Mimo Draskovic

Business Logistics in Sea Ports –

role, contemporary tendencies, evoluting, application and optimization

- Monography -

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role, contemporary tendencies, evoluting, application and optimization

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PREFACE

Logistics in general and business logistics particularly represent contemporary scientific disciplines and an important management tool in many other disciplines, especially maritime transport and sea ports. It contributes to the achievement of strategic, tactical and operational business goals in terms of more efficient management of production facilities, material, financial and IT flows.

The importance of integrated marketing logistics in modern times became decisive in reducing the overall cost of port services and for the business success of sea ports, thus, for the reduction of the overall maritime transport cost. Previous research in the foreign and local scientific and professional literature confirmed that the concept of integrated marketing logistics is used in all situations of movement of goods, information and resources from the place of origin to the destination of use.

This text is of a study character. It is structured in eleven different thematic units, which explain the complex nature of business logistics in sea ports from different aspects. Most of these units are compatible from the point of view of application of marketing logistics in the sea ports industry. The aim of this book is exactly the give an insight to the readers into numerous and diverse possibilities for the use of business logistics in the aforementioned sector, as an important part of the global maritime industry, and national maritime industry, as well. Besides, various parts of business logistics are studies through various scientific courses at the Maritime faculty of Kotor.

This text was developed in the previous decade, mostly from the amended published scientific papers that I have published in the international magazines as the author (topics 1-6, and 12) or the co-author (topics 7-11). For that reason, the manuscript covers heterogeneous topics, but all of them are functionally connected to marketing logistics in the maritime industry. This is a logical sequence, as I am employed as a Associate Professor at the Maritime faculty of Kotor, where I teach various scientific disciplines that apply marketing logistics.

I take this opportunity to extend my sincere gratitude to the coauthors, university professors S. Bauk, D. Pupavac, L. Malyaretz, O. Dorokhov, and L. Dorokhov, with whom I have written five papers that are published in an adapted form in this book. I hope that in this way we managed to make them accessible for a much wider audience, as they were published in the international magazines with a relatively low circulation. Besides, the libraries will be enriched with a book covering the topic that is rather rare in the world of book publishing.

Montenegro has a strong maritime tradition. The longlasting crisis had a negative effect on the maritime industry. However, ports prevailed, as a great development opportunity, which can be used in the future by attracting foreign investment and big international service providers. Consistent application of business logistics represents a prerequisite for the development of maritime as a priority economic sector in Montenegro. We hope that this book will be a useful element in this development roadmap. Especially having in mind that there is an obvious lack of research and analysis on this issue in Montenegro and the region. This increases the importance and makes the research presented in this book even more topical.

I am grateful to the publisher Faculty of Management, Rzeszow University of Technology, Poland.

My special thanks go to the respected editors:

- Prof. dr *Borut Jereb,* University of Maribor, Faculty of Logistics, Slovenia
- Prof. dr hab. *Yuriy Bilan*, Faculty of Management, Rzeszow University of Technology, Poland, and
- Prof. dr *Ratko Zelenika*, Faculty of Economics, University of Rijeka, Croatia

The editors provided their sincere and professional assistance through their constructive advice, proposals and suggestions.

Author

Part one

BUSINESS LOGISTICS IN SEAPORTS

1. CONTEMPORARY TENDENCIES IN THE DEVELOPMENT OF SEA PORTS

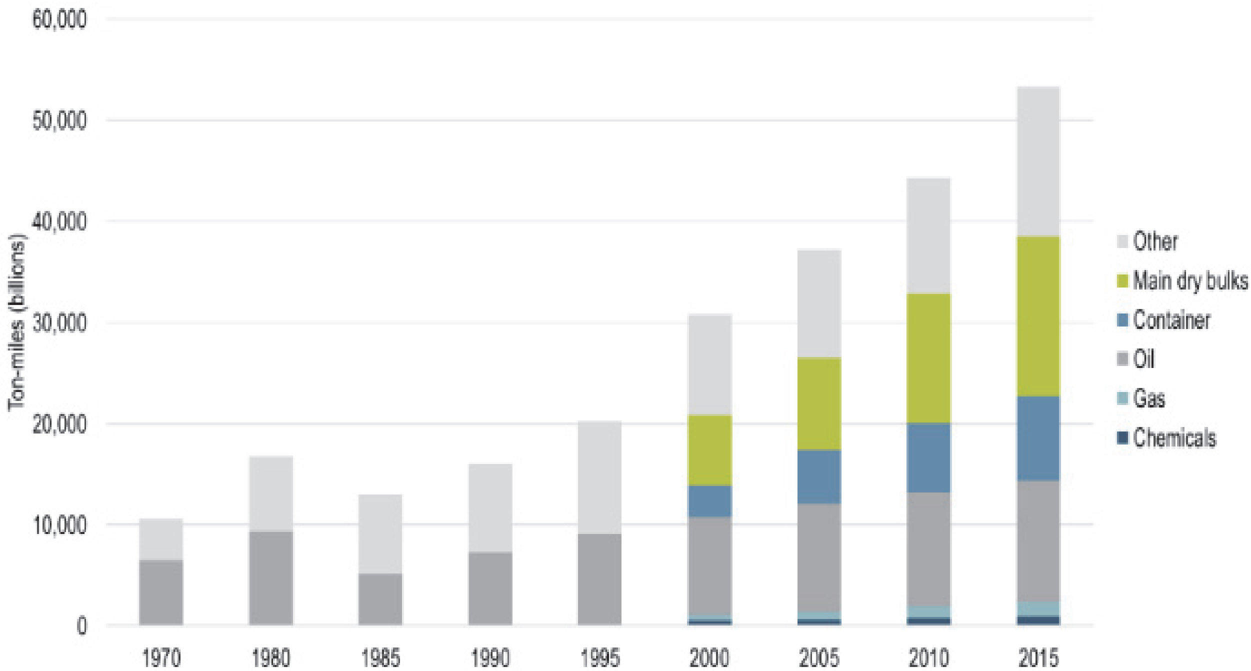
The text below discusses the influence of economic tendencies on the development of sea ports, the effects of the containerization development on the evolution of integrated marketing logistics strategy. It also deals with the enhanced concentration of the port transport and logistics operators and the development of port logistics efficiency. In addition to this, we also provide the comparative analysis of the development of Adriatic and Mediterranean sea ports and financial analysis of selected development trends in sea ports marketing logistics. Started from the idea that the flow of goods and logistics, as well as the integration of functional logistics in sea ports, dominantly determine the development of global markets.

World seas and oceans are vast navigable water surfaces, used for maritime transport. Maritime cargo flows are one of the main foundations of the world trade and links between production and consumption through the seaports as the largest industrial, transport, trade and logistics hubs. The maritime industry is the most important, considering its significant contribution to the global economic network, which includes the flows of goods and developing the global markets. Analysis of the contemporary trends in the seaport development is associated with many technological, organizational, economic, logistical, and other phenomena of global and regional character.

1.1 Dependence of the Seaport Development on the Global Economic Trends

More than 65% of international trade is performed via sea and seaports. In 2007, the quantity of cargo amounted to 32.9 billion ton-miles of cargo, whose structure was dominated by liquid cargo (34%), bulk cargo (24%), containers (15%), and other. The value of world transport exports services in 2001 was $340 billion (US dollars). Seaborne freight transport has experienced strong growth and profound changes in recent decades. For example, in the period 1970-2007, the seaborne trade has quantitatively increased more than three times (Figure 1.1).

Figure 1.1. Indicators of world seaborne trade in the period 1970-2015 (in billions ton-miles)



Source: UNCTAD Review of Maritime Transport, various years.

After the Great geographical discoveries, the Atlantic Ocean was the busiest, (i.e. the connections between seaports London, Rotterdam, New York, Le Havre, Porto, Lisbon, and others). At the end of 20th and beginning of 21th century, dominance in the maritime and port transport have assumed sea routes and ports in the Pacific, including the Far East Asian countries, especially China with her seaports, and among them six of the ten largest ports in the world. Clearly, there is a close coherence and direct dependence between the economic growth rate and volume of foreign trade and maritime transport.

Figure 1.1.1. World seaborne trade in the period 2000-2017 (in billions ton-miles)

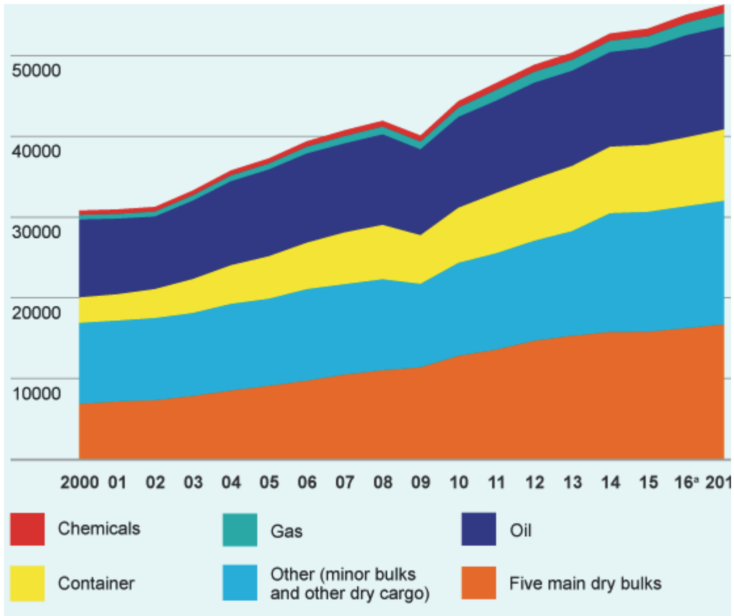
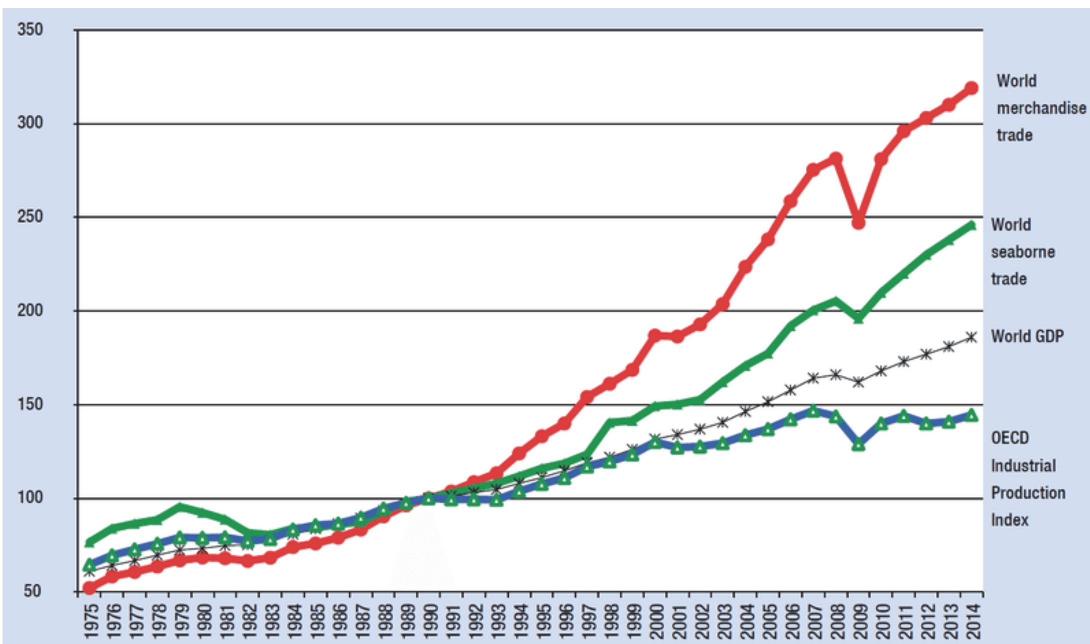
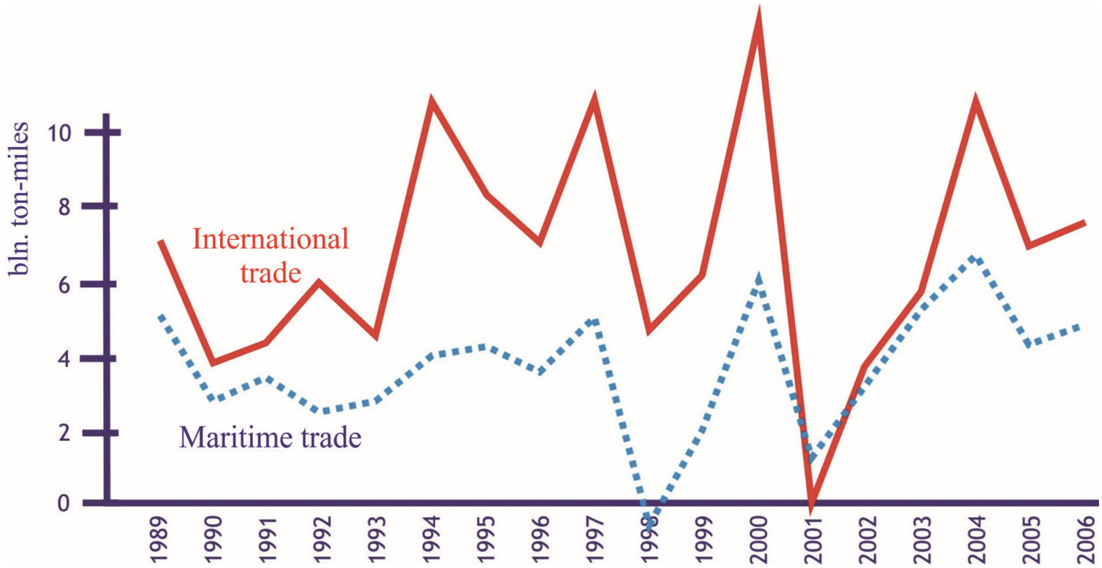


Figure 1.1.2 World seaborne trade, World merchandise trade, World GDP and OECD industrial production index 1975-2014 (base year 1990=100)



Source: https://www.google.me

Figure 1.2. Growth rates of international and maritime trade

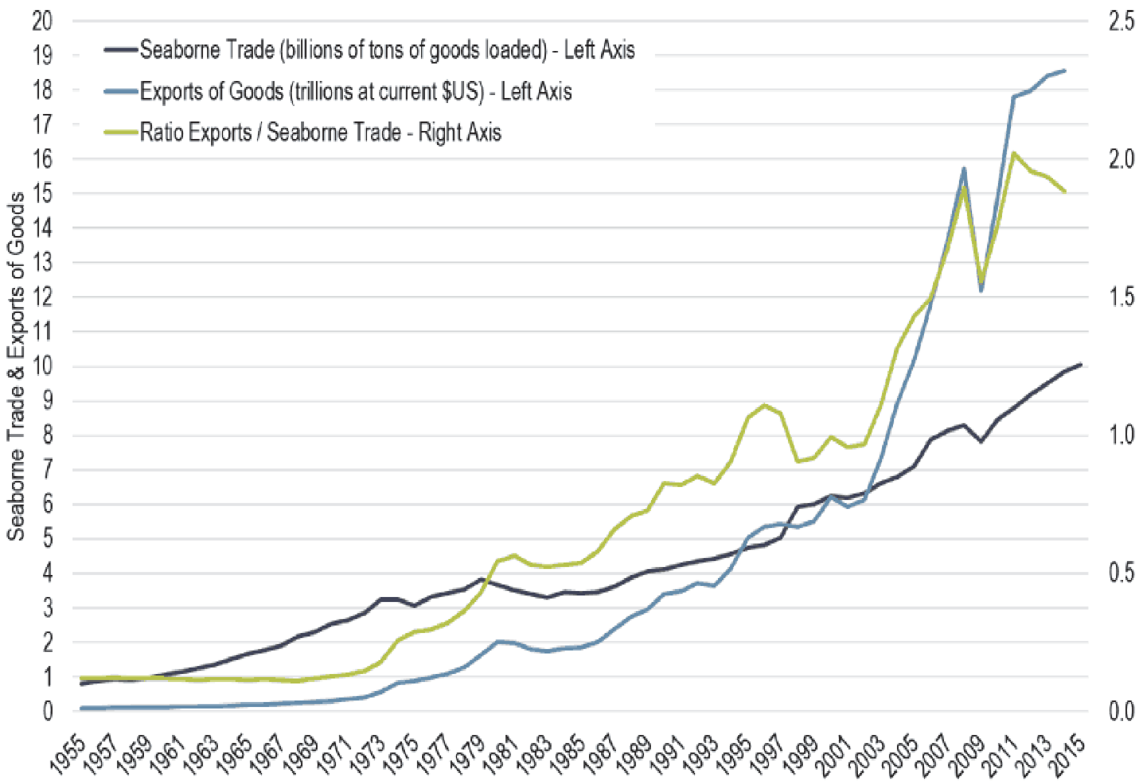


Sources: IMF, World Economic Outlook; Review of Maritime Transport; Fearnleys Review.

World trade has significantly affected not only the steady increase of the maritime trade and container cargo, but also the application of integrated marketing logistics, with supporting introduction of modern information and communication technologies, and lately, the widespread use of electronic commerce (e-commerce). Modernization, privatization and liberalization of the seaports, which began in the early 90s, have significantly contributed to improving and increasing the port infrastructure and quality of logistics operations. The development of world trade and global maritime trade in the period 1989-2006, measured through the annual growth rate, shows significant mutual similarity and complementarity in both growth and decline. However, the world trade mostly increased at higher rates of growth (Figure 1.2).

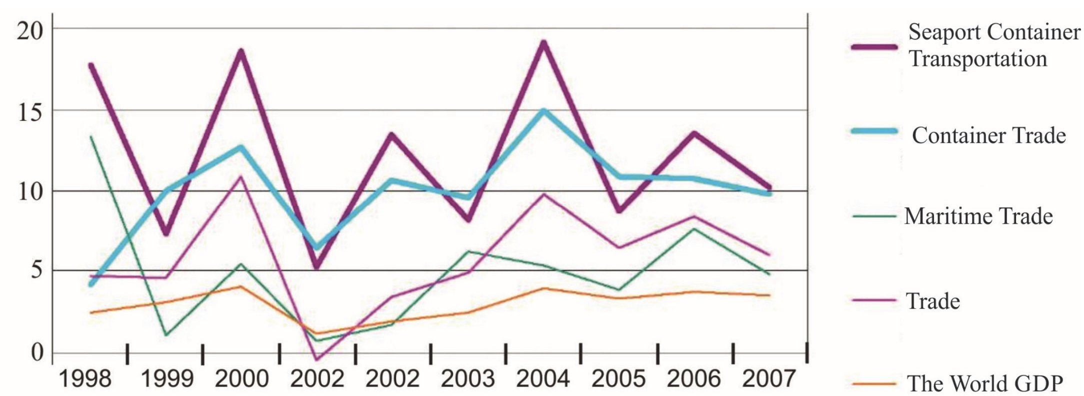
To confirm the mutual, close connection and dependence between certain variables at the global level (annual growth rate of world GDP, global trade, maritime commerce, etc.) and certain volume of the seaport transport, we designed the graphic, displayed below. It clearly shows extremely high level of dynamic correlation and complementarity, and the differences are mostly manifested in the elasticity degree of the annual growth rate of certain variables. Quantitative and qualitative characteristics of maritime transport (total growth of transported cargo, the increase of container transport, etc.), with its absolute and relative dynamics, are directly (often proportionally) dependant and conditional on the level of economic development in individual countries and regions, as well as on the individual parameter of growth indicators (GDP, foreign trade, foreign direct investment, etc.).

