information, developing an online shopping channel and maintaining the business are easier said than done. As well as the positive outcomes, there are also some barriers and challenges of online shopping channels.

As Ram and Sheth (1989) state consumers tend to demonstrate resistance to innovations. According to the authors, the reasons behind this resistance might be classified into two categories: functional barriers (including usage, product or service value and risks associated with the product use) and psychological barriers (consisting consumers' traditions and norms and, perceived product image).

If this classification is taken as a base for identifying the challenges regarding online shopping, the access to the Internet or "*availability of necessary technology*" (Laohapensang, 2009, p. 503) will be one of the barriers. As Rudolph, Rosenbloom and Wagner (2004) point out low-income consumers who may not afford an Internet connection and consumers who do not own credit cards which is compulsory for online shopping will not have a choice to shop online. Another functional barrier is the lack of both using senses (Rudolph, Rosenbloom and Wagner, 2004) and face-to-face interaction with sales associates in online shopping (Zhou, Dai & Zhang 2007). However, the latter one can be solved by providing substitutes such as increasing the responsiveness, for example via providing e-mail addresses, phone and fax numbers and other channels of communication such as online chat rooms (Kim&Kim, 2010). The last functional barrier is regarding the perceived risk of consumer which may be classified as functional risk and economic risk. For instance, when a consumer buys a product from a web-site, since it is not possible to try the product first, it is impossible to be sure about the performance of the product. In that sense, it is possible to lose your money with a dysfunctional product or may pay more if your request is sent to another address. These examples constitute consumers' economic risk which may be more severe if the web-site is not promising security in terms of your credit card or personal information (Rudolph, Rosenbloom and Wagner, 2004; Laohapensang, 2009; Kim and Kim, 2010). These negative attributes of online shopping affect the trust of consumers negatively which adds a new stage to online shopping: building confidence and trust (Constantinides, 2004). In order to build the confidence, online retailers should demonstrate that their web-sites are secure (Fenech and O'Cass, 2001) and they should increase their e-service quality (Kim and Kim, 2010). In that sense, marketers and web designers need to work together to make sure that Web-site:

- is easy to use and appealing to target consumers,
- links are set up and sustained and there are no broken links,
- structure and lay-out is well-organized (Santos,2003)
- provides security and privacy (Rudolph, Rosenbloom and Wagner, 2004; Laohapensang, 2009; Kim and Kim, 2010).

In terms of psychological barriers, online shopping is challenging since consumers are used to see, touch and feel the product in order to understand the quality. Moreover, from the image barrier perspective, consumers may view the process as complicated and the delivery process as too long (Rudolph, Rosenbloom and Wagner, 2004).

Another challenge is related with the shopping environment which is called as content factors by Constantinides (2004, See Table 1). According to the author, content factors have two dimensions: aesthetics (which is also stated by Santos, 2003) and marketing mix. On one hand, the atmosphere of a web-site has an important impact of attracting online consumers through providing positive and powerful stimulus for consumers to explore, search and possibly shop from the web-site. Moreover, web-site may provide information regarding product's, for instance, low price which is one of the biggest motives for online shopping (Constantinides, 2004).

Table 1. *Factors affecting Web-experience*

Functionality Factors		**Psychological Factors**	**Content Factors**	
Usability	*Interactivity*	*Trust*	*Aesthetics*	*Marketing Mix*
Convenience	Customer service/after sales	Transaction security	Design	Communication
Site navigation	Interaction with company	Customer data misuse	Presentation quality	Product

	personnel			
Information architecture	Customization	Customer data safety	Design elements	Fulfilment
Ordering/payment process	Network effects	Uncertainty reducing elements	Style/atmosphere	Price
Search facilities & process		Guarantees/return policies		Promotion
Site speed				Characteristics
Findability/accessibility				

Source: Adapted from Constantinides (2004)

Due to these challenges, the authors believe that the behaviours of consumers regarding online shopping, strategies of online retailers and web-site quality should also be studied. The forthcoming results will provide online retailers with the insight of the factors that they should consider in order to improve their online shopping channels and customer satisfaction. Therefore, the objective of this study can be listed as follows:

(1) To test whether there is a difference between university students and university staff (academic and administrative) in terms of online shopping behaviour and;
(2) To test whether there is a difference between the perceptions of university students and university staff in terms of web-site quality.

Hypotheses

In order to test the objectives of this study, four main hypotheses are developed.

H_1: Online shopping behaviour differs among the students and academic staff.

H_2: Online shopping behaviour differs among students and administrative staff.

H_3: Perceptions of students and academic staff differ with respect to web-site quality of companies.

H_4: Perceptions of students and administrative staff differ with respect to web-site quality of companies.

To support these hypotheses, two sub-sets of hypotheses have been defined. For hypotheses H_1 and H_2, 16 sub-hypotheses have been formulated and analyzed while, 11 sub-hypotheses have been developed and analyzed for the hypotheses H_3 and H_4, considering the web-site qualities of online shopping channels.

Research Methodology

This is a quantitative descriptive study is based on a questionnaire survey asking participants the factors that influence their use of online shopping and their perceptions of web-site quality.

Questionnaire Design

In order to clarify the objective of the study and to ensure confidentiality, an information paragraph has been written on the questionnaire sheet. In the questionnaire design, there were two parts. The first part includes 10 questions and most of them were profile questions such age, gender, education and income. Moreover, the participants were asked how much time they spent on Internet per day, how often they shop online, the types of goods they usually buy online, the factors that are important while they are shopping online, who advices them to shop online and whether they like shopping online or not and why. The second part of the questionnaire includes two separate sections.

This second part was adopted from Osman, Yin-Fah and Hooi-Choo (2010). The first section has 16 questions regarding online shopping behaviour. Another section of the questionnaire examines the perspectives of users on web-site quality by asking 11 questions.

This makes the total number of questions in the second part twenty-seven. These twenty-seven questions were measured through using a five-point Likert type scale ranging from 1 which is "*Strongly disagree*" to 5 "*Strongly agree*".

Since the scales were in English, they were translated to Turkish due to the mother tongue of the participants of the study. After the translation of the questions, opinions of experts (i.e.: lecturers and professors) have been taken. Moreover, in order to ensure that the questions are understandable, a pilot study has been undertaken. As the sample population includes both students, academic and administrative staff, 12 people, four from each group, have been selected to fill in the questionnaire and then their comments have been asked. According to these comments from both the experts and pilot study, the questionnaire had taken its final form.

Sample

The sampled population was both the academic and administrative staff and the students of a university in Turkey. University and academic staff were selected on a convenience basis. Choosing students and academic staff as a sample for the study is suitable since online consumers tend to be younger and well-educated (Lee and Lin, 2005). Moreover, as students are generating the largest portion of internet users (Lee and Lin, 2005), making a comparison between university staff, who earn income and who tend to be lighter internet users, and students will be meaningful. 80 questionnaires have been distributed to administrative staff through stating the researchers' intention to collect at the end of the day, but 32 questionnaires (40% response rates) have returned. For the academic staff, the response rate was 45,7 % as 32 questionnaires have returned out of 70. As for students, two departments have been selected, namely business administration and logistics management. 100 questionnaires distributed to students and; 80 have returned with a response rate of 80%. In total, 144 questionnaires were completed among three groups of respondents (See Table 2).

Table 2. The distribution of respondents

	n	%
Groups		
Students	80	55,6
Academic staff	32	22,2
Administrative staff	32	22,2

Data analysis

In order to gain insight into the underlying dimensions of online shopping behavior of individuals, different types of questions and statements are asked in the questionnaire, and then these were analyzed by statistical techniques and procedures.

The accumulated data were processed by SPSS (Statistical Package for the Social Sciences Version 17) program. In order to test internal consistency, reliability analysis is applied. In general, the number that is acquired from reliability analysis demonstrates the strength of diverse items complementing each other in the measurement of diverse features of the scale (Cerit, 2000). The reliability coefficients that are higher than 0,70 are considered to be significant in both social sciences and marketing research and thus, the coefficients that are higher than 0,70 are considered as internally consistent (Hair et al., 1998). The Cronbach Alpha for the scales is 78,8 %. Then, relative frequencies of multiple-choice questions were used in order to construct profiles of respondents. Likert-scale questions were comparatively analyzed for the groups of age, gender, income, education, and occupation through usage of t-tests.