Figure 1.2.1 International Seaborne Trade and Exports of Goods, 1955-2016



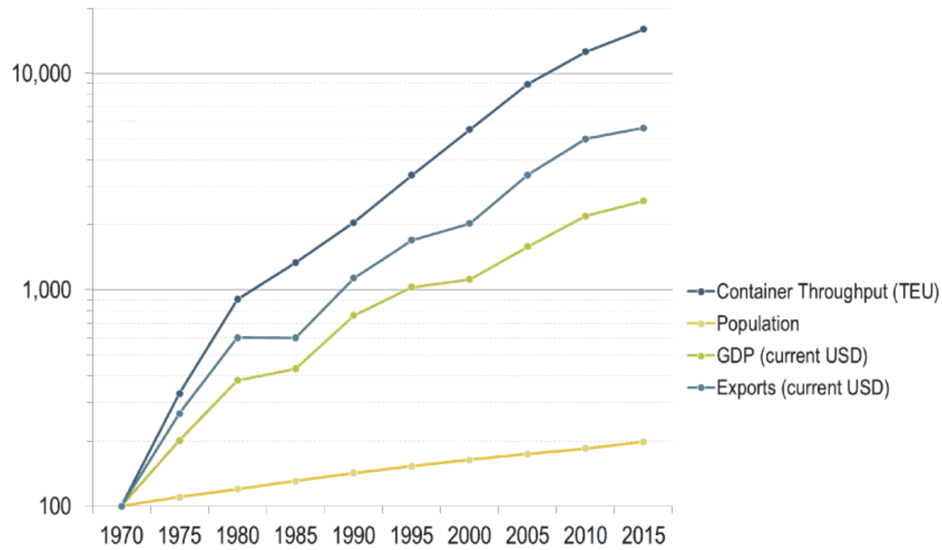
Source: https://www.google.me

Figure 1.3. Annual growth rates of the world GDP, trade, maritime trade, seaport container transportation, and container trade from 1998 to 2007



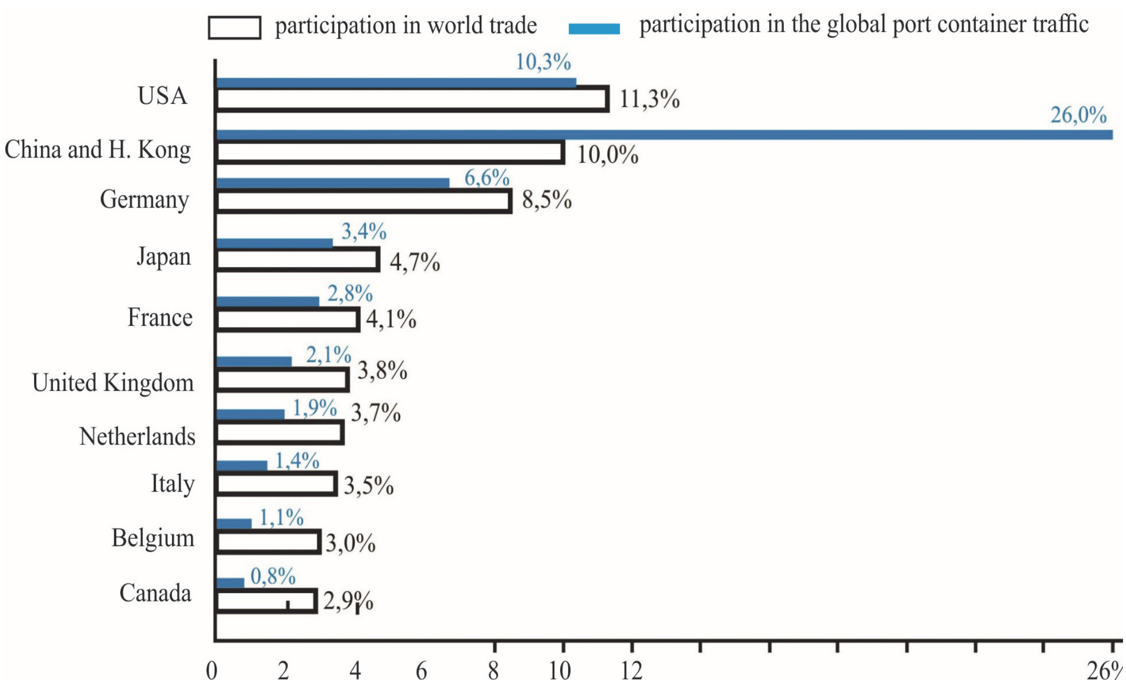
Source: IMF, World Economic Outlook, Review of Maritime Transport i Fearnleys Review.

Figure 1.3.1. Global Trade and Container Throughput (1970=100)



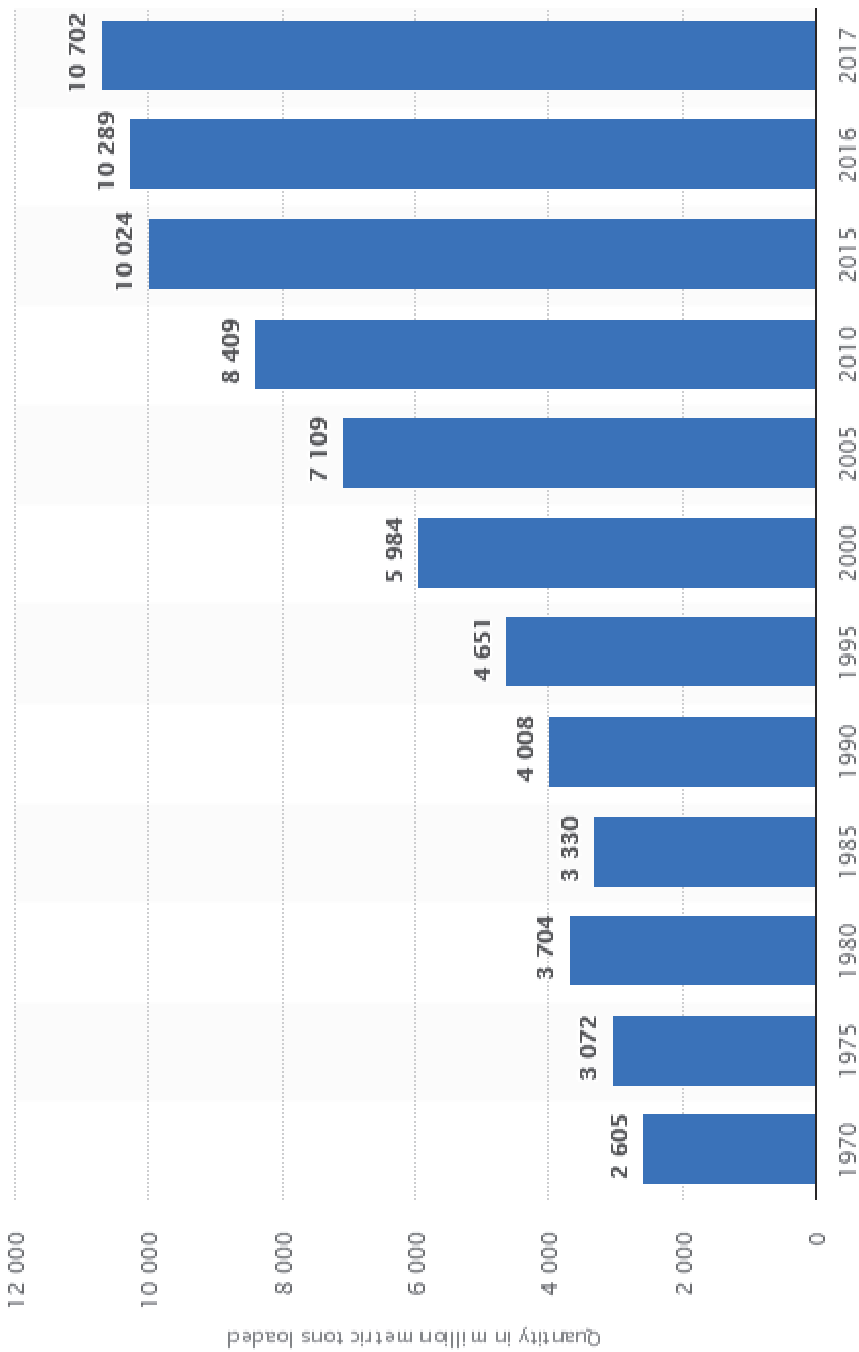
Source: https://transportgeography.org/?page_id=1762

Figure 1.4. Correlation of the world trade (participation of the biggest 10 in 2007), economic growth (GDP), and maritime transport



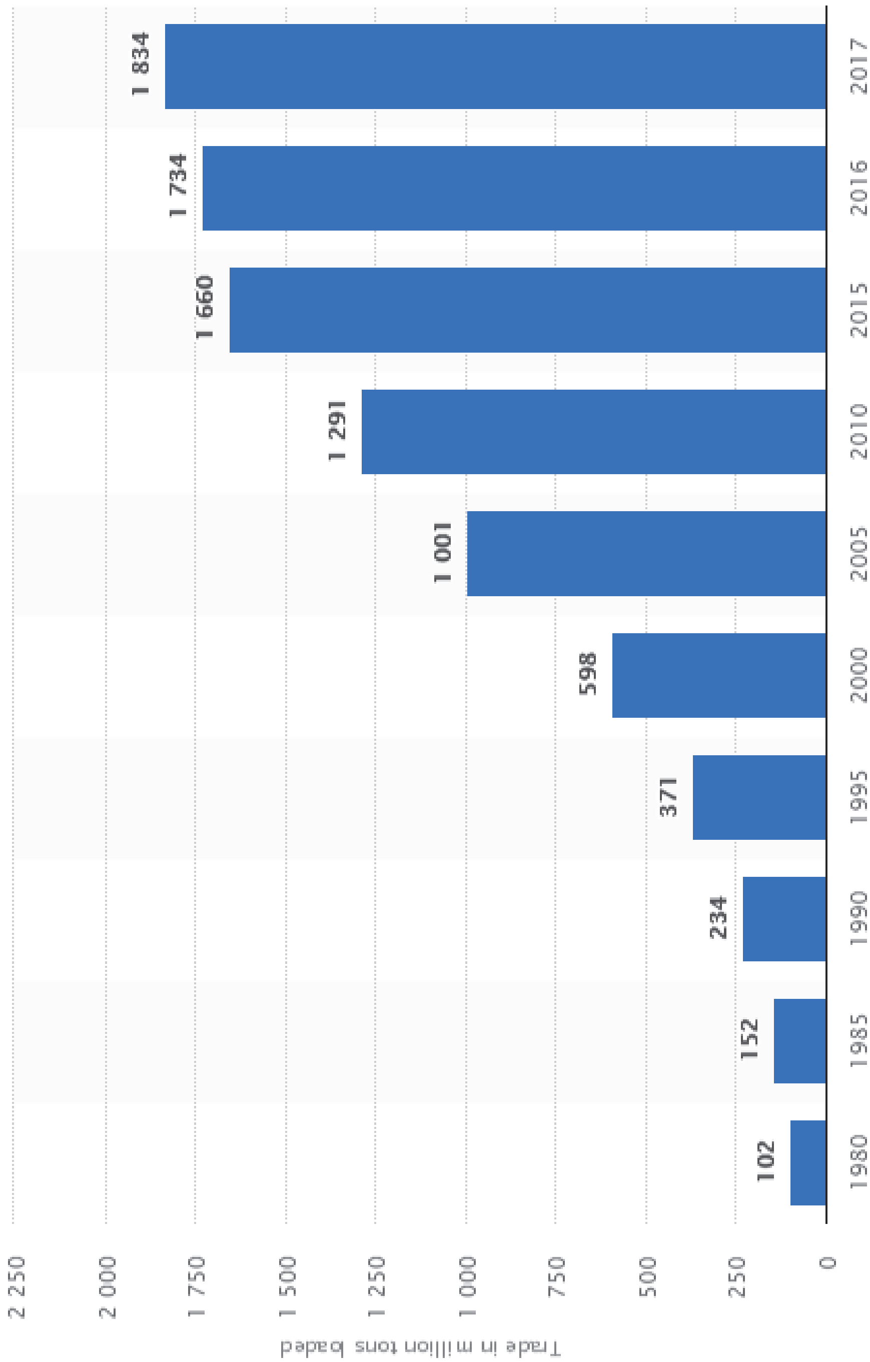
Source: IMF, World Economic Outlook, Review of Maritime Transport i Fearnleys Review.

Figure: 1.4.1. Quantity of loaded freight in international maritime trade from 1970 to 2017 (in million metric tons loaded)



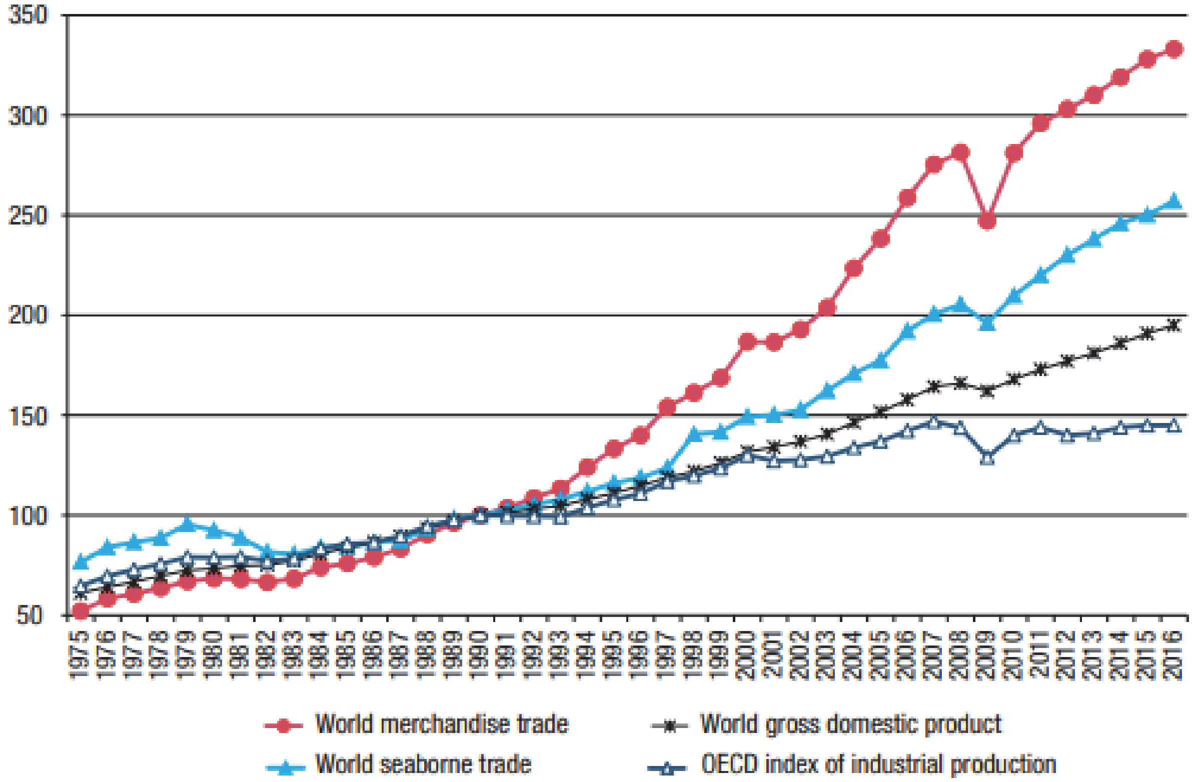
Source: https://www.statista.com/statistics/234698/loaded-freight-in-international-maritime-trade- since-1970/

Figure: 1.4.2. International seaborne trade carried by container ships from 1980 to 2017 (in million tons loaded)



Source: https://www.statista.com/statistics/253987/international-seaborne-trade-carried-by-containers/

Figure 1.4.3 Organization for Economic Cooperation and Development index of industrial production and world indices: Gross domestic product, merchandise trade and seaborne shipments, 1975–2016 (1990 = 100)

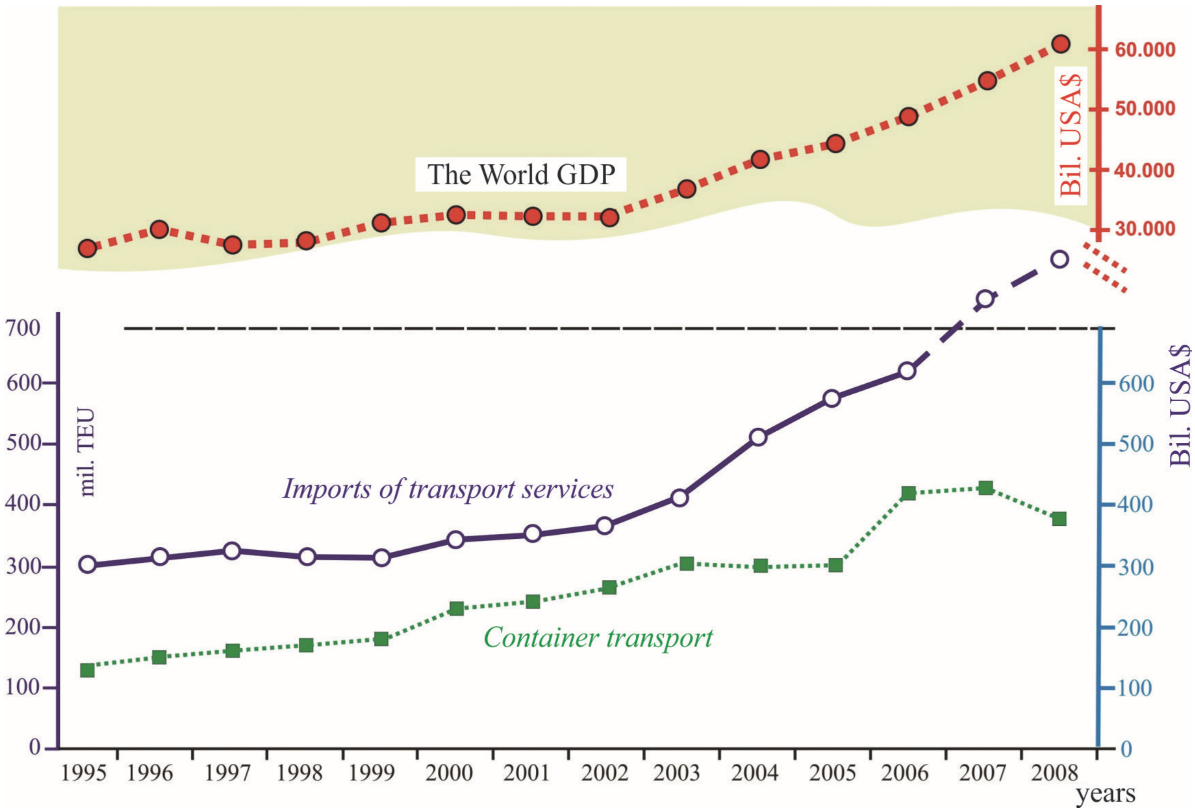


Sources: UNCTAD, Review of Maritime Transport 2017, p. 3.

Therefore we start with a comparative analysis of the correlation between world trade, economic growth (GDP) and maritime transport (Figure 1.4). It is obvious that most developed countries (according to the GDP growth rates) have the largest share in the global foreign trade, but also in the seaport container traffic. The US has the largest share in the foreign trade with 11.3% and a share of 5.2% in the global maritime container transport. China with Hong Kong holds the second place with a share of 10% in the international foreign trade and 26% of the global port container transport. Germany is in the third place (8.5%), and Japan in the fourth place with similar relative share in both of these indicators (4.7% and 3.4%).

Many forecasts suggest that the next four decades will bring a major transformation in terms of economic development. In 10 years, China with its high GDP growth rates, will jump from the 4th to the 3rd place, and by the mid-century will take over primacy from the United States. In the period 1991-2010 China has achieved a very dynamic economic growth at average annual rates ranging from 7% to 13.4%. In addition, China's container trade surplus achieved in 2003 is on top, with Europe (2 million TEUs) and the USA (5.1 million TEUs).

Figure 1.5. Comparison of absolute growth of world GDP, exports of transport services and the growth of maritime transport

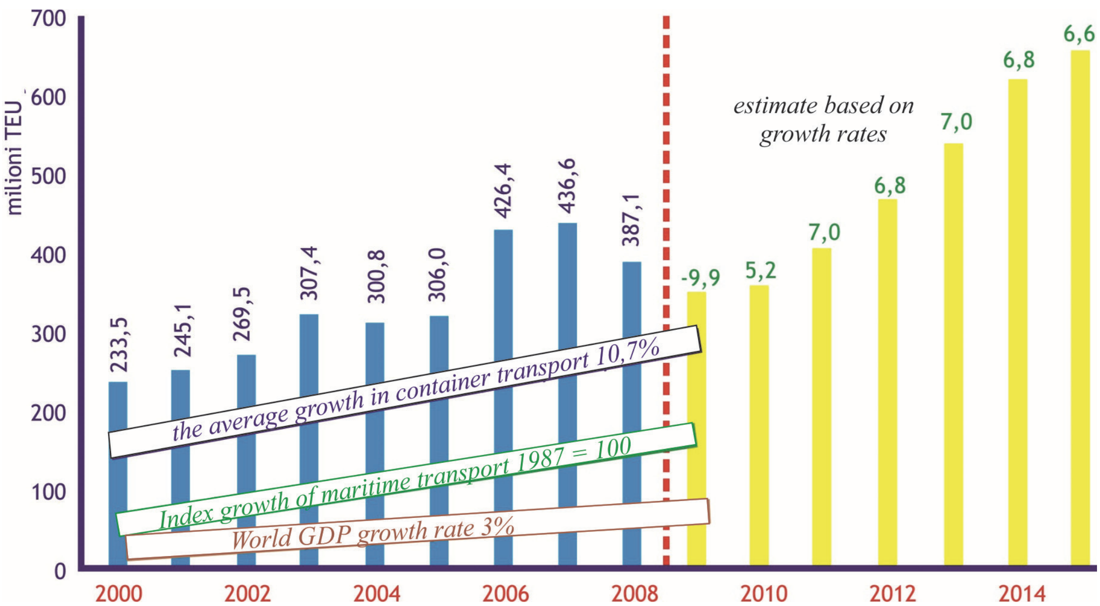


Source: America's Container Ports 2009, p. 8.