Results, Evaluation and Discussion

This section consists of the information about the respondents, and the results of hypotheses testing along with discussion of the results.

Profile of the respondents

In this study, 45,8% of the respondents were male, whereas females consist of 54,2%. Most respondents were between 21-24 years of age which constitutes 56,6%. This was an expected result as the majority of the respondents are university students. The minimum percentages come from the age group of 30-34, with a percentage of 5,6. This is also an expected result as majority of the employees of the university is not more than 40 years old.

The total of 75 % of the respondents represent an undergraduate degree, while 2,8 % were graduates of high school. In terms of income levels, the incomes of most of the respondents (34,0%) is between 1000-1499 TL, which is followed by the wages between 500-999 TL (31,3%).

When the patterns of Internet usage is considered, approximately 37% of the respondents are using internet more than four hours in a normal day. Regarding online shopping experiences, while 53 of the respondents state that they are rarely shopping from the internet, only 6 of the participants express that they are usually shopping online. Further, participants are asked about who advises them to shop online. The majority of them take their best friends opinion (48,9%) into consideration first, then their boy/girl friends opinion on the subject comes with a percentage of 29,3. In "others" category, some of them also mentioned their neighbours, colleagues and no one. Generally, the goods that participants buy from Internet are mostly dresses and accessories (38,9%). Shopping for fun such as buying theatre or concert tickets comes after dresses and accessories (17,4%), while books and electronic goods have the same percentage (16,7%). The least bought goods (3,5%) come from the category of *'Others'* which includes commodity goods such as food and groceries and, unique things that they cannot find in stores such as toys for pets.

Results of Hypotheses Testing

The purpose of the four main hypotheses of the study (**H_1, H_2, H_3, H_4**) is to search whether there is a difference between (1) the online shopping behaviour of students and university staff, academic and administrative and; (2) the perceptions of students and university staff with respect to web-site quality.

The first group of hypotheses was based on the idea that there is a difference between online shopping behaviours of students and university staff, both academic and administrative respectively.

The results for the first group of hypotheses are summarized in **Table 4.** None of the hypothesized variables are supported for students and academic staff. This means the online shopping behaviour of students and academic staff is not significantly different. The reason for this may be related with demographic characteristics of the two groups. Generally the majority of the students ages are between 21-24, whereas academic staff is between 25-29. The two groups both think online shopping is neither easy nor difficult and the majority of both groups spend approximately 3 or 4 hours per day on Internet. Besides, the social interactions between these groups exist, thus it may be possible for them to affect each other in terms of online shopping behaviour. Although, there seems to be no significant difference between students and academic staff, regarding the groups of students and administrative staff, hypotheses **H_{22}** (p=0,020), **H_{23}** (p=0,021) and **H_{29}** (p=0,001) are supported. This means students and administrative staff differ significantly in terms of perceptions regarding 7/24 availability of shopping behaviour, the easiness of online shopping in respect to traditional shopping and the wide range of offerings.

The second group of hypotheses was, on the other hand, developed to reflect the idea that the perceptions of students and, academic and administrative staff regarding the characteristics of companies' web-site quality web-site quality may have different effects on their online shopping behaviour.

The results of the second group of hypotheses can be found in **Table 5**. Among the hypotheses, **H_{34}** (p=0,032), **H_{35}** (p=0,024), **H_{37}** (p=0,009), **H_{39}** (p=0,015), **H_{310}** (p=0,001) and, **H_{311}** (p=0,026) are supported with $p<0,05$. The results of the analysis demonstrate significant differences between the perceptions of students and academic staff regarding web-site quality. For instance, academic staff is more prone to put security in the first place while selecting online shopping channels. This actually makes sense as they are in control of their own economic budget and they know the difficulty of earning money and thus, they are more careful about spending it. Moreover, although in total nearly 30% of the respondents find online shopping easy, it makes sense that academic staff are more prone to choose a powerful e-retailer that provides confidence due to its brand name. This is because they have met with computers and the Internet later than the university students which make them more suspicious about the technological developments.