In 2007, China was rated 3rd in the world with a share of 7.7% of world trade, and together with Hong Kong's 10.3%, it was on the 2nd place, behind the United States (11.3%). China has developed the largest network of the world's major sea routes, with the world's largest hub airports and the largest logistics centers. Also is predicted a significant economic growth of Brazil and Russia and their movement towards the top of the list of the most developed countries in the world. However, according to the indicators of additional value (output value less the costs of materials and components) China is not yet the manufacturing center of the world.. In fact, China's production is only about 15% of the added value in the world's production, which is significantly less than the US 24% and EU 20% - by Bardhan, 2020, p. 15.

In the period 1995-2008, world GDP was doubled in absolute terms (increased from $29,391 billion to $60.863 billion), while in the same period there was an absolute container growth of almost three times (from 137.2 to 387.1 million TEUs), and the growth rate in container traffic was 8.3% (the same rate for the period 2000-2008 was 10.7%, because there was a rapid growth after 2000). Figure 1.5 shows that the increase in value of exports of transport services and the average annual growth of the total world container traffic had approximately the same growth trends until 2003. The trend of container growth was three times faster than trend GDP growth and somewhat faster than the world exports of transport in the same period.

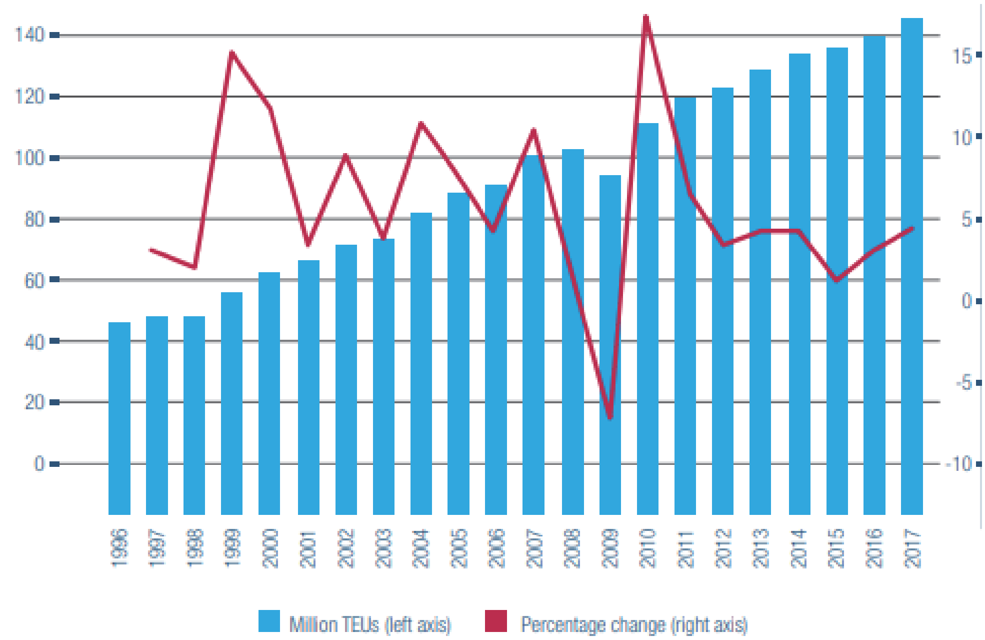
Figure 1.6. Comparison of data and increase the overall maritime container transport selected global indicators 2000-2008



Source: Containerisation International Yearbook; World Economic Outlook Database; Drewry Shiping Consultants, 2007; Clarkson Research Services; June 2009; Global Economic Prospects: „Crisis, Finance, and Growth", 2010.

After 2003, the growth in container transport turns sensitive, while exports of transportation services was constantly increasing, even during the global economic and financial crisis, which began in 2007. The crisis had a very negative impact on all economic indicators, as well as the overall maritime transport of cargo and container transport. It was estimated that in period 2009-2015, presented nubers would again indicate positive growth rates. Significantly, in the period 1970-2007 the total worldwide maritime trade increased more than three times: from 10.654 billion ton-miles at 32,932 billion ton miles. This growth took place at small rates, but it was continuous, constant and uninterrupted, which means it was not too resilient to the global economic recession.

Figure 1.6.1. Global containerized trade, 1996–2017
(Million 20-foot equivalent units and annual percentage change)



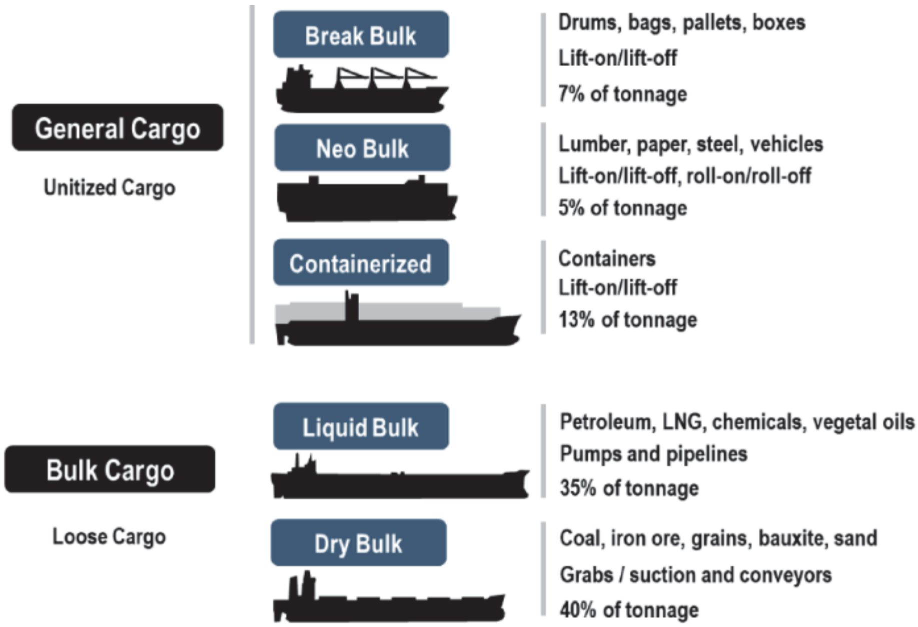
Source: UNCTAD secretariat calculations, based on data from MDS Transmodal, 2017.

Exports of transport services on a global level increased in the period 2000-2006, faster than the growth of maritime transport, provided that in the initial period 2000-2002 this growth was much slower, while in the period 2002-2006 it was very strong and grew at an average rate of over 10% (Figure 1.6). In the period 1980-2005, index growth in container traffic grew almost seven times faster than the corresponding increase in maritime transport (*Regional Shipping and Port Development Strategy Under a Changing Maritime Environmen*t, 2005, p. 5), and in the period 1987-1999, two times faster (Regional Shipping and Port Development Strategy Under a Changing Maritime Environment 2006, p. 13). This has contributed significantly to the development of integrated marketing logistics in the port transportation, without which the development of container transport is practically impossible. The rapid expansion of maritime trade has led to the rapid growth of bandwidth in many seaports. But, as a result, there have been many negative impacts of port activities, including local pollution and congestion of all other transport forms.

1.2 The Impact of Containerization on the Evolution of Strategies of Integrated Marketing Logistics

Estimations of the growth in container transport over the next five years are pretty optimistic. As much more homogeneous in terms of cargo, the container transport has high growth rates, even today. It had extremely positively influenced the development of logistics facilities, port infrastructure (construction of larger, modern terminals for cargo transshipment and other operations). Its share in total maritime transport has continuously increased, which in 2007 amounted to approximately 15%. Total container transport reached a record in its volume of almost 407 million TEUs in 2007. Two years earlier (2005), the total maritime transport was 6.808 million tons of cargo (Shipping Statistics and Market Review May-June 2009).

Figure 1.7. Types of Maritime Cargo

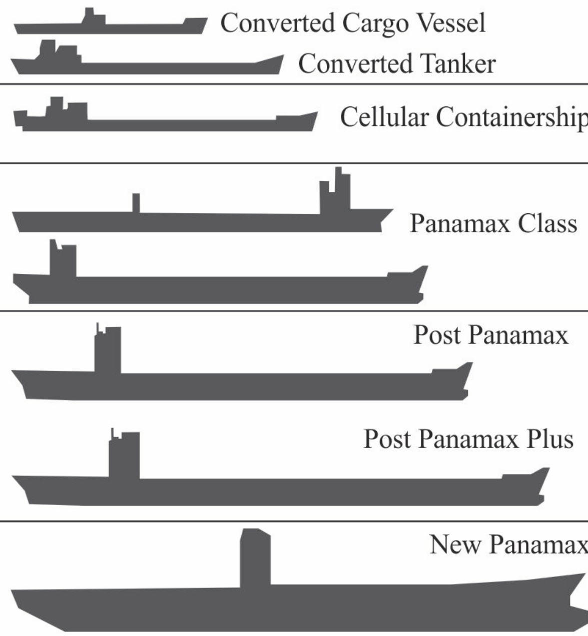


Source: https://transportgeography.org/?page_id=10258

Containerization of the maritime transport is closely linked with the development of integrated marketing logistics and linkage of different types of transport on a principle “door-to-door”. This has imposed the need for international standardization (TEU), the construction of special ships and container terminals, and new logistic standards, operations and strategies. Here should be mentioned the organizational development, which is related to outsourcing and integration of logistics operators. All this led to a gradual reduction of total logistic costs (port and maritime supply chain), and also the simpler, more reliable and faster cargo handling. This had a positive impact on the shorter ship retention in ports, reduction of transhipment costs and freight costs in integrated supply chains. Along with the expansion of container transport, there was a technological evolution of container ships (Figure 1.7).

For the purpose of this paper is significant the quality index of logistics services (Table 1.1). At the first place is Singapore. This is not coincidence, because Singapore is a large global hub port, first in the ranking of the world's largest container ports in 2007, with 24.79 million TEUs, and second in the ranking of the world's total freight traffic, with 537 million tonnes (*American Association of Port Authorities*). Netherlands is 2nd, Germany is 3rd, Japan is 6th, Hong Kong is 8th, the United Kingdom is 9th, Canada is 10th, Belgium on 12th, the United States is 14th, France is 18th, Italy is 22nd, and China is 30th.

Figure 1.7.1 World Container Ship Evolution: generation, timing and capacities

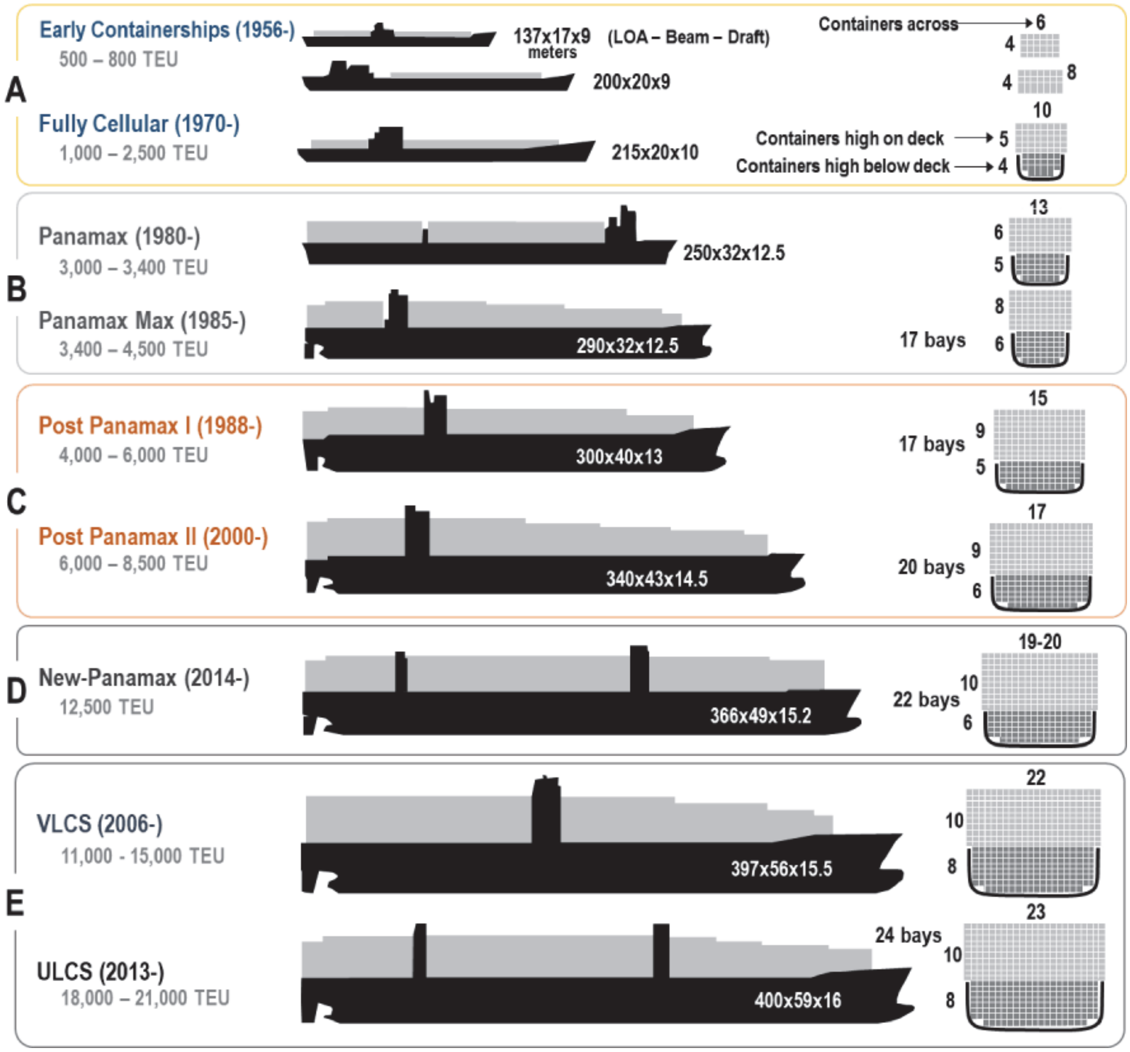


		Length	Draft	TEU
First (1956-1970)	Converted Cargo Vessel Converted Tanker	135m 200m	< 9 m < 30 ft	500 800
Second (1970-1980)	Cellular Containership	215m	10 m 33 ft	1,000-2,500
Third (1980-1988)	Panamax Class	250m 290m	11-12 m 36-40 ft	3,000 4,000
Fourth (1988-2000)	Post Panamax	275m-305m	11-13 m 36-43 ft	4,000-5,000
Fifth (1988-2000)	Post Panamax Plus	335m	13-14 m 43-46 ft	5,000-8,000
Sixth (1988-2000)	New Panamax	397m	15.5 m 50 ft	11,000-14,500

Source: http://www.container-transportation.com

According to these parameters, the development of integrated marketing logistics is accompanied by appropriate economic growth, trends in foreign trade and maritime transport. However, that can not be said for China, which occupies the unenviable 30th place, and South Korea (25th place) in terms of quality of the port service logistics. China is world's No 1 in total volume of port and container traffic, and South Korea is also highly rated. One can only speculate on the development expansion when China improve its logistics services. It is soon expected, given the intense Chinese capital investments in logistic port infrastructure. Netherlands holds a relatively equal level with regard to maritime transport of cargo and containers, on the one hand and quality of logistics (2nd place), on the other hand.

Figure 1.7.2. Evolution of Containerships



Source: https://transportgeography.org/?page_id=1762

According to Deloitte Benchmarking Report, which ranks the logistics in several primary factors influencing comparative advantages (besides the product quality, customer service, flexibility, and production costs), L. Suckling (2005, pp. 2-4) points out a dominant importance of logistics costs, but also the barriers for their reduction. Character of seaports imposes the volume of activities, locations and logistics costs, which are proportional to the size of the seaport. From this point of view it becomes clear that the development of the world's largest ports has been achieved through major improvement in the field of logistic activities.

This was greatly supported by simultaneous technological trends in the last two decades, primarily in the area of informatics, automation, and transportation (containerization makes about 15% of the world maritime cargo transport, support activities such terminals, logistics centers, etc.). Development strategy of seaports was mainly developed on the principles of functional logistics integration, which has gone through several evolutionary stages (T. Notteboom, J. P Rodrigue 2005, p. 3), namely: networking, expansion, specialization, and regionalization. All these stages have been dominated by the effect of relation decentralization-commercialization, which has contributed to developing the logistics integration of seaports.

Table 1.1. The Top 10 Performers on the 2014 LPI-Largely Unchanged Since 2007

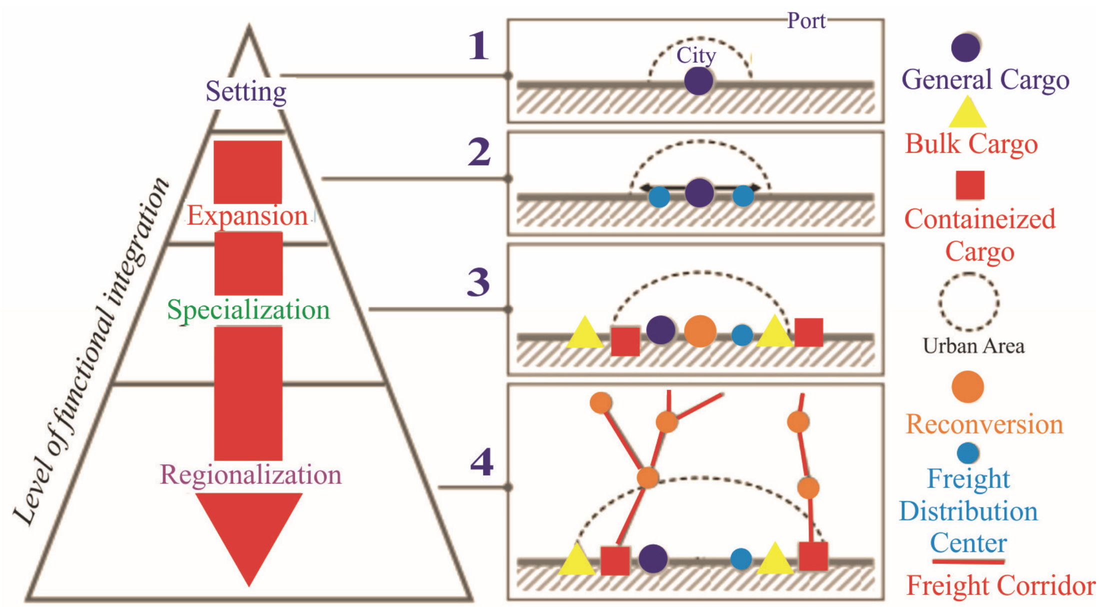
Country	*2014 LPI*		*2012 LPI*		*2010 LPI*		*2007 LPI*	
	Rank	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*
Germany	1	4.12	4	4.03	1	4.11	3	4.10
netherlands	2	4.05	5	4.02	4	4.07	2	4.18
Belgium	3	4.04	7	3.98	9	3.94	12	3.89
Un. Kingdom	4	4.01	10	3.90	8	3.95	9	3.99
Singapore	5	4.00	1	4.13	2	4.09	1	4.19
Sweden	6	3.96	13	3.85	3	4.08	4	4.08
Norway	7	3.96	22	3.68	10	3.93	16	3.81
Luxemburg	8	3.95	15	3.82	5	3.98	23	3.54
USA	9	3.92	9	3.93	15	3.86	14	3.84
Japan	10	3.91	8	3.93	7	3.97	6	4.02

Sources: WTO 2007; 2014; Arvis et al. (2008).

Regionalization, as the most modern form of the seaport integration strategy, extends the capabilities of the port hinterland through numerous market strategies and policies, linking it with internal distribution centers of goods. It brings the perspective of the port development through variety of logistic and port parameters. Port regionalization is characterized by strong functional interdependence, and even mutual development of specific transshipment centers and multimodal logistics platforms in the hinterland. This finally enables forming a regional network of transhipment centers. Many factors favor regionalization, and above all: local restrictions (lack of space, insufficient depth of the sea, inadequate port infrastructure with regard to the cargo handling on bigger boats, economic and logistical inefficiencies, poor protection of the environment, etc.), and modern global changes in distribution networks, supply chains, and integrated marketing logistics (traditional and innovative forms of 3PL, 4PL and 5PL type).