Table 4. *The Results of the tests for* H_1 & H_2

Statements/Hypothesis	Students			Academic Staff			Administrative Staff			Total			Results of T-tests	
	N	mean	SD[3]	N	mean	S,D[3]	N	mean	SD[3]	N	mean	SD[3]	Students & Academic Staff	Students& Administrative Staff
1. I think shopping on the internet saves time.	80	4,0375	1,1523	32	4,283	,906	32	4,2813	,991	144	4,0903	0,833	Not Supported	Not Supported
2. It is a great advantage to be able to shop at any time of the day on the internet.	79	3,9747	1,3006	32	2,543	1,162	32	4,4688	,841	143	4,1538	1,1464	Not Supported	**Supported P<0,05**
3. It is more difficult to shop on the Internet.	79	3,1646	1,2550	32	3,902	,984	32	2,5	1,367	143	2,9650	1,3131	Not Supported	**Supported P<0,05**
4. I prefer traditional/conventional shopping to online shopping.	80	3,6	1,2488	32	2,500	1,191	32	3,1250	1,408	144	3,4653	1,2399	Not Supported	Not Supported
5. Shopping online is risky.	79	3,1899	1,1666	31	3,478	,989	31	2,8387	1,240	141	3,0496	1,1359	Not Supported	Not Supported
6. I believe online shopping will eventually supersede traditional shopping.	80	3,4250	1,1449	32	3,780	1,093	31	3,0645	1,34	143	3,2867	1,1666	Not Supported	Not Supported
7. I will prefer online shopping only if online prices are lower than actual price.	80	3,5875	1,1550	32	1,957	1,194	32	3,5938	1,0429	144	3,6319	1,0561	Not Supported	Not Supported
8. A long time is required for the delivery of products and services on the internet.	79	3,2025	1,1252	32	4,185	,948	32	3,1875	,998	143	3,1608	1,0724	Not Supported	Not Supported
9. Selection of goods available on the internet is very broad.	78	3,6282	1,1855	32	2,435	1,161	32	4,2813	,7289	142	3,8662	1,0995	Not Supported	**Supported P<0,05**
10. The description of products shown on the web sites are very accurate.	79	2,9494	1,073	32	3,587	1,050	32	3,1250	1,008	143	3,0420	1,0473	Not Supported	Not Supported
11. The information given about the products and services on the internet is sufficient.	79	3,1139	1,0126	32	3,398	1,045	32	3,1875	1,0298	143	3,1189	,996	Not Supported	Not Supported
12. Online shopping is as secure as traditional shopping.	78	2,6154	1,1422	32	2,500	1,209	32	2,75	,9504	142	2,6831	1,0610	Not Supported	Not Supported
13. I feel unsecure about giving my credit card number on Internet.	78	3,2564	1,1891	32	4,000	1,059	30	3,6333	1,0662	140	3,3286	1,1471	Not Supported	Not Supported
14. Internet reduces the monetary costs of traditional shopping to a great extent (parking fees, etc.)	77	3,6753	1,0692	32	3,674	1,149	32	3,2813	1,1977	141	3,4894	1,1315	Not Supported	Not Supported
15. The obligation of holding credit cards is a burden for online shopping.	80	3,1625	1,3259	32	2,286	1,232	32	3,375	1,2378	144	3,3125	1,2818	Not Supported	Not Supported

16. I would be frustrated about what to do if I am dissatisfied with a purchase made from the Internet.	80	3,675	,9908	32	4,054	,987	32	3,875	,9419	144	3,7708	,951	Not Supported	Not Supported