Transition to the port regionalization is a market-orchestrated process, imposed to the seaports, due to the increased interest of market participants for a greater integration of marketing logistics. It all started with the creation of logistic networks between hub ports and their operators. This process was accelerated by the expansion of world container transport at a CAGR of 10.7%, the corresponding expansion of port trade and specialization. International supply chains are becoming more complex, and logistic models are continuously developing, influenced by the globalization factors. Regionalization is actually a strategic response to the increasing demands of efficiency in the supply chain, growing integration and reducing total logistic costs of distribution. It is believed that average land costs account for 18% of total logistics costs, and could be reduced up to 1/3 with the application of appropriate strategies regionalization (Ibid., p. 21).

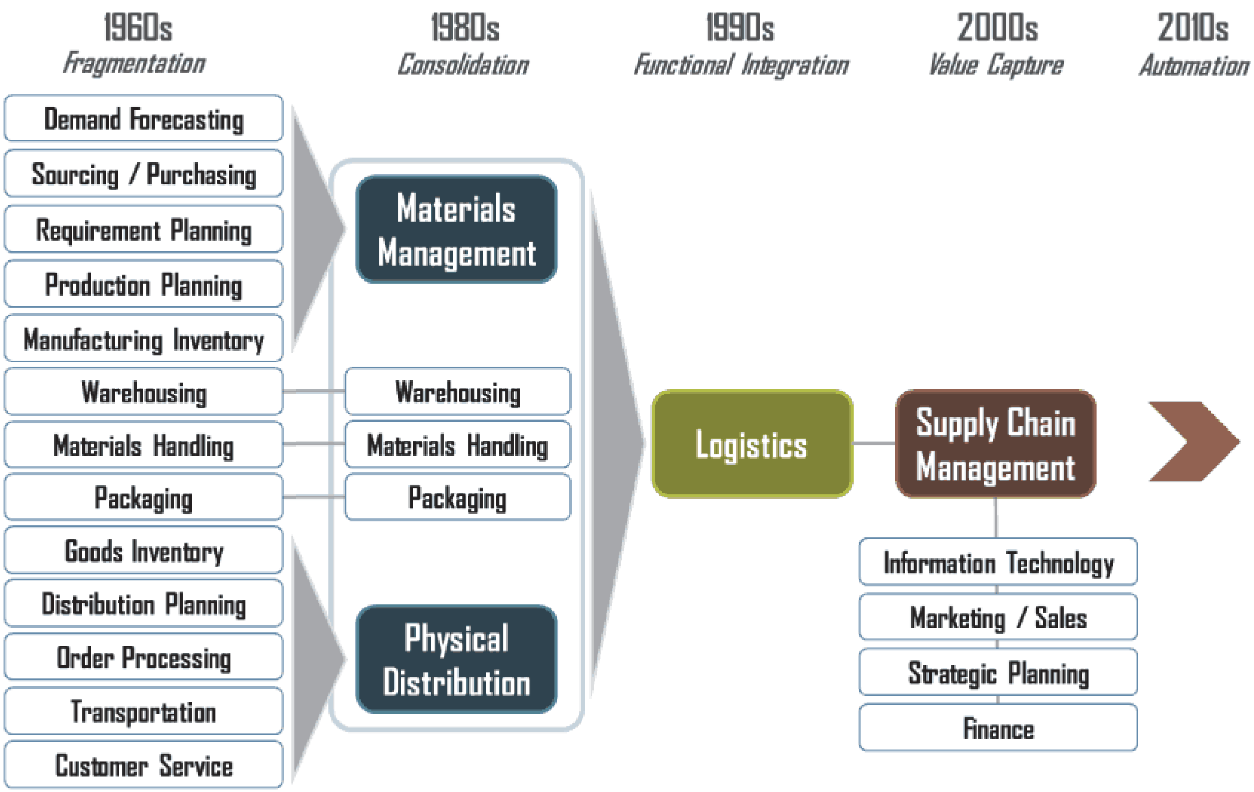
Figure 1.8. Evolution of logistical integration strategies in seaports



Source: Notteboom and Rodrigue, 2005, p. 3.

J. P. Rodrigue (2008) argues that regional improvements, which are available to the seaports, could even double the increase of the existing port terminals throughput. Modern regionalization allows that capacity of the port is no longer a major limiting factor in terms of the seaport attractiveness. The world's major seaports are increasingly opting for the regionalization strategy, because there is a cheap land at their disposal outside the airport, and externalities are not internalized. Therefore, the port regionalization is much cheaper than the increase of infrastructure capacity within the ports themselves.

Figure 1.8.1. Evolution of logistical integration



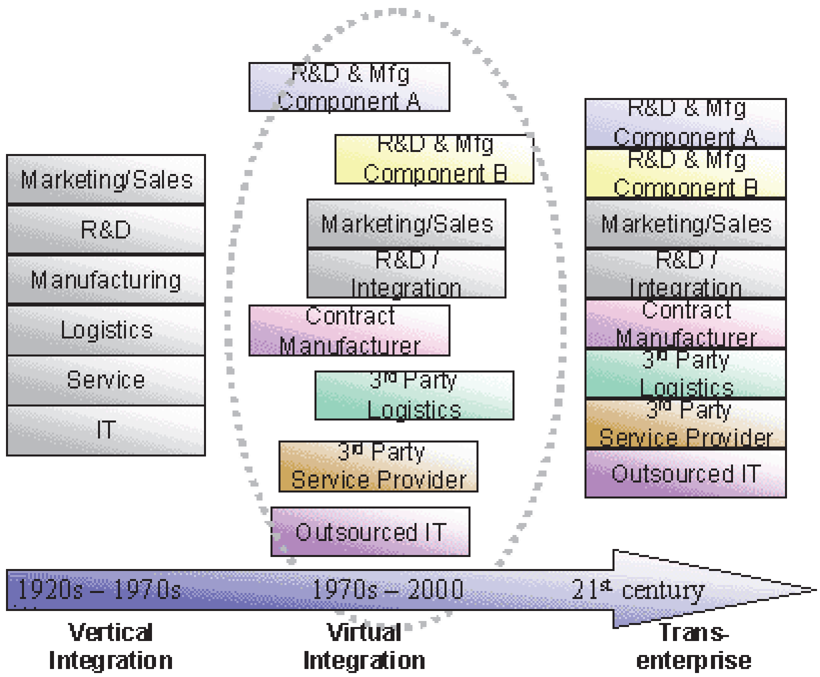
Source: https://www.google.me

The evolution of supply chain management has been characterized by an increasing degree of integration of separate tasks, a trend that was underlined in the 1960s as a key area for future productivity improvements since the system was highly fragmented. Although the tasks composing logistics have remained relatively similar, they initially consolidated into two distinct functions related to materials management and physical distribution during the 1970s and 1980s. This process moved further in the 1990s as globalization incited a functional integration and the emergence of logistics in a true sense; all the elements of the supply chain became part of a single management perspective.

Only with the implementation of modern information and communication technologies did a more complete integration became possible with the emergence of supply chain management. It allows for the integrated management and control of information, finance and goods flows and made possible a new range of production and distribution systems. Supply chain management has become a complex sequence of activities aiming at value capture and competitiveness. More recently, the growing level of automation of supply chains has been a dominant element of the evolution of both physical distribution and materials management. This is particularly notable within distribution centers that have experienced a remarkable push towards automation such as storage, materials handling and packaging.

Initially, logistics was an activity divided around the supplying, warehousing, production and distribution functions, most of them being fairly independent from the other. With the new organization and management principles, firms were following a more integrated approach, thus responding to the upcoming demand for flexibility without raising costs. At the same time, many firms took advantage of new manufacturing opportunities in developing countries through outsourcing and offshoring. As production became increasingly fragmented, activities related to its management were consolidated. Spatial fragmentation became a by-product of economies of scale in distribution.

Figure 1.8.2. Evolution to the Transenterprise

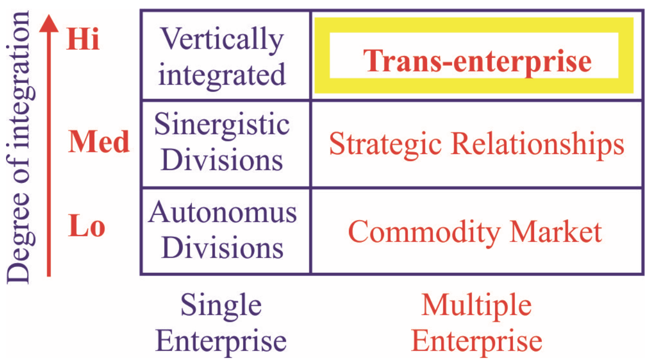


Source: http://www.chainlinkresearch.com/parallaxview/v2_01/policy1.htm

During the last two decades, many of the old vertically integrated enterprise/empires have splintered into numerous core-competency-focused firms, loosely bound into the so-called virtual extended enterprises. The next two decades will witness re-integration into transenter-prises - tightly knit federations of companies with long-term commitments and deep investments in integrating together into a more efficient and effective whole. The governance and investment models for these entities will transcend traditional strategic supplier relationships, combining the characteristics of vertically integrated companies and virtually integrated extended supply chains. Transenterprises will go far beyond traditional strategic supplier relationship along two dimensions:

- *Extraordinary commitments* - financial and legal – massive investments and deep or exceptionally long contractual commitments binding the players into long-lasting transenterprises.
- *Extraordinary integration* – physical, process, IT systems, policies, and/or governance integration to a degree normally found only within a single enterprise.

Figure 1.8.3. Evolution to the Transenterprise



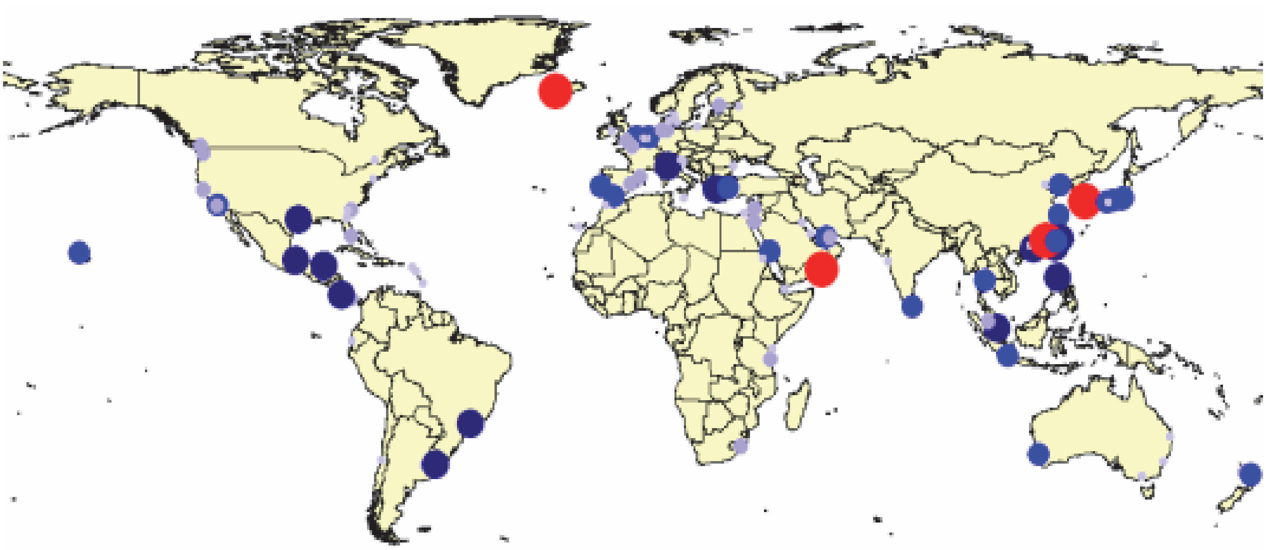
Source: http://www.chainlinkresearch.com/parallaxview/v2_01/policy1.htm

We are already seeing early versions of transenterprises. In the automotive industry, there is a movement towards supplier parks. In supplier parks, the automotive OEM (*original equipment manufacturer*) selects a group of key suppliers to co-invest in a physically integrated factory. The suppliers' manufacturing lines are housed on the same campus, generally in the same building, with their operations literally connected via conveyor belts. The net result is a large vertically integrated plant/campus with raw steel coming in one end, and finished autos out the other. This is physically very similar to the massive, vertically integrated automotive plants of the early twentieth century, but with a very different ownership and governance, because the assets are owned by many different firms. Suppliers invest hundreds of millions of dollars in equipment, and commit to decade long leases. The OEM takes on massive switching-cost risks. In some cases, suppliers have agreed to common HR governance across all the companies in the park to set compensation policies for the transenterprise, superceding the individual company policies.

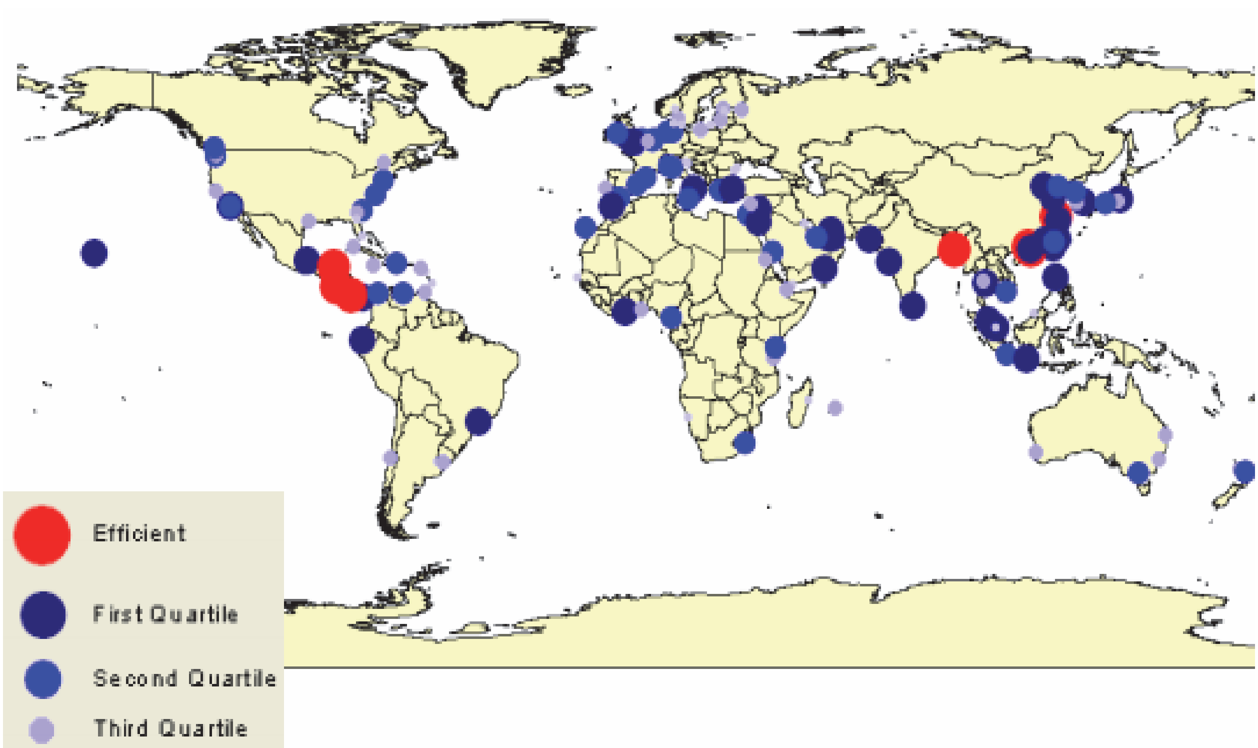
The growth in traffic volume in the world's largest seaports in the period 1991-2004 (Figure 1.9) is the result of high investments in the port and logistic capacities, and the increasing application of integrated marketing logistics.

Figure 1.9. The growth in traffic volume in the world's largest seaports 1991-2004

Ports in 1991



Ports in 2004



Source: Sheon, 2007, p. 196.

1.3 The Concentration Development of the Port Transport and Logistics Operators

The concentration of the port transport (total and container) is one of the most important issues in the international maritime market, the global economic development and the development of integrated marketing logistics. It is shown in Table 1.2, and in Figures 1.10 and 1.11. When it comes to total port cargo traffic, there is a very strong concentration, because the share of the five largest ports in total worldwide turnover in 2006 was 25.82 % (in absolute value it is 1,976.4 million tons). Since the following five largest ports have accounted with 14.9% (1145.9 million tons), this has caused an increase in the concentration of the ten largest ports up to 40.78% of the global port transport. At the same year, the concentration of the port transport, measured through the participation of 20 largest world ports, was 64.67% (4950.9 million tons), and in the 25 top world ports it was 73,48% (5625.0 million tons).

This concentration was followed by huge investments in the port infrastructure and logistics integration. Analysis of the concentration of the container port traffic shows that five largest container ports have 23.58% (100.5 million TEUs), the 10 largest have 34.30%, the 20 largest have 49.91, while the 25 largest container ports have 53,29% of the traffic share. However, this level of concentration is some what lower in the total freight transport. In the 5 largest ports is reduced by 2.24%, in the 10 largest ports by 6.48%, in the 20 largest by 14.76% and in the 25 largest by 20,19%. Clearly, this difference increases significantly with the number of monitored ports, which further testifies on a higher degree of the cargo transport concentration in relation to the container transport.

Table 1.2. The concentration of total cargo and container port traffic in major seaports in 2006/2012

2006

Total cargo tonnage (mil. metrics tons)			
poz	*Port*	*Country*	*Mil. tons*
1.	Shanghai	China	537,0
2.	Singapore	Singapore	448,5
3.	Rotterdam	Netherlands	378,4
4.	Ningbo	China	309,7
5.	Guangzhou	“	302,8
		Total 5	1976,4
6.	Tianjin	China	257,6
7.	Hong Kong	Singapore	238,2
8.	Qingdao	China	224,2
9.	Busan	South Korea	217,9
10.	Nagoya	Japan	208,0
		Total 6-10	***1145,9***
		Total 10	***3122,3***
11.	Qinhuangdao	Shina	204,9

12.	S. Louisiana	United States	204,6
13.	Kwangyang	South Korea	202,4
14.	Houston	United States	201,5
15.	Dalian	Shina	200,5
16.	Shenzhen	"	176,0
17.	Antwerp	Belgium	167,4
18.	Chiba	Japan	167,0
19.	Ulsan	South Korea	161,1
20.	New York	United States	143,0
		Total 11-20	***1828,4***
		Total 20	***4950,7***
21.	Yokohama	Japan	138,2
22.	Hamburg	Germany	135,3
23.	Kaohsiung	Taiwan	135,1
24.	Inchon	South Korea	129,6
25.	Dampier	Australia	126,1
		Total 21-25	***674,3***
		Total 25	***5625,0***
		Total world	***7655,0***

2012

k	*Port*	*Country*	*Measure*	*Mil. Tons*
1	Ningbo-Zhoushan	China	MT	744,000
2	Shanghai	China	MT	644,659
3	Singapore	Singapore	FT	538,012
4	Tianjin	China	MT	477,000
5	Rotterdam	Netherlands	MT	441,527
6	Guangzhou	China	MT	438,000
7	Qingdao	China	MT	407,340
8	Dalian	China	MT	303,000
9	Busan	South Korea	RT	298,689
10	Port Hedland	Australia	MT	288,443
11	Hong Kong	China	MT	269,282
12	Qinhuangdao	China	MT	233,235
13	South Louisiana	United States	MT	228,677
14	Houston	United States	MT	216,082
15	Nagoya	Japan	FT	202,556
16	Shenzhen	China	MT	196,458
17	Port Klang	Malaysia	MT	195,856
18	Antwerp	Belgium	MT	184,136
19	Dampier	Australia	MT	180,366
20	Ulsan	South Korea	RT	174,117

Table 1.3. Top 20 container terminals and their throughput for 2005-2007
(TEUs and percentage change)

Port name	*2005*	*2006*	*2007*	*% change 2006-2005*	*% change 2007-2006*
Singapore	23192200	24792400	27932000	6.90	12.66
Shanghai	18084000	21710000	26150000	20.05	20.45
Hong Kong (China)	22601630	23538580	23881000	4.15	1.45
Shenzhen	16197173	18468900	21099000	14.03	14.24
Busan	11943151	12030000	13270000	1.58	10.31
Rotterdam	9250985	9645508	10790604	4.36	11.77
Dubai	7619219	8923465	10653026	17.12	19.38
Kaohsiung	9471056	9774670	10256829	3.21	4.93
Hamburg	8087545	8861545	9900000	9.57	11.72
Qingdao	630700	7702000	9462000	22.12	22.85
Ningbo	5208000	7068000	9360000	35.71	32.43
Guangzhou	4685000	6600000	9200000	40.88	39.39
Los Angeles	7484624	8469853	8355039	13.16	-1.36
Antwerp	6482061	7018899	8176614	8.28	16.49
Lonh Beach	6709818	7290365	7312465	8.65	0.30
Port Klang	5715855	6326294	7120000	10.68	12.55
Tianjin	4801000	5950000	7103000	23.93	19.38
Tanjung Pelepas	4177121	4770000	5500000	14.19	15.30
New York / New Jersey	4792922	5092806	5400000	6.26	6.03
Bremen / Bremerhaven	3735574	4428203	4892239	18.54	10.48
Totat top 20	186445934	208470488	235813816	11.81	13.12

Source: UNCTAD, Containerisation International, May 2008.

Analyzing the concentration of the port transport is attempt to eliminate 2007 and 2008 as record years, in order to, at least partially, cover the impact of the crisis in 2008. Nevertheless, Figure 1.10 shows that throughout the period 2000-2008 there was a very large and continuous increase in the concentration of container transport in the major seaports, achieving the absolute growth in the 5, 10 and 20 largest ports, in the total container port transport. This increase in concentration has contributed significantly to the schedule of container transportation in 2008.

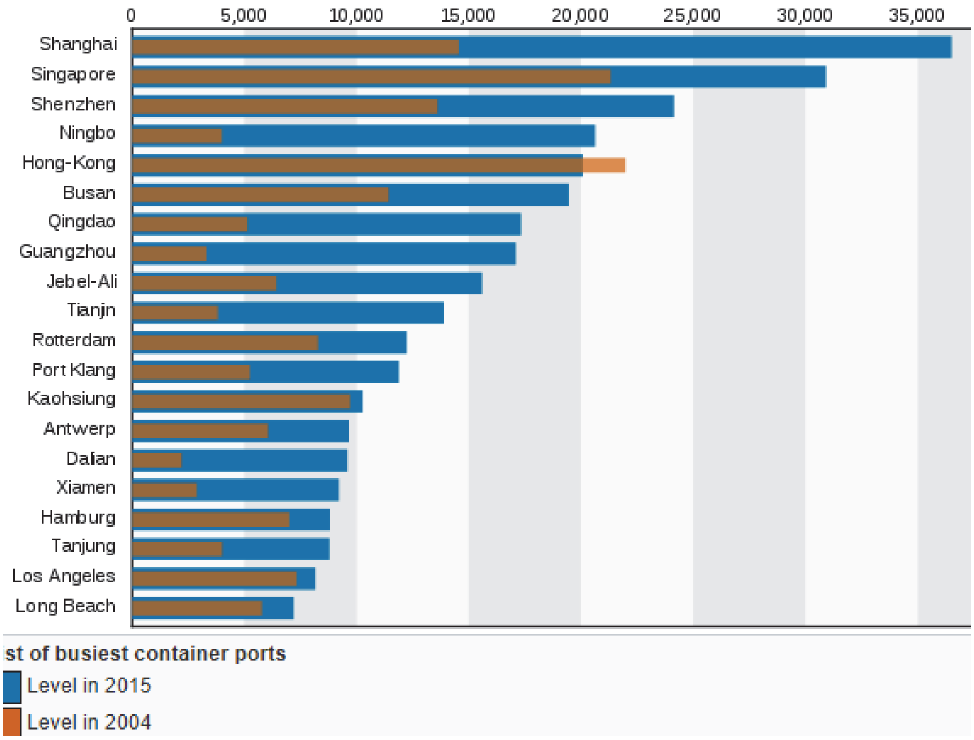
Table 1.3.1. Top 20 container terminals for 2012-2016 (Million TEU)

Port	*2016*	*2015*	*2014*	*2013*	*2012*
Shanghai, China	37.13	36.54	35.29	33.62	32.53
SIngapore	30.90	30.92	33.87	32.60	31.65
Shenzhen, China	23.97	24.20	24.03	23.28	22.94
Ningbo-Zhoushan, China	21.60	20.63	19.45	17.33	16.83
Busan, South Korea	19.85	19.45	18.65	17.69	17.04
Hong Kong, S.A.R., China	19.81	20.07	22.23	22.35	23.12
Guangzhou Harbor, China	18.85	17.22	16.16	15.31	14.74
Qingdao, China	18.01	17.47	16.62	15.52	14.50
Jebel Ali, Dubai, United Arab Emirates	15.73	15.60	15.25	13.64	13.30
Tianjin, China	14.49	14.11	14.05	13.01	12.30
Port Klang, Malaysia	13.20	11.89	10.95	10.35	10.00
Rotterdam, Netherlands	12.38	12.23	12.30	11.62	11.87
Kaohsiung, Taiwan, China	10.46	10.26	10.59	9.94	9.78
Antwerp, Belgium	10.04	9.65	8.98	8.59	8.64
Dalian, China	9.61	9.45	10.13	10.86	8.92
Xiamen, China	9.61	9.18	8.57	8.01	7.20
Hamburg, Germany	8.91	8.82	9.73	9.30	8.89
Los Angeles, U.S.A.	8.86	8.16	8.33	7.87	8.08
Tanjung Pelepas, Malaysia	8.28	9.10	8.50	7.63	7.70
Keihin Ports, Japan	7.61	7.52	7.85	7.81	7.85

Source: https://www.mardep.gov.hk/en/publication/pdf/portstat_2_y_b5.pdf

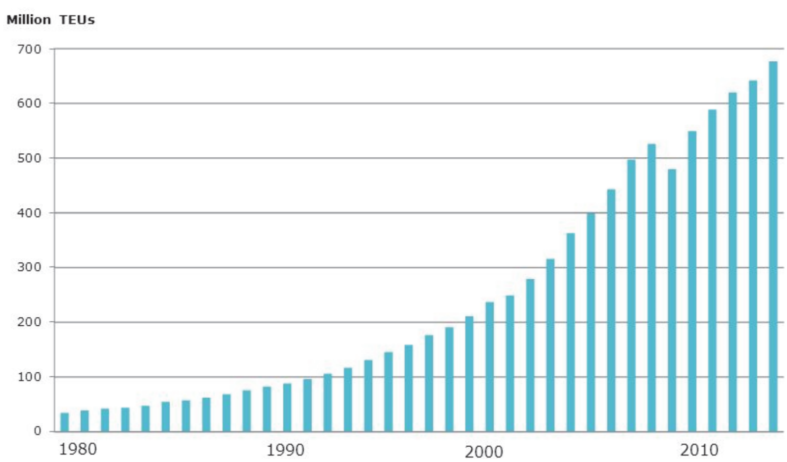
Comparison of the five largest container ports according to capacity during the period 1990-2008, also confirms the above reasoning. That was the highest degree of container transport concentration. At the beginning of 1990s, the port traffic volume was almost six times lower, and in 1995 three and a half times lower, not to mention the concentration, because only three or four seaports of today's top five were noticeable. Singapore and Hong Kong had only glimpses of concentration, which significantly increased in 2000 and later developed at an accelerated rate, in line with the rapid increase in the volume of port transport. Since 2005, Singapore and Hong Kong were joined by Shanghai, Shenzhen and Busan in high concentration degree.

Figure 1.10. Container Traffic 2004 / 2015 (in thousand TEUs)



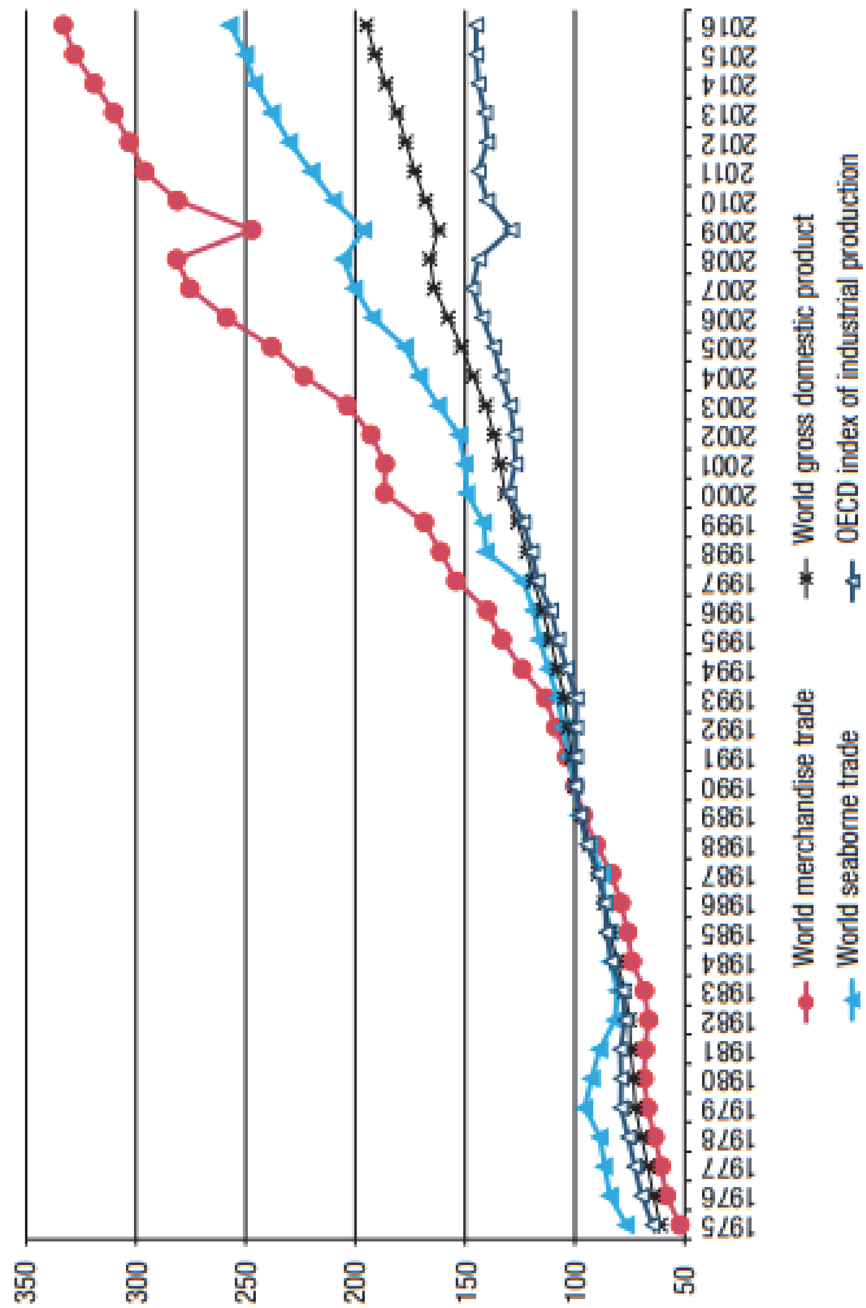
Source: https://en.wikipedia.org/wiki/List_of_busiest_container_ports

Figure 1.10.1 World Container Traffic (in million TEUs)



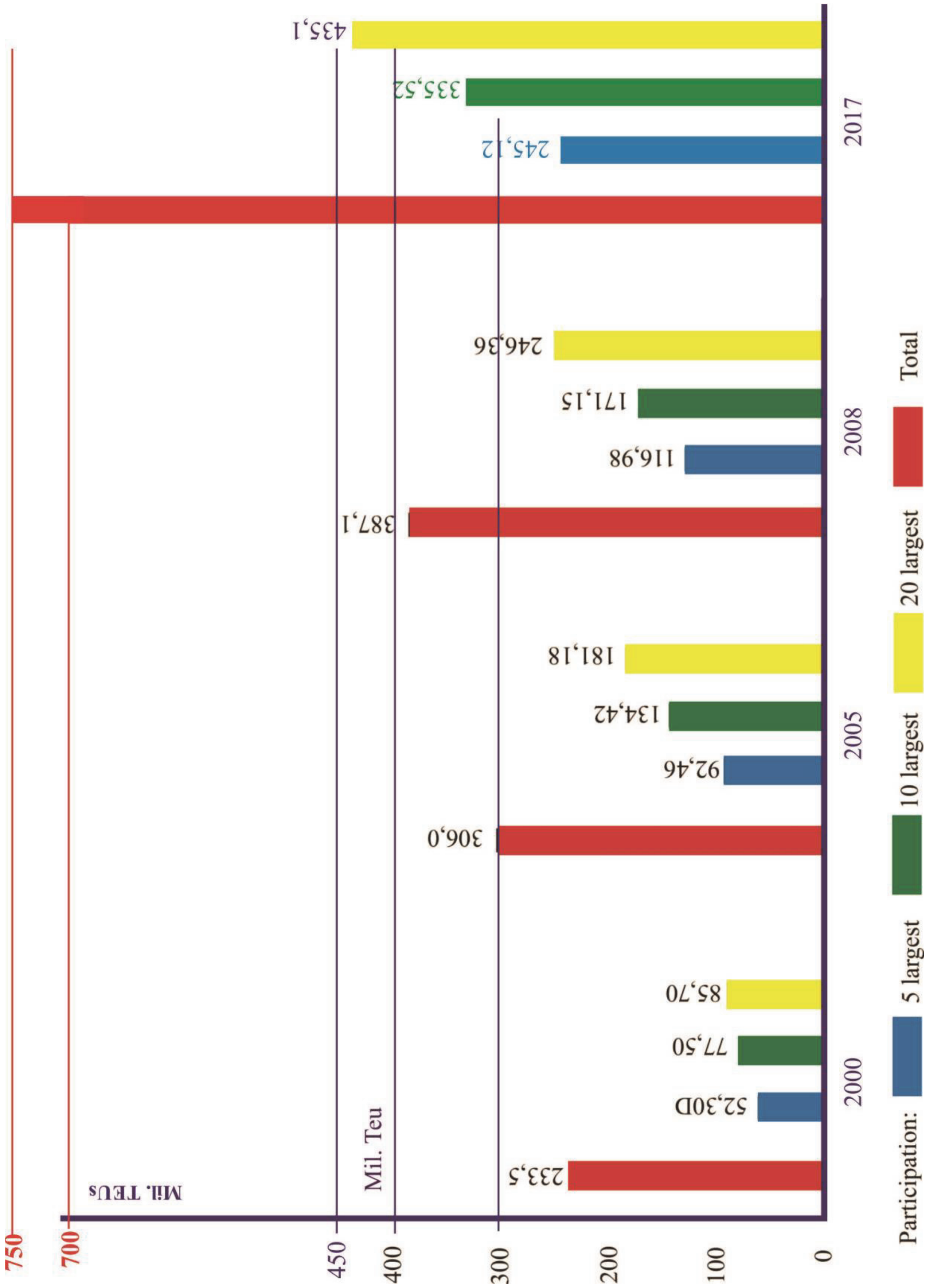
Source: www.google.me

Figure 1.10.2. Organization for Economic Cooperation and Development index of industrial production and world indices: Gross domestic product, merchandise trade and seaborne shipments, 1975–2016 (1990 = 100)



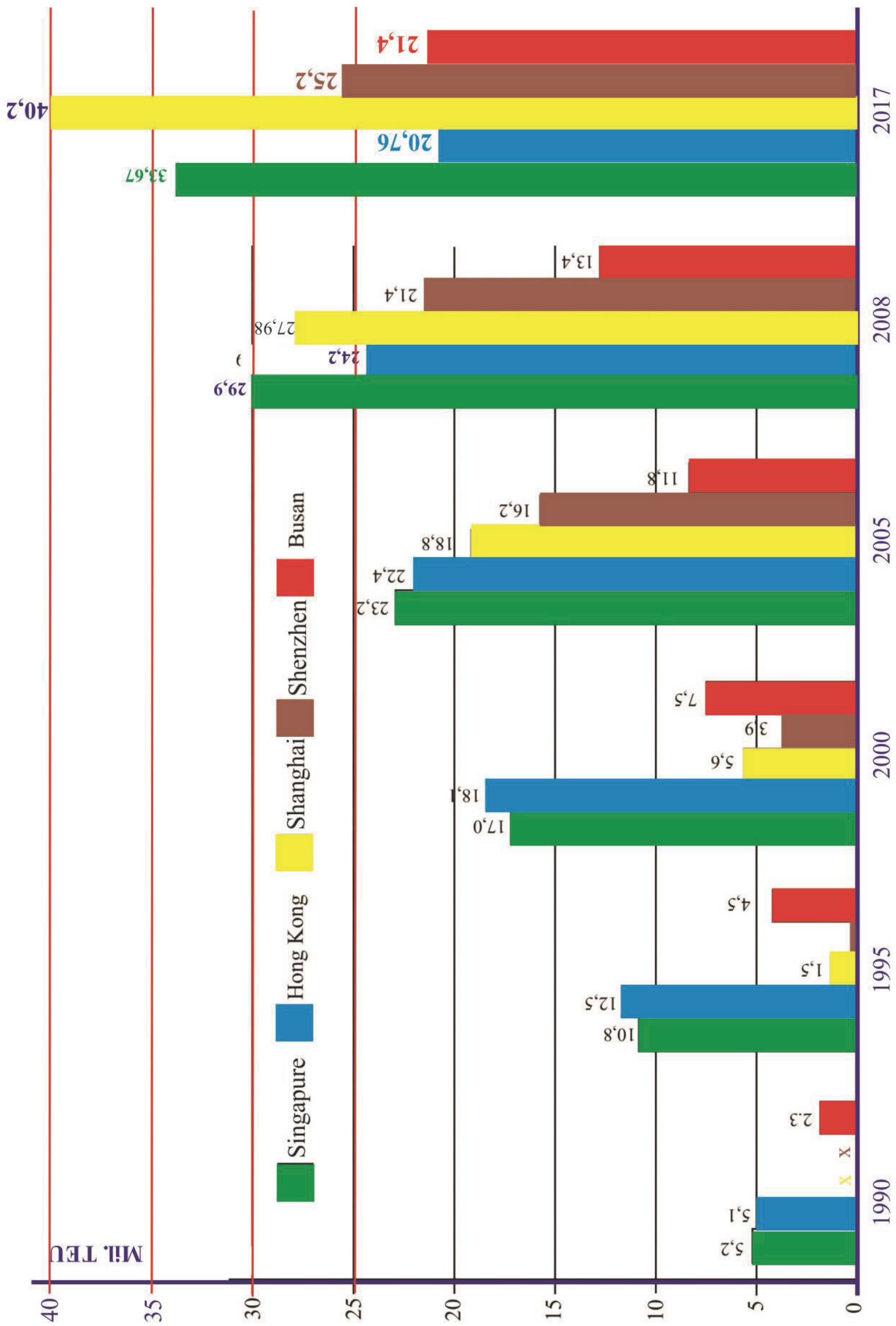
Sources: UNCTAD, Review of Maritime Transport 2017, p. 3.

Figure 1.10.3. The concentration of container traffic in world's major seaports for 2000-2008 (in millions of TEUs)



Source: Containerisation International Yearbooks, 2009.

Figure 1.11. Comparison of the world's largest container ports according to capacity during the period 1990-2008



Sources: America's Container Ports: Fright Hubs That Conn ect Nation to Global Markets, june 2009, p. 18; *Containerisation International Yearbooks*, 2009; https://en.wikipedia.org/wiki/List_of_busiest _ container _ports

Concentration in the port industry can be analyzed in terms of the regional distribution of seaports and the number of logistics terminal operators among the five largest in the world (Hutchison Port Holdings HPH, APM Terminals, PSA International, DP World and COSCO Pacific). According to the first criterion, with the use of additional selective criteria, where the analysis is limited to the seaports with container capacity of over five million. Table 1.4 indicates that the largest number (13) of such seaports are located in Asia, there are four in Europe, three in North America and one in the Middle East.