Table 5. *The Results of the test for* H_3 & H_4

Statements/Hypothesis	Students			Academic Staff			Administrative Staff			Total			Results of T-tests	
	N	**mean**	**SD**[3]	**N**	**mean**	**S,D**[3]	**N**	**mean**	**SD**[3]	**N**	**mean**	**SD**[3]	**Students & Academic Staff**	**Students& Administrative Staff**
1.I am cautious in trying new website and would rather stick with a website I usually buy or familiar with.	76	3,8026	1,189	32	4,2188	,870	31	4,000	,966	139	3,9424	1,082	Not Supported	Not Supported
2. When shopping online, I prefer the website that I am familiar with.	77	3,974	1,158	32	4,375	,871	32	4,1563	,883	141	4,1064	1,047	Not Supported	Not Supported
3. I feel that familiarity with the website prior to purchase reduce the risk of undertaking an online shopping.	78	3,9231	1,042	32	4,125	,907	32	3,5313	,983	142	3,8803	1,014	Not Supported	Not Supported
4. I often seek out the advice of my friends regarding which website to buy as not to make a wrong decision.	79	3,6329	1,052	32	4,0313	,782	32	3,75	,915	143	3,7483	,975	**Supported P<0,05**	Not Supported
5. When shopping online, a powerful brand name of an e-retailer can entrust me and enhance my confidence on my choice.	79	3,9494	1,131	32	4,3125	,535	32	4,2813	,728	143	4,1049	,955	**Supported P<0,05**	Not Supported
6. When shopping online, I often go and buy on a website I experienced and familiar with.	79	3,9367	1,066	32	4,1875	,780	32	4,125	,870	143	4,035	,967	Not Supported	Not Supported
7. When shopping online, I often purchase at the website which can provide more information of product and selection.	79	3,6329	1,002	32	4,0938	,734	32	4,000	,950	143	3,8182	,954	**Supported P<0,05**	Not Supported
8. I enjoy taking chances in trying new and different website.	78	2,7179	1,104	32	2,3438	,902	32	2,625	1,157	142	2,6127	1,077	Not Supported	Not Supported
9. I seek related information and knowledge about various website from professional associations,experts,friends,family members and work associates.	79	3,3671	,963	32	3,8438	,808	32	3,5938	,910	143	3,5245	,933	**Supported P<0,05**	Not Supported
10. The web enhances my effectiveness in products searching and buying.	79	3,3418	1,073	32	3,9688	,740	32	4,0313	,897	143	3,6364	1,018	**Supported P<0,05**	**Supported P<0,05**
11. When shopping online, I often purchase at the website which assure me of safety and easy of navigation and order.	79	4,1519	1,039	32	4,5	,568	32	4,3438	,700	143	4,2727	,890	**Supported P<0,05**	Not Supported

Among the results of the second group of hypotheses, differences between university students and administrative staff have also been searched. Within the analysis, these groups only demonstrate differences in terms of hypothesis $\mathbf{H_{410}}$ (p=0,002) as it is significant in 95 % confidence interval (p<0,05). This means students and administrative staff differ significantly regarding their perceptions on the effectiveness of using Internet while searching for products. The reason for this may be related with the motivations of online shopping. For instance, it is possible that administrative staff is more utilitarian shoppers who look for convenience and control over the shopping experience (Sorce, Perotti and Widrick, 2005). On the other hand, students may be hedonic shoppers who also consider that the shopping experience should be entertaining. Thus, as well as the effectiveness, other characteristics of web-sites such as the user-friendliness and the stylish design may increase the total online shopping experience for these customers.

Conclusion

The development of information and communication technologies has started to shape the everyday life of individuals. For instance, individuals started to search for information regarding anything through search engines such as Google and Yahoo and, they have also started to search entertainment such as watching TV shows. Another aspect of individual life has also affected by these changes in communication technologies. With the Internet, individuals begin to purchase goods online. This provides advantages for both consumers and practitioners and thus, it also caught the attention of researchers.

For consumers, online shopping provided a convenient way of purchasing goods since they do not need to leave their homes. In this study, this is also confirmed since more than half of the participants (70,7%) agreed that they like online shopping because it is practical which means they find it easier, quicker and cheaper. Moreover, with the development of Web 2.0, an interactive, participative and collaborative environment (Aglargoz and Polatoğlu, 2012) has been created and in such an environment consumers had the chance to develop relationships with companies (Melewar and Smith, 2003). For organisations, Internet provided low entry barriers and chances to do business all around the world which means new markets and prospective customers. With the increasing competition, missing the e-commerce trend has become an important drawback for companies.