Table 1.4. The regional distribution of sea ports in 2008 with container capacity of over five million TEUs and logistics terminal operators among the five largest in the world

Region	*Name of seaport*	*Capacity in mil. TEU*	*Number provaders*
Asia	Singapore	29,92	1
	Shanghai	27,98	4
	Hong Kong	24,25	4
	Shenzhen	21,41	4
	Busan	13,43	3
	Ningbo	11,23	2
	Guangzhou	11,00	2
	Qingdao	10,32	3
	Kaohsiung	9,68	0
	Tianjin	8,50	4
	Port Klang	7,97	1
	Tanjung Pelepas	5,60	1
	Ksiamen	5,03	2
Europe	Rotterdam	10,80	1
	Hamburg	9,70	4
	Antverp	8,66	4
	Bremen-Bremerhaven	5,50	4
Middle East	Dubai	11,83	1
North America	Los Angeles	7,85	1
	Long Beach	6,49	0
	New York/New Jersey	5,30	1

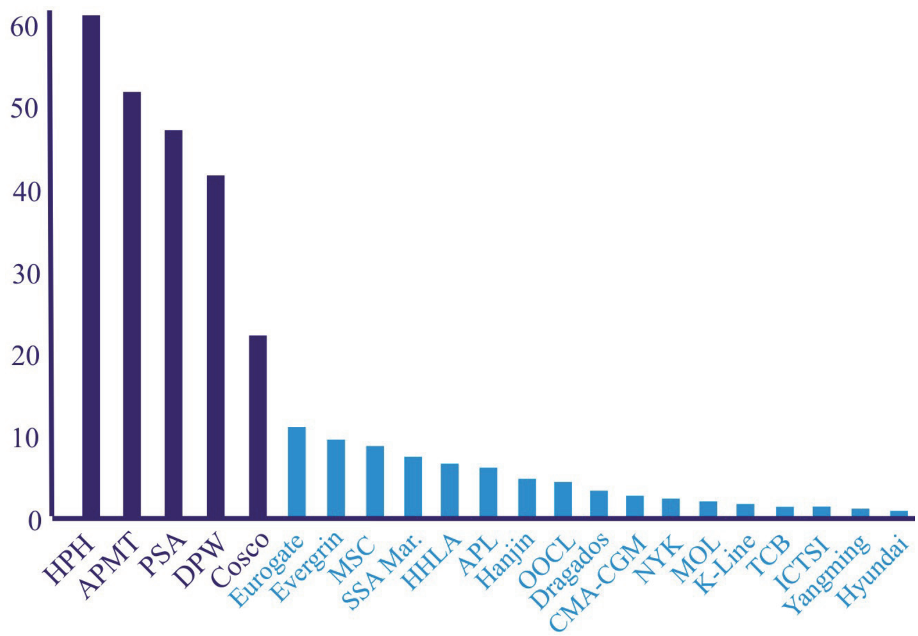
Source: *Shipping Statistics Yearbook 2007*.

Situation is similar in terms of regional concentration of the largest logistics terminal operators, because 31 are located in Asia, 13 in Europe, 2 in North America, and one of the largest is in the Middle East. Of all (104) the world's greatest seaports, 34 are located in Asia is

(32.69%), 28 in Europe (26,92), 20 in North America (19,23%), 9 in Latin America (8.65%), 7 in Central Africa (6.73%), and 6 in Oceania (5.77%).

The world's largest seaports (104) include offices of 22 major logistics terminal operators with 213 branches. Their regional concentration is very strong. In Asia are located 92 branches (43.19%), in Europe 54 (25.35%), in North America 49 (23.0%), in Latin America 8 (3.75%), in Central Africa also 8 (3.75%) and Oceania has two branches of large operators (0.93%) - Ibid. In addition, the concentration and volume of treated port transport is highly expressed, as shown in Figure 1.12. Five largest logistics port operators (HPH, APMT, PSA, DPE and Cosco) not only have a container traffic of over 20 million TEU (from 22 to 61 million TEU), but the largest logistics operator has a similar turnover of eight operators, ranking from 6th-13th place (61 million TEU).

Figure 1.12. Concentration of container transhipment in the port logistics operators in 2006 (Mil. TEU)



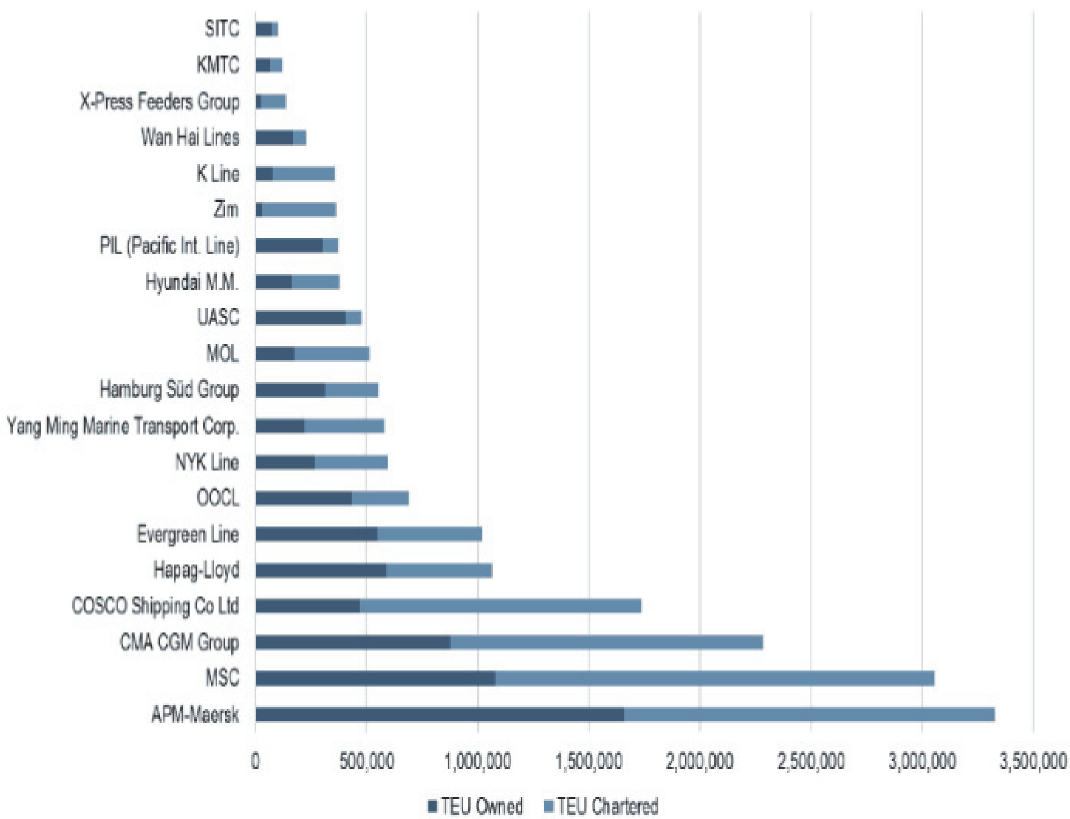
Source: Shipping Statistics Yearbook 2007.

55

Operators from 14th-22nd place have a turnover of around 26 million TEU, which is only 4 million TEU more than COSCO, which is ranked No. 5. However, two largest operators, APMT and HPH, together have a turnover of approximately 112 million TEU, which is approximately 25 million TEU more than 17 operators together, classified from 6th to 22nd place (together they have approximately 87 million TEU). More than 20 of the 100 largest seaports in the world are actually reload operators, in the sense that at least half of their transport is cargo reloaded on the ship-port-ship relation (Baird 2007).

Comparing concentration of transport in seaports with concentration at port logistics operators, conclusion is that much higher concentration (more than twice) is in the latter. The reasons can be found in the fact that global logistic operators have more related factors of influence, dominated by big business, modern logistic infrastructure, management knowledge, skills, quality multimodal projects, the latest transport and information technology, as well as long-term tradition and private management structure, which in addition to providing quality logistics services successfully applies the economic principle of economy scale. Also, a great contribution to the concentration gave the application of integrated marketing logistics principle, and on that basis a number of vertical and horizontal business integrations. Significant is greater and more active involvement of global logistic operators in a global supply chain, which definitely affects their logistical efficiency through reduction of prices, increased quality, speed, competence and reliability of the services performed.

Figure 1.12.1. World's Largest Maritime Container Shipping Operators, 2017

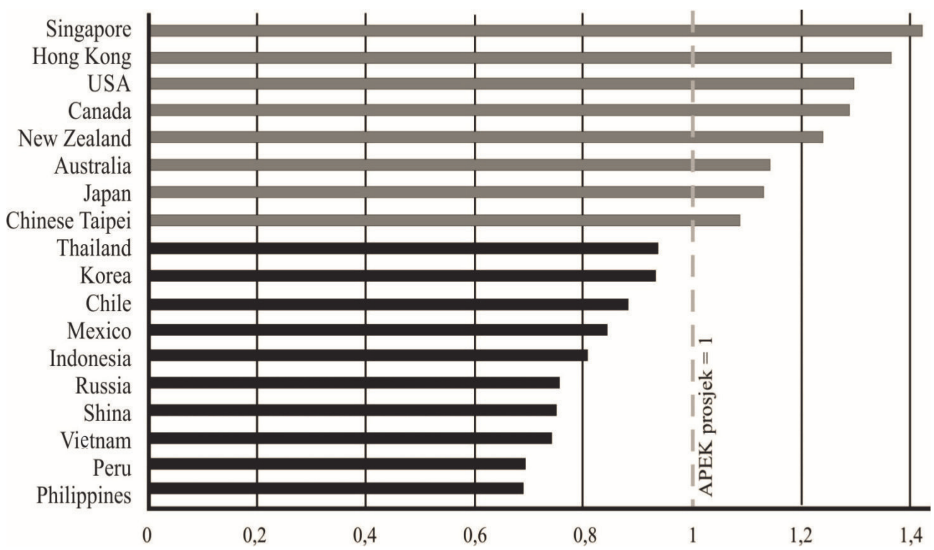


Source: Alphaliner.

1.4 Development of Logistic Efficiency in Ports

All the above indicators and various comparative analysis provide a logical rather than methodological and empirical conclusions about the connection between the growth of the port transport and the corresponding efficiency of the port logistics. Big investments in logistics infrastructure can not guarantee the quality of the port logistic services, nor high resulting efficiency. In 2002, APEC (*Asia Pacific Economic Cooperation*) has developed methodological index system for measuring the quality level and efficiency of the port logistic infrastructure, and related logistic activities and performance. According to this calculation, if the APEC logistics index equals one, then the logistic efficiency is solid (normal). Development methodology requires a whole range of complicated procedures, indicators and analysis. It falls into the domain of corporate secrets innovators. However, available data are only for the countries where APEC has its branch offices and customer services.

Figure 1.13. Comparison of selected countries in 2000, according to the APEC logistic port efficiency index



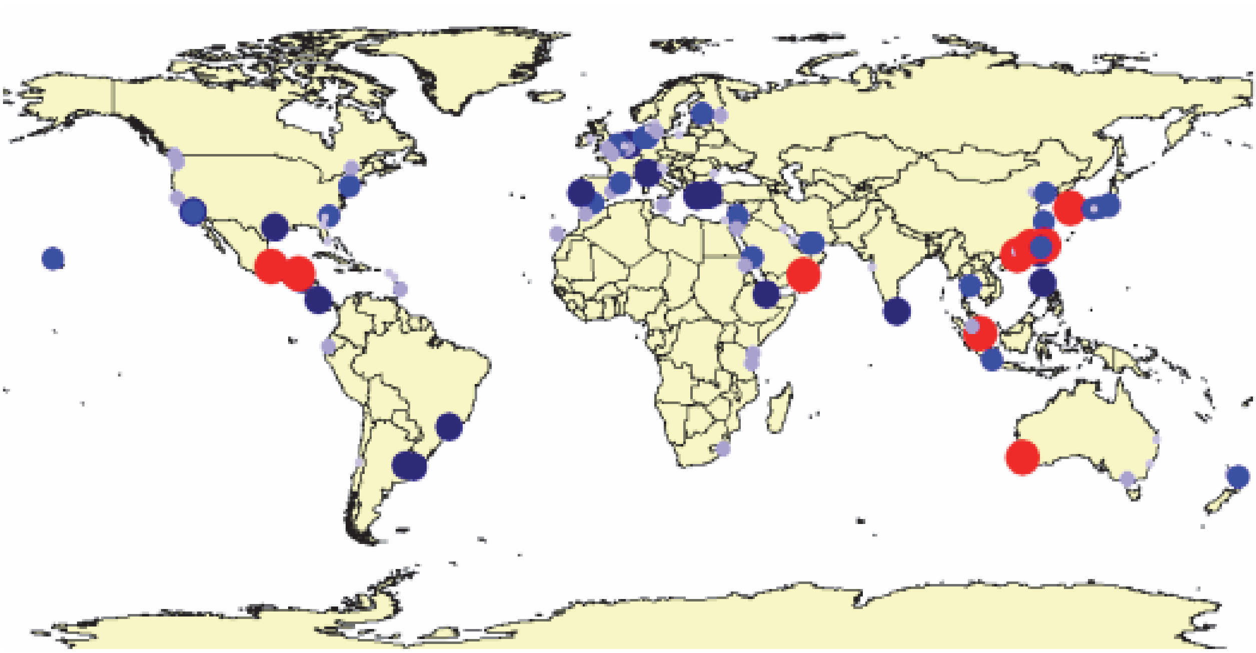
Source: Sheon, 2007, p. 15.

According to data for 2000, Singapore is the leader in logistics efficiency, followed by Hong Kong, Canada, USA and New Zealand, with very high level of logistical efficiency (logistic index over 1,2). In the group of countries with excellent logistics index between 1 and 1.2 are Australia, Japan, Ma-laysia and Chinese Taipei. The logistic index between 0.8 and 1.0 have Korea, Chile, Mexico, Thailand and Indonesia. A group with a range of logistic indexes between 0.6 and 0.8 include China, Russia, Viet-nam, Philippines and Peru. The limit of 1,0 represents the average value which should be exceeded to achieve satisfactory logistical efficiency. In 2000, China and Russia were very close to that value, and today almost have 1,0 logistic index.

The validity of the port logistics efficiency can be verified in practice through comparing the price of handling containers in selected ports. Thus, for example, in 2002 that price in Singapore was $117 US dollars/TEU, and in the Chinese port of Kaohsiung $140 US dollars/TEU, which is ascribed to the influence of logistical efficiency. To calculate the efficiency of the port logistics is used DEA (*Data Envelopment Analysis*) model, based on the inclusion of diverse techniques of mathematical program-ming. The concept is very complicated because it calculates different DEA coefficients, but it is essential that its results include five seaport categories according to the degree of logistics efficiency (in the matrix horizontally), namely: efficient (DEA=1), first class (1<DEA<2,19), second class (2.19 <DEA <3.19), third class (3.19<DEA<4.36) and fourth class (4.36<DEA) - Ibid., p. 203. In the matrix vertically are grouped various port categories ("classes") according to the volume of container traffic. It is created ba-sed on the obtained map of the world's seaports to the DEA logistic efficiency, as shown in Figure 1.14. It demonstrates comparison of DEA efficiency in 1991-2004.

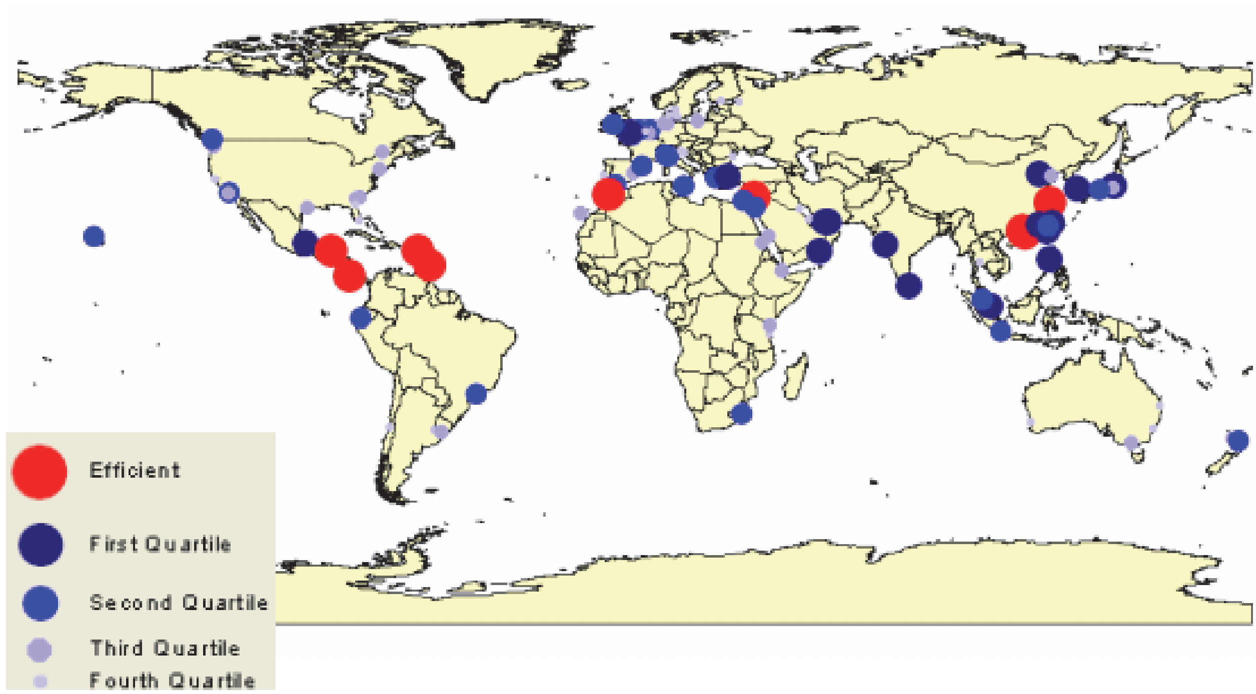
Figure 1.14. Growth of DEA efficiency in the major seaports in the period 1991-2004

1991



Source: Sheon, 2007, p. 205.

2004



59 *Source*: Sheon, 2007, p. 205.

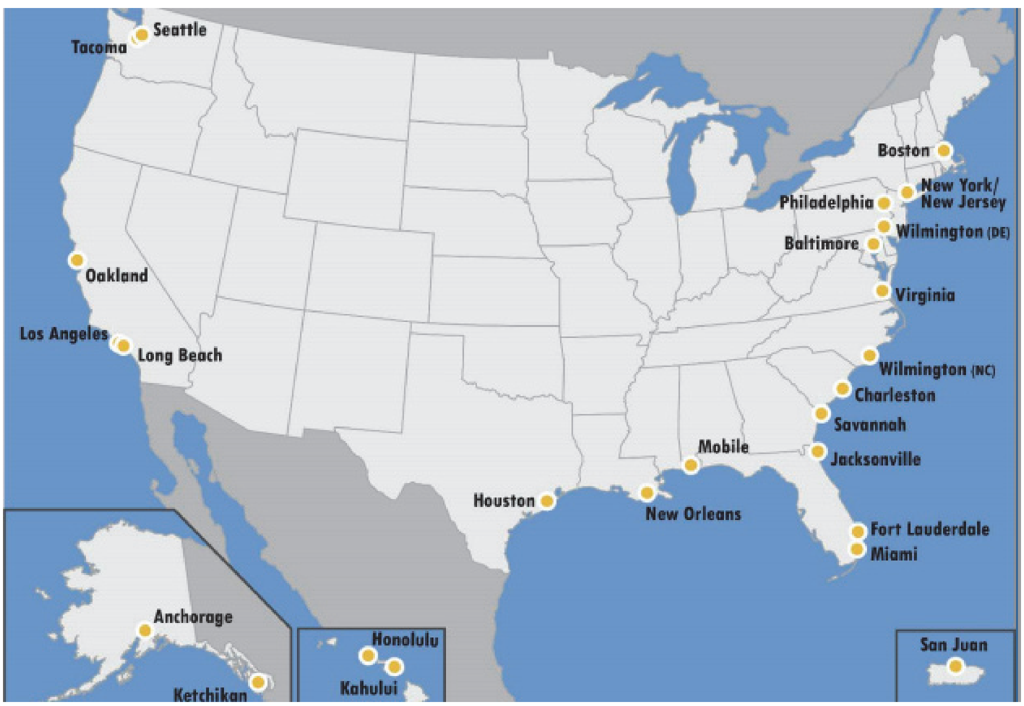
Thanks to the significant and constantly growing investments in the port and logistical capacities, which followed market trends and requirements, grew the quality and importance of integrated marketing logistics in the world's largest seaports. In the monitored period was noticed the increase of the world's great ports, that have a high level of logistics efficiency as well as significant increase of the efficiency level in almost all major seaports.

B. Blonigen and W.Wilson (2006) find that the level of logistical efficiency directly influences the choice of a partner for a particular port to cooperate with. Ports can increase their logistical efficiency and attractiveness by taking advantage of complementarities with other parts of the supply chain, for example, through closer ties with the interior and logistic distribution centers, also through more efficient use of capacity in the port and the hinterland where possible (De Langen, 2008). Efficient use of port and logistic capacities assumes continuous implementation of technological and operational port innovations.

Figure 1.14.1. Location of Top 25 Ports by Total Tonnage

Source: Port Performance Freight Statistics Program: Annual Report to Congress 2017, p. 13

Figure 1.14.2. Location of Top 25 Ports by TEU



Source: Port Performance Freight Statistics Program: Annual Report to Congress 2017, p. 15

1.5 Comparative Analysis of the Seaport Development in Adriatic and Mediterranean

Adriatic ports of Rijeka, Koper and Trieste are mutually competitive because of their geographical position. Their main comparative advantage is the short distance from the world's major maritime routes of container ships. Basic advantage of Rijeka port in relation to Koper and Trieste is its natural sea depth in the Gulf and therefore in the basin (18 m), which enables the reception of ships carrying capacity of up to 35,000 DWT. All the port terminals are located in the free zone, meaning that the production, processing, transport and transshipment of goods could be performed without paying VAT and customs duties. Total capacity of Rijeka port is approximately 33 million tonnes per year, of which 24 million tonnes relates to oil and oil deriatives, and 9 million tonnes is turnover of the general and bulk cargo (http://www.portauthority.hr/en/Home.aspx). The port of Rijeka is an extremely frequent due to its excellent traffic connections with continental hinterland and the sea. The advantage of Rijeka port in relation to the seaports of North Sea or Baltic Sea is shorter link between Europe and the Middle and Far East. Another advantage is a small distance from the main world routes for container ships.

Koper port is the youngest of the observed Northern Adriatic ports, and the only one that has been developed without strong maritime tradition. For decades it has invested in the construction of land and port transport infrastructure. The port of Koper is 10 times larger than the port of Rijeka. This allows it to achieve a higher annual cargo traffic. But its further development is limited by the shallow basin, about 12 meters deep. This prevents the mooring of the largest container ships. Nevertheless, the Koper port have annual handling between 250.000 and 300.000 TEU, which is more than double container traffic in Rijeka port (Figure 1.15). In addition, the problem of the Koper port is the lack of facilities for handling and poor infrastructure connections with the hinterland, which are not sufficient for the total daily turnover. Its annual turnover is greater of the Rijeka port for approximately a million tons. Diverse structure of cargo in the port of Koper is the main reason for achieving nearly four times higher annual revenue from the port of Rijeka (Baric et al, Ibid.).

Three centuries ago the port of Trieste was one of the major generators of technological development in Central Europe. It was developed using the advantages of its geographical position and ambitions of continental hinterland. The growing importance of the Trieste port increased at the beginning of the 18th century, when the port of Rijeka was also declared a free port (www.portauthority.hr/en/portfolio/through_history). Compared to the ports of Koper and Rijeka, the Trieste port has much better connections with railway routes, which allow a greater flow of cargo. The sea depth and geographic location in the northernmost part of the Adriatic allows cooperation with countries of Central Europe, avoiding major costs mandatory for the ports further south.

Figure 1.15. Location of container ports in the North Mediterranean Sea

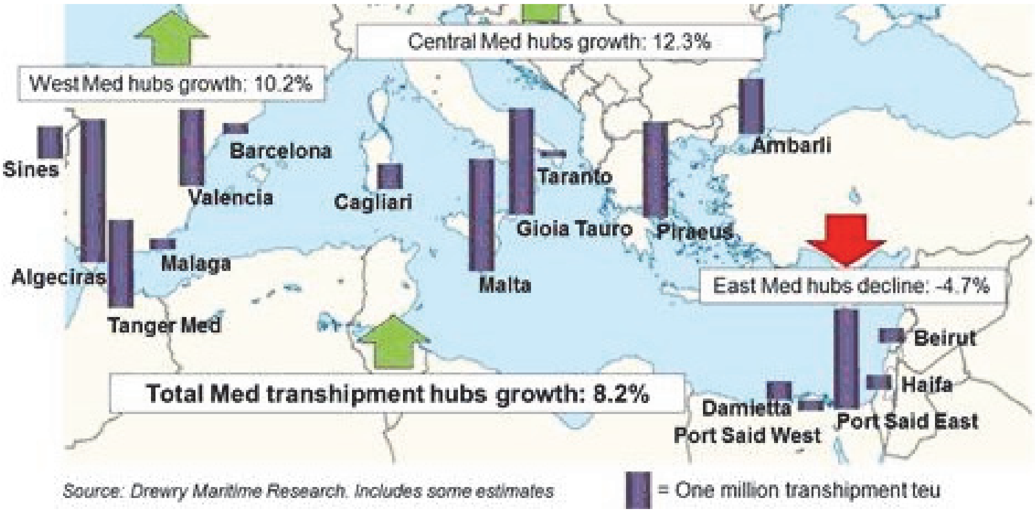
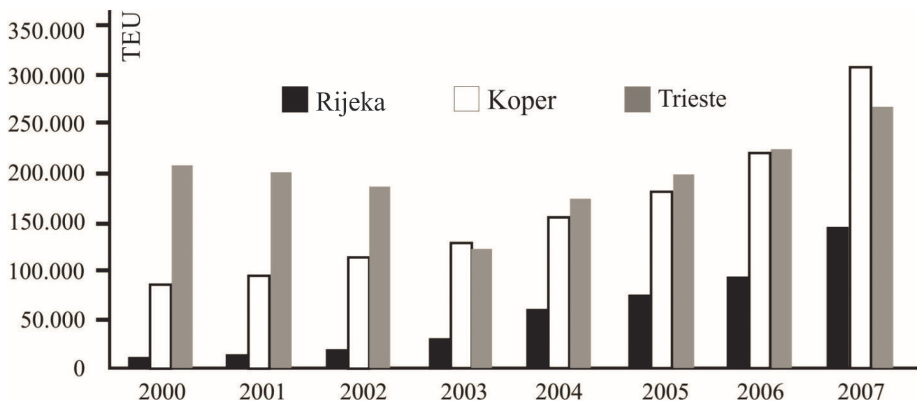


Figure 1.16. Container traffic in the seaports of Rijeka, Koper and Trieste in the period 2000-2008



Source: Baric et al., Ibid.

Narrow catchment area of the Trieste port includes Vienna, Munich and Milan. The wider catchment area includes Zurich, Stuttgart, Prague, and Budapest. This gives it a more favorable position compared to the ports of Rijeka and Koper, which have less catchment area and poor transport connections with the hinterland. This also allows a much higher total turnover of cargo, however, the container traffic is somewhat slower than in the port of Koper (Figure 1.16). The port of Trieste plans to build two new piers 7 and 8 with 18 meters depth, able to accommodate container ships of the latest generation. This will significantly improve the container traffic flow.

Table 1.5. Comparison of container transport in the ports of Rijeka, Koper and Trieste with selected Mediterranean ports for the period 2004-2008 (mln. TEU)

Port name	*Total container transport of 3 seaports*
Together: Rijeka, Koper and Trieste	0,7 mln. TEU
Individually Mediterranean ports of medium size: Marsaxlokk, Piraeus, La Spezia, Marseille, Taranto, Damietta, Izmir, Alexandria, Cagliari and Livorno.	from 0,6-1,5 mln. TEU
Individually the largest Mediterranean ports: Algeciras, Port Said, Gioia Tauro, Valencia, Barcelona and Genoa.	from 2-3,5 mln. TEU
Individually Black Sea ports of medium size: Constanta, Izmir, Braila and the Greek port of Piraeus	0,6-1,6 mln. TEU

Source:http://www.poslovni.hr/domace-kompanije/jadranske-luke-za-europu-96643

According to European and international relations, the ports of Rijeka, Koper and Trie-ste belong to the category of small and medium-sized ports. There is a need for centralization and concentration of seaports in the world shipping market. This indicates the need for a joint approach and greater cooperation between the three main north-Adriatic ports. In this way, they would simultaneously become medium-sized seaports of north-western European, Greek and Black Sea traffic routes (capacity of 0.6-1.5 mln. TEU) - Table 1.5 Especially considering the plans of their container capacity. Clearly, the Mediterranean seaports with container transhipment of 2-3,5 mln.TEU are not endangered by competition of north-Adriatic seaports.

The "Portus" project predicts the creation of North Adriatic port system, including Italy, Slovenia, and Croatia. Over time, this integrated port system would be expanded to Bosnia and Herzegovina, and Montenegro. It includes 4 Italian regions (Friuli Venezia Giulia, Veneto, Emilia Romagna and Marche), Croatian ports of Rijeka and Ploce, Slovenian port of Koper and Montenegrin port of Bar. "Portus" refers to the centralization of cargo to be transported on the traffic routes from Asia to Europe through Mediterranean (http://www.poslovni.hr/domace-kompanije/jadranske-luke-za-europu-96643). Contemporary shipping market is characterized by the growing influence of large container ships carrying capacity of several thousand TEU. Therefore, the service quality of port logistics services, ti-me of implementation, and price competition are extremely important. North Adri-atic seaport insufficiently take advantage of their favorable geographical position with gravitational hinterland, good traffic connections, and proxi-mity to the main maritime routes that connect Europe and the Far East.

Through rapid infrastructure development and the logistics, and the exten-sive use of the multimodal transport concept, they could equally compete with the Mediterranean and the Baltic ports in quality of port services and volume of cargo handling. World's container shipping industry is dominated by the shipping line between specialized container port terminals, different in order of magnitude. The-re are major hub (network) seaports with huge harbor terminals, which enables high traffic. However, there are many medium and small container terminals in the so-called spoke-ports. The world's major routes operate between a limited number of hub ports and smaller feeder routes, linking hub-ports with spoke-ports. Such or-ganization increases the intensity of traffic between hub ports, and hence enables growth of spoke ports (Cordeau et al., 2007). These are the basic conditions for the future development of the Adriatic sea ports, which need to take advantage of the most economical and the shortest connections with Europe.

L. Qianwan (2010) has analyzed the technical efficiency of 32 Mediter-ranean container seaports (Table B5), located in 9 countries (France, Spain, Italy, Malta, Slovenia, Croatia, Montenegro, Greece and Turkey). These seaports are dif-ferent not only in size, the development of capacity and the logistics, port throughput and transport volumes, but also in different ope-rating policies, regulations, management structures, regulatory characteristics and the ownership structure. In 2006, 18 Mediterranean seaports had an annual throughput of less than 500,000 TEU, 10 seaports were medium-sized with an annual flow of between 500,000 and 2,000,000 TEU, and only 4 seaports had more than 2,000,000 TEU.

Their significance is considerable, because the container traffic through them on the line Asia-Europe amounted approximately 18.3 million TEU, of which 12.5 million TEU from Asia to Europe, and 5.8 million TEU in the opposite direction (*Containerisation International Yearbook*, 2007). Due to their size, the seaports of Bari, Bar, and Tarragona can be categorized as very small ports, beca-use their bandwidth is below 500,000 TEU. On the other hand, the seaports of Gi-oia Tauro, Alicante, and Valencia are relatively large, since their throughput is hig-her than 2,000,000 TEU.

Table 1.6. Ranking of selected north-Mediterranean seaports by the level of technical efficiency index in the period 1998-2006

Years / *Ports*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
EFICIENT PORTS									
Algeciras	0.88	0.88	0.89	0.90	0.90	0.91	0.91	0.91	0.92
Barcelona	0.87	0.88	0.88	0.89	0.89	0.90	0.90	0.91	0.91
Gioia Tauro	0.84	0.85	0.85	0.86	0.87	0.87	0.88	0.89	0.89
Piraeus	0.81	0.82	0.83	0.84	0.84	0.85	0.86	0.87	0.87
Izmir	0.69	0.71	0.72	0.73	0.74	no	0.77	0.78	0.79
Genova	0.59	0.60	0.62	0.64	0.65	0.67	0.68	0.69	0.71
Valencia	0.58	0.60	0.61	0.63	0.65	0.66	0.67	0.69	0.70
La Spezia	0.55	0.56	0.58	0.60	0.62	0.63	0.65	0.66	0.68
MEDIUM EFICIENT PORTS									
Marseilles	0.34	0.36	0.38	0.40	0.42	0.44	0.45	0.47	0.49
Venice	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.39	0.41
Tesaloniki	0.21	0.23	0.25	0.27	0.29	0.31	0.33	0.35	0.37
Alikante	0.17	0.19	0.21	0.23	0.24	0.26	0.28	0.30	0.32
Koper	0.12	0.14	0.15	0.17	0.18	0.20	0.22	0.24	0.26

INEFICIENT PORTS									
Ravena	0.07	0.08	0.09	0.11	0.12	0.13	0.15	0.17	0.18
Trieste	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.13	0.15
Kadiz	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.12
Taragona	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.10	0.11
Bar	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09
Rijeka	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.07
Bari	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02

Source: Qianwen, 2010, p. 32.

L. Qianwen has calculated the technical efficiency indexes by mathe-matical modeling, which included four internal variables as inputs: bond length (m), total terminal area, capacity utilization with holding containers (in TEUs) and quality of handling capacity (in tons). Many of these indicators include quality of logistic services. L. Qianwen has used two model types: gross and net effect for as-sessing the impact of exogenous factors, such as volume of trade and production technology.

Technical efficiency index varies between 0 and 1, wherein a larger num-ber indicates a higher efficiency. In 2006, 4 seaports had a very high level of tech-nical efficiency (Algeciras, Barcelona, Gioia Tauro, and Piraeus). Among them, the port of Piraeus is medium in size with about 1.5 million TEU throughput in 2006. Other 3 are huge seaports with more than 2.5 million TEU throughput in 2006. Significantly, the technical efficiency index varies from year to year, and increases mostly depending on investments in the seaport infrastructure. Parallely with the growth of technical efficiency index increases the quality of logistics services. However, index does not include the development of integrated marketing logistics. L. Qianwen came to the conclusion that the seaport efficiency depends primarily on the form of investment strategy in infrastructure, which may be aggressive and/or non-aggressive. Table 1.6 shows that Adriatic port of Koper was the only significant investment in port infrastructure and logistics, and that with better capacity utilization and application of measures integrated marketing logis-tics it managed to keep up with technical efficiency, and join the group of semi-efficient ports. Apart from significantly smaller volume of port traffic and frozen infra-structure investments, the port of Bar has recorded a steady growth of technical efficiency, and it ranks slightly higher than the port of Rijeka, but still at the bot-tom of the list of monitored seaports. However, in relation to the port of Koper, the port of Bar lags significantly by 0.17 index points, or nearly three times less. The port of Trieste with 0.18 index points is close to the group of semi-efficient ports.

1.6 Financial Analysis of Selected Development Trends of the Seaport Marketing Logistics

The seaport marketing logistics has developed parallelly with very dynamic development of world trade and the rise in export of world transportation services (Figure 1.17). In the period 2000-2006, export of world transportation services has increased from $350 billion to $630 billion, (i.e. it was nearly doubled). The value of marine transportation increased from $227,5 billion to $409,5 billion. This growth was followed by significant investments in ports. According to official data of the world institutions, only investments in the port container terminals amounted $13.85 billion in 2002-2007, accounting for an annual average investment of approximately $2.5 billion.

Figure 1.17. Exports of world transportation services, in the period 2000-2006 (in billion US$)

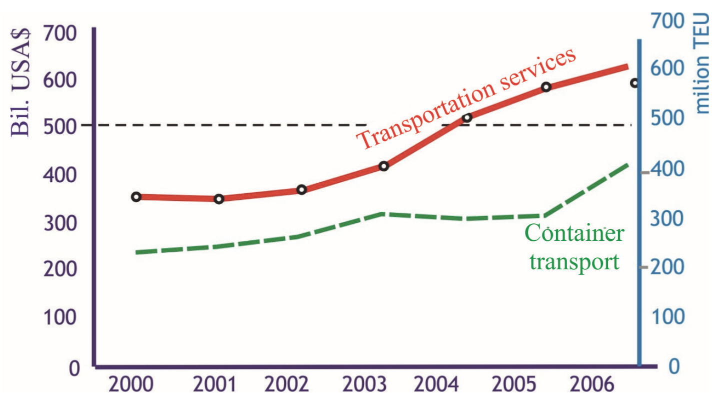


Table 1.7. Container Terminal Investments Requirements from 2002-2007

Region	*Additional throughput estimated by 2007 (Mil. TEU per annum)*	*Investment required for Quau, Yard, and Cranes (US$ billion)*
North America	8.3	1.56
West Europe	14.6	2.10
FAr East Asia	38.7	4.44
South East Asia	31.3	2.87
Middle East	4.1	0.48
LAtin America	9.7	1.51
Oceania	1.2	0.23
Africa	2.9	0.47
East europe	0.8	0.19
World	111.5	13.85

Source: Sheon, Ibid., p. 6

More than half of these investments have been invested in Asian seaports (Far East and Southeast - Table 1.7).

Increased investments have directly contributed to strengthening and rapidly adapting to their integrated marketing logistic needs and requirements of modern economic trends in the world and demanding maritime markets. The best proof are container service prices per unit in various seaports throughout the world.

In Asia, the price in 2002 ranged from 75 US $/TEU to 140 US $/TEU (Kelang 75US $/TEU, Singapore 117 US $/TEU, Manila 118 US $/TEU and Kaohsiung 140 US $/TEU), in Australia and New Zealand amounted to 119 US $/TEU, in North America ranged from 190 US $/TEU (Halifax) to 259 US $/TEU (Oakland and Los An-geles), in Northern Europe was from 120 US $/TEU (Antwerp) to 156 US $/TEU (Rotterdam) and 163 US $/TEU (Hamburg), in seaports of Southern Europe the corresponding price ranged from 200 US $/TEU (Piraeus, Barcelona) to US $/TEU (La Spezia) - Sheon, Ibid., p. 17. Clearly, the container transportation has doubled on the main global routes (traffic di-rections) - Table 1.8, which was enabled by additional capital investments in the major seaports and a corresponding improvement in the quality of their integrated marketing logistics.

Analyzing the selected largest and most important intra-regional and inter-regional trade flows, and appropriate container transport (Figure 1.17), we came to the results which tend to officially confirm our conclusions.

Table 1.8. Increase in container transportation in major international maritime routes towards Europe, in the period 2005-2010 (in million TEU)

Years / *Routes*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
South Asia - Europe	2,2	2,6	3,0	3,2	3,6	4,0
Europe - South Asia	4,0	4,3	4,8	5,1	5,5	5,9
Far East - Europe	11,0	13,0	14,9	15,7	16,5	17,0
Europe - Far East	4,8	4,9	5,0	5,1	5,2	6,0
West Africa - Europe	0,38	0,39	0,40	0,42	0,45	0,49
Europe - West Africa	0,69	0,69	0,69	0,78	0,79	0,82
Eastern and Southern Africa - Europe	0,51	0,50	0,50	0,52	0,60	0,61
Europe - Eastern and Southern Africa	0,61	0,69	0,71	0,78	0,81	0,20
Oceania – Europe	0,30	0,33	0,30	0,32	0,35	0,38
Europe - Oceanija	0,41	0,41	0,45	0,49	0,50	0,51
Latin America – Europe	2,2	2,5	2,9	3,1	3,3	3,7
Europe – Latin America	1,0	1,0	1,1	1,1	1,2	1,4

Sources: *Containerisation International*, Jan. 2008; *Pomorski zbornik*, 2008, 1, p. 106.

Figure 1.18. indicates that container transportation flow consistently follows the highest values (flows) of intra-regional and inter-regional trade in 2006. Europe dominates in intra-regional trade with $3,651 billion, which makes 31.4% of total intra-regional on the global scale. North America has $1.002 billion (14.1% of total world intra-regional trade) in trade with Asia, $709 billion USA% (6.1% of total world trade) in trade with Europe, and $242 billion (2.1% of total world trade) in trade with Latin America.

In the same year, Europe achieved an enviable level of trade with Asia ($970 billion or 8.3% of total world trade), with North America (above), with Latin America ($388 billion or 3.3% of total world trade) and with Africa ($268 billion or 2.39% of total world trade).

Container transportation is taken as representative for several reasons:

- it is presented in all major publications such as UNCTAD, WTO, World Bank, IMO and other world organizations and institutions,
- it has the greatest impact on development trends with time integrated marketing logistics seaports, and 3) it has a very high value participation in world trade in the period 1970-2006 (Table 1.9), which has been continuously increasing, from 45.9% to 56.3%, with the total amount of 5.3 million.
- The world container traffic value has increased from $120 billion in 1995 to $280 billion in 2000 and about $300 billion in 2005. After that, in 2006 and 2007, there was a sharp rise in the world container traffic value, with a record of over $400 billion.