Although the above statements demonstrate the positive outcomes of online shopping, it also produces some disadvantages such as the difficulty in developing an online shopping channel. Despite the fact that online shopping channels come with new markets and possible customers, low-income consumers still do not have an Internet access (Rudolph, Rosenbloom and Wagner, 2004). This is still a relevant concern for Turkey, as the majority of houses in Eastern part of Turkey do not have an Internet connection. However, this was not a relevant drawback in this study because it is conducted in a university, located in Western part of Turkey, which provides students with laptops and Internet access. Moreover, consumer resistance towards such an innovation may be another obstacle as Ram and Sheth (1989) stated. The reason of this resistance may be the absence of senses during the shopping experience (Rudolph, Rosenbloom and Wagner, 2004). This is also confirmed by this study which demonstrated that nearly half (45,5%) of all of the respondents stated their disturbance regarding this absence. However, the online shopping channels have found ways to solve this problem. For instance, Amazon.com provides the inside views of books and it has a good repay policy if the product that you bought is damaged. Another reason for resisting may be the perceived risk of consumer which includes functional and economic risk. These risks are related with the expected performance and the security of paying options, respectively (Kim and Kim, 2010). Accordingly, as mentioned above, a functional risk can be omitted with a good repay or change policy. However, providing the security of paying options is more severe than other risks as it may bring out the theft of credit card or personal information (Laohapensang, 2009). The presence of this problem is also confirmed by this study. For instance, "*Online shopping is as secure as traditional shopping*" statement indicate mean values 2,61; 2,5; 2,75 for students, academic staff and administrative staff respectively. This shows that although online shopping channels have customer-centric mission statements on their web-sites, creating customer value is not just providing goods and services in a quicker and cheaper way, but also in a trustworthy manner. Thus, online shopping channels should invest more in building confidence and trust. For instance, companies need to illustrate that their web-sites are safe and they are doing anything in order to protect their customers.

Research Limitations and Further Research

One of the limitations of this study is the language of the scale. The original language of the surveys is English, although the possibility of misinterpretations have been decreased by a pilot study, there is a possibility of a misfit between the cultural orientations of the sample and the statements in the scale. In order to decrease a similar misfit, new statements can be added to the survey or it is possible to develop a new survey which may be a better fit to Turkish university students and staff. Another limitation is the low response rates from academic and administrative staff. Although, the questionnaires are distributed and collected after a day, the response rate was low.

As the study gives further information on the perceptions of Generation Y regarding online shopping, another study may make a comparison between the Generation X and Generation Y regarding their attitudes towards online shopping. Further research may focus on revealing the reasons behind the negative perceptions towards online shopping through in-depth interviews.

Acknowledgement

The authors acknowledge the contributions of Begüm Kaplan in conceptualization of this paper.

References

Aglargoz, O., & Polatoglu, V. (2012). Employing User-Generated Content for Decision Making in Business Firms. *2012 SIBR Conference on Interdisciplinary Business and Economics Research.* Bangkok.

Alba, J., Lynch J., Weitz, B., Janiszewski, C., Lutz, R., Sawyer, A., & Wood, S. (1997). Interactive home shopping: consumer, retailer, and manufacturer incentives to participate in electronic marketplaces. *Journal of Marketing, 61* (3), 38–53.

Bellman, S., Lohse, G. L. & Johnson, E. J. (1999). Predictors of online buying behavior. *Communications of the ACM, 42* (12), 32-38.

Cerit, A. G. (2000). Maritime transport as an area of competitive advantage in international marketing. *International Journal of Maritime Economics, 2,* 49-67.

Cheung, C., Zhu, L., Kwong, T., Chan, G., & Limayem, M. (2003). Online consumer behaviour: A review and Agenda for future research. *16th Bled e-Commerce Conference*, (s. 194-218). Bled.

Childers, T. L., Carr, C. L., Peck, J. & Carson, S. (2001). Hedonic and utilitarian motivations for online retail shopping behaviour. *Journal of Retailing, 77,* 511-535.

Czinkota, M. & Ronkainen, I. (1990).*International Marketing,* 4th ed., Dryden Press, Orlando, FL.

Constantinides, E. (2004). Influencing the online consumer's behavior: the Web experience. *Internet Research , 14* (2), 111-126.

Correa, T., Hinsley, A., & Gil de Zuniga, H. (2010). Who interacts on the Web?: The intersection of users' personality and social media use. *Computers in Human Behaviour , 26*, 247-253.

Degeratu, A.,Rangaswamy, A. & Wu, J. (2000). Consumer choice behavior in online and traditional supermarkets: the effects of brand name, price, and other search attributes. *International Journal of Research in Marketing, 17* (1), 55-78.

Delafrooz, N., Paim, L. H., & Khatibi, A. (2009). Developing an instrument for measurement of attitude towards online shopping. *European Journal of Social Sciences, 7* (3), 166-177.

Fenech, T.& O'Cass, A. (2001). Internet users' adoption of Web retailing: user and product dimentions. *Journal of Product&Brand Management, 10* (6), 361-381.

Hair, Joseph F., Rolph E. Anderson, Ronald L. Tatham and William J. Black (1998). Multivariate Data Analysis. New Jersey: Prentice Hall.

Hernandez, B., Jimenez, J. & Martin, J. M. (2011). Age, gender and income: do they really moderate online shopping behaviour?. *Online Information Review, 35*(1), 113-133.

Kilian, T., Hennigs, N., & Langner, S. (2012). Do Millenials read books or blogs? Introducing a media usage typology of the Internet generation. *Journal of Consumer Marketing , 29* (2), 114-124.

Kim, J., & Kim, C. (2010). E-service quality perceptions: A cross-cultural comparison of American and Korean consumers. *Journal of Research in Interactive Marketing , 4* (3), 257-275.

Laohapensang, O. (2009). Factors influencing internet shopping behaviour: A survey of consumers in Thailand. *Journal of Fashion Marketing and Management , 13* (4), 501-513.

Lee, G. & Lin, H. (2005). Customer perceptions of e-service quality in online shopping. *International Journal of Retail&Distrinution Management, 33* (2), 161-176.

Limayem, M., Khalifa, M. & Frini, A. (2000). What makes consumers buy from Internet? A longitudinal study of online shopping. *Systems, Man and Cybernetics, Part A: Systems and Humans, 30* (4), 421-432.

Lohse, G. & Spiller, P. (1998). Electronic Shopping: How do customer interfaces produce sales on the Internet?. *Communications on the ACM, 41* (7), 81-87.

Mangold, W. G. & Faulds D. J. (2009). Social Media: The new hybrid element of the promotion mix. Murray: Murray State University 52, 357—365.

Marston, C. (2007). Motivating the "What's in it for me?" Workforce: Manage Across the Generational Divide and Increase Profits, New Jersey: John Wiley and Sons, Inc.

Melewar, T.C. & Smith, N. (2003). The internet revolution: some global marketing implications. *Marketing Intelligence & Planning, 21* (6), 363-369.

Osman, S., Yin-Fah, B., & Hooi-Choo, B. (2010). Undergraduates and Online Shopping Behavior. *Asian Social Science , 6* (10), 133-146.

Park, C., & Kim, Y. (2003). Identifying key factors affecting consumer purchase behaviour in an online shopping context. *International Journal of Retail and Distribution Management , 31* (1), 16-29.

Ram, S. & Sheth, J. N. (1989). Consumer resistance to innovations: the marketing problem and its solutions. *Journal of Consumer Marketing, 6* (2), 5-14.

Rehmani, M & Khan M.I. (2011). The impact of e-media on customer purchase intention. (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 3, Islamabad Pakistan : Department of Social Sciences, 100-103.

Rubin, A. (2011). Living in an age of emotional rationality: Wendell Bell, social medi and the challenges of value change. *Futures , 43*, 583-589.

Rudolph, T., Rosenbloom, B. & Wagner, T. (2004). Barriers to online shopping in Switzerland. *Journal of International Consumer Marketing, 16* (3), 55-74.

Santos, J. (2003). E-service quality: A model of virtual service quality dimensions. *Managing Service Quality , 13* (3), 233-246.

Schaffer, E. (2000). A better way for web design. *Information Week , 784*, 194.

Sorce, P., Perotti, V., & Widrick, S. (2005). Attitude and age differences in online buying. *Emerald, 33,* 122-132.

Zhou, L., Dai, L. & Zhang, D. (2007). Online shopping acceptance model: a critical survey of consumer factors in online shopping. *Journal of Electronic Commerce Research, 8* (1), 42-62.