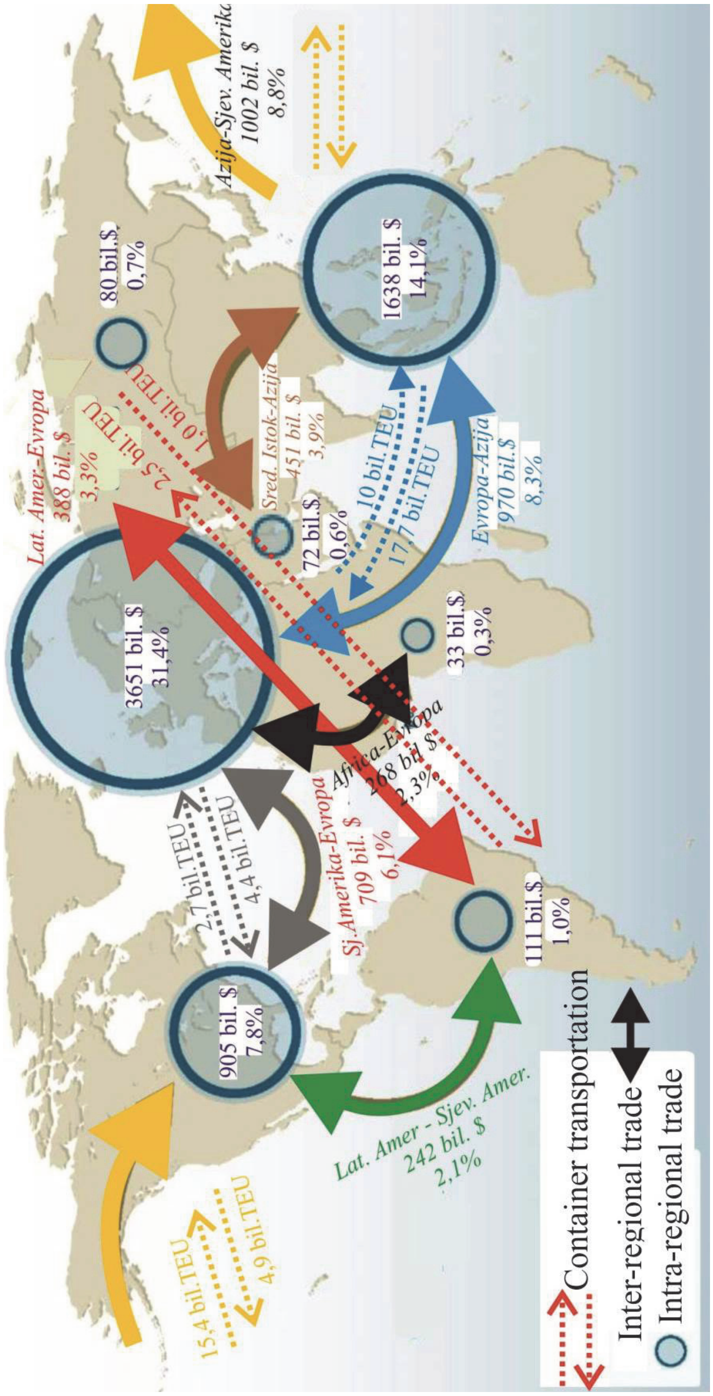
Table 1.9. World container traffic and share in world trade, in the period 1970-2006

Years	*Container traffic (mil. TEU)*	*Share in world trade (%)*
1970	5.3	45,9
1980	34.8	49,6
1990	84.6	52,4
2006	369.7	56,3

Source: Shipping Statistics and Market Review, 2007, p. 12.

In 2004, five largest world operators realized a total revenue of more than $5 billion, namely: Nippon Express $14.84 billion, Exel Group $11.12 billion, Schenker $9.65 billion, Deutsche Port Logistics $8.16 billion, and Kuehne+Nagel $7.03 billion. The following five in ranking the largest logistic operators (UPS SCS, TNT Logistics, Panalpina, CH Robinson and Geodis) received a total income between $4-5 billion (according to: *Containerisation International*, Sept. 2005, p. 23).

Figure 1.18. Selected intra-regional and inter-regional trade flows (in US $) and container transportation in 2006 (TEUs)



Source: Adapted from *International Trade Statistics,* 2007.

Table 1.10. Total income of the world's 10 largest port logistic operators in the period 1998-2004 (in bil. US $)

1998		*2004*	
Title	*Total income*	*Title*	*Total income*
Geodis	10,50	Nippon Express	14,84
Schenker	10,50	Exel Group	11,12
TNT Logistics	7,35	Schenker	9,65
Deutsche Bahn Cargo	7,08	Deutsche Post Logistics	8,16
NFC/Exel	6,90	Kühne+Nagel	7,03
Kühne+Nagel	6,25	UPS SCS	5,01
Danzas	5,90	TNT Logistics	4,91
Maersk Moeller	5,80	Panalpina	4,72
Panalpina	5,09	CH Robinson	4,34
Deutsche Post Fracht	4,80	Geodis	4,05

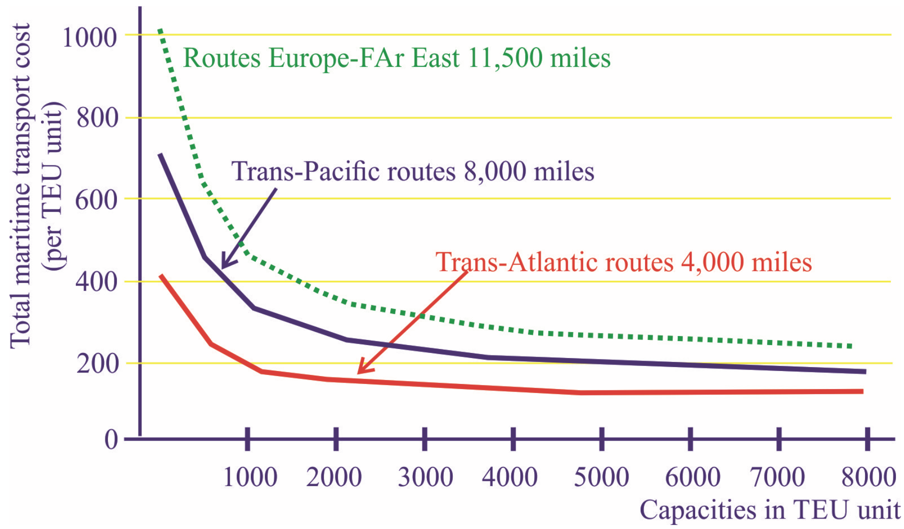
Sources: *Containerisation International*, Sept. 2005, p. 23; *The Evolution of Porta In a Competitive World*, 2002, p. 37.

For comparison, Table 1.10 represents the total income of the world's 10 largest port logistic operators in 1998 and 2004: increased concentration, followed by an increase in integrated marketing logistics led to the separation of the five largest port logistic providers, which in 2004 together achieved the observed total revenue in the amount of approximately $51 billion. The corresponding data for the five largest port logistic providers in 1998 amounted to $41 billion, which is approximately 20% smaller amount. Huge investments, latest logistic achi-evements, knowledge, and integrated marketing logistics have produced great turmoil, so among the five largest port logistics operators remained just Schenker, and among top ten remained al-most all of the rest with slightly changed positions in rankings.

Volume of the total transportation cost in various maritime routes (Figure 1.19), at various distances and of various ship capacities, depends on the development level and quality of integrated marketing logistics in the seaport.

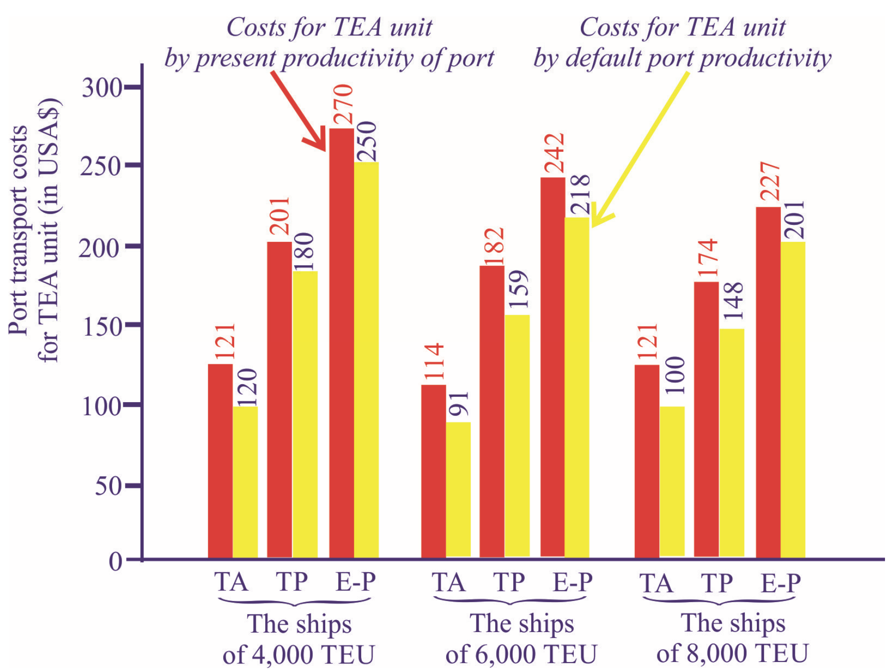
For a better understanding of the integrated marketing logistic impact on the total maritime transport cost, we analyzed the specific impacts of increased seaport productivity on the total container transport costs in various routes (Figure 1.20). Two variants were taken in account: a) the cost at the current port productivity, and b) the costs at the assumed port productivity (with additional investments in logistics infrastructure and integrated marketing logistics). It can be seen that the average in-crease in productivity ranges from 10%-20%, depending on the ship capacity and the maritime route length.

Figure 1.19. Total maritime transport cost as a function of various ship capacities and distances of individual routes (per TEU unit)



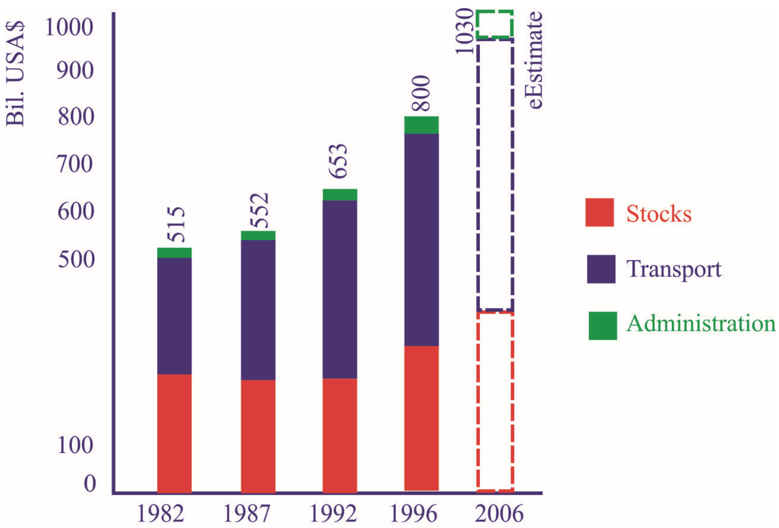
Source: The Evolution of Ports in a Competitive World, 2002, p. 27.

Figure 1.20. Impact of the increase in port productivity on the total cost of the various transport routes (per TEU unit)



Source: author's calculation

Figure 1.21. Structure of total logistic costs in the USA, in the period 1982-2006



Source: Delaney, 1997, p. 37.

The impact of integrated marketing logistics is the highest in transportation services (Figure 1.21). In the structure of total logistics cost in the USA, in the period 1982-2006, there was a significant increase in transport logistic costs from $250 billion to $480 billion in 1982, and to estimated $690 billion in 2006. Thereby, the logistic costs of holding stocks were only slightly increased, and logistics administration costs have tripled, although at a low level from $15 billion in 1982 to approximately $45 million as of 2006.

Sea ports, with their hinterland and their foreland, are the original and final points (destinations of goods) of the above stated maritime flow of goods. They comprise various economic activities in terms of production and services, among which a special place is taken by the logistics activities, due to their dominant influence on the creation of additional value for port services, and therewith on the achievement of comparative advantages, not only for sea ports but also the entire delivery chains. Sea traffic is the cheapest, and often the simplest, and/or sometimes the only way of goods transportation among continents and ports. It can also be considered the pioneer of the globalization process.

Nevertheless, the competition on the maritime market is extremely large, so the port business needs not only the application of modern integrated marketing logistics, but also its everyday enhancement in terms of strategy, methods, techniques, application and adoption of new technologies.The quantitative and qualitative features of sea transport and its dynamics are in direct dependence and correlation with the level of economic development of certain countries and regions, as well as certain parameter indicators of growth (GDP, foreign trade and exchange, direct foreign investments etc.).

Since the logistics is placed among few primary factors of influence on comparative advantages, its great application in the biggest sea ports influences the rapid growth of their comparative advantages, in some cases growing into competitions. The development of integral marketing logistics in sea ports positively influences the economic growth, the balance of foreign trade and especially of port transport. It is closely related to the concentration of port transport.

2. IMPORTANCE OF GLOBAL LOGISTIC NETWORKS FOR MARITIME TRANSPORT

Contemporary logistic networks are characterized by the small number of members and domination of logistic operators, offering not only transportation but also storage service, informational assistance and very often a global approach as well. The use of informational technologies and applications is required for optimization of logistic networks.

This study deals with importance of logistic networks in maritime transport and their informational components, as well as with application of outsourcing strategy in maritime logistic.

In the last 15 years the services sector has seen tremendous growth in terms of its importance and participation in processes of the work engagement, and thus has become a key factor of economic development in many countries, particularly in developed ones. Despite this general uptrend, the importance of certain types of services is varied. Among those that significantly outperform this general trend in the service sector are transport services, and logistic sector within them (Draskovic, 2008, p. 11). The logistics is a term used in economic science and means activities of physical movement (distribution) and storage of goods and services from producer to customer. Marketing logistics deals with service delivery, which include various service operations to enhance physical-distributive flows of goods, services and resources, which led to the creation of *added value*, and thus the *competitive skills*.

The goal is to faster and better overcome time and spatial discrepancies between production and consumption, (ie. that the necessary products and services be found timely and at the right place). From the perspective of integrated marketing logistics, the growing efficiency of any logistic system is a priority, because an added value depends on the extent of its implementation in various ways: transportation, storage, stock, loading, unloading and the like. The concept of integrated marketing logistics is used in all situations of moving goods, information and resources, generally from their production to the final destination. In this context, logistics is defined as a set of coordinated activities in order to move resources as neccessary for requirements of the customer (user). So, logistics is essentially the integral management of goods (material, services, information, and financial) flow.

Like any other management, logistics includes classical management functions: planning, organization, control, management and staffing, as well as coordination and motivation as “supportive” functions. All these functions need to be combined in order to complete the basic flow (material and services), to support additional flows (informational, financial and service) and to achieve optimization of aforementioned flows (rational decisions, inter-functional, and inter-organizational coordination).

The impact of logistics on the business success of transport companies has led to an increase in demand for creating integrated logistic systems. This especially refers to large shipping companies, major seaports, and global network organizations of maritime business. Starting point is the basic classification of maritime services on shipping, port and auxiliary activities (customs, shipping, agency, brokerage, control, inspection, insurance, etc.). The port and shipping business, as the narrow parts of maritime affairs, are predominantly service-oriented, and in disciplinary and functional terms are directly connected with integrated marketing logistics. Therefore, this paper analyzes a theme of the port and shipping organizations.

2.1 Categorical Definitions

Logistics functions are usually related to a certain level of microeconomics (i.e. the specific company) and then it implies a set of logistic operations that are selected due to increased efficiency of logistic system. In the literature, there is a classification on basic (maintenance of product and service quality standards, acquisition of material resources, transportation, inventory management, orders procedures management, production procedures support and information support) and supporting logistic functions (storage, processing, protective packaging, demand, and cost prognosis, providing spare parts and related services, collection and utilization of feedback waste). Each specific area of business requires a different formation of logistic services (i.e. the organization of logistic functional areas). For example, the wholesale includes typical procurement of goods and its distribution - sales organization. Stil, beginning with the fact that logistic marketing emphasizes the concept of integrating all roles (primary and supporting), it is clear that among them there must be a close connection and interdependence, which is the main task of logistics. The port and shipping organizations are dominated by transportation services, inventory management, information support, storage, cargo processing, protective packaging, various port services and accompanying service.

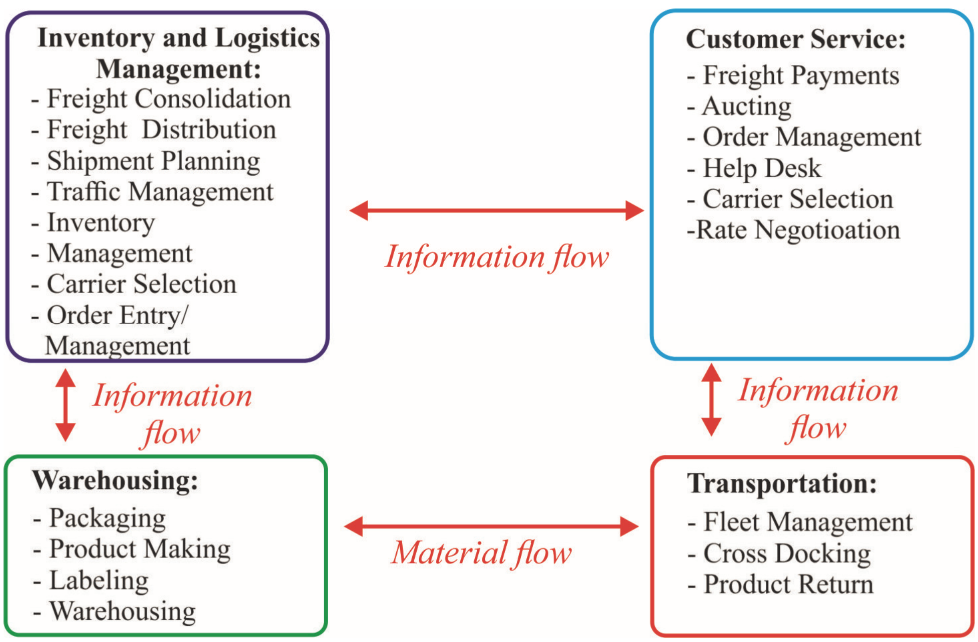
In the thesaurus, APICS *logistic system* is a term defined as the process of planning and coordinating all aspects of the physical movement of material flows in order to minimize overall costs and provide the desired level of service. Western authors increasingly use the term of logistic chain or supply chain, as more pragmatic. For a discussion on the logistic system, apart from the system access, it is necessary to respect certain methodological principles: minimization principle of total logistic costs, global optimization principle, integration principle of all logistics links and flows, modeling principle (economic-mathematical, graphic, etc.), the principle of information and computer support, coordination of logistics subsystems principle (technical, economic, organizational, legal, human, environmental, etc.), TQM principle - total quality management, the principle of natural environment protection, and the principle of stability, flexibility and adaptability. Logistical subsystems are the building blocks of functional and organizational units of the logistic system, consisting of some elements and links, and implementing concrete logistic functions and operations. There are three main participants in the company logistics: delivery (suppliers), the company, and consumers (buyers). When considering the question of the logistics system, it is necessary to point out the role and importance of logistic intermediary, called "Third Party Logistics" (3PL), namely: the freight forwarders, operators (service providers), freight terminals, agents, exporters, importers, etc.

Logistical chain and supply chain are the terms used in the literature as synonyms, especially when it comes to integrated logistic systems. In the ANNEX glossary (1994, p. 95) they are defined as "*a set of all business process forms (design, production, sales, service, purchasing, distribution, resource management, supporting business functions), required to meet the demand designed for products or services - from starting point of obtaining the source materials or information, to the point of delivering to the user*". Mentzer (2001, p. 4) argues that supply chain consists of three or more economic units directly involved in the external or internal flows of manufacture, services, finance and/or information from the source to the consumer.

Thus, the logistic chain is treated as the integration of basic interrelated logistic functions, from the supplier - consumer, which are necessary to create additional value. It is believed that the logistics chain in practice must be arranged in-line, due to a simpler accounting and expedited cost analysis, resource optimization, more rational decision-making, proper distribution of risks and profits, and better organization of monitoring the logistic plan achievement (Sergeev, 2005, p. 49). Managing the supply chains is the integration of key business processes, as pointed out by Lambert and Stock (2001, p. 54), starting with initial supplier and ending with consumer, including all levels of delivering goods and services, as well as the material and information flows which increase the value of the product to the users.

Applied to maritime organisations, Figure 4.1 (p. 87) shows that all the links of the supply chain, on the relation supplier of the suppliers-consumer of the consumers, exists in the global maritime market (environment) and are subject to the inter-organizational port and/or shipping coordination. Such coordination includes two main blocks: *business assumptions*, which include trust, liabilities, risks, etc., and *functional areas* of the company (marketing, sales of the port and/or shipping services, etc.). In order to achieve the objectives set in the far right block - (customer satisfaction of the port and/or shipping services, profitability and competitive advantage of the port and/or shipping organizations), it is necessary to implement the various flows in the supply chain service of the port and/or shipping organizations - resource, informational, financial, manufacturing, service and other.

Figure 2.1. Categorization of logistics functions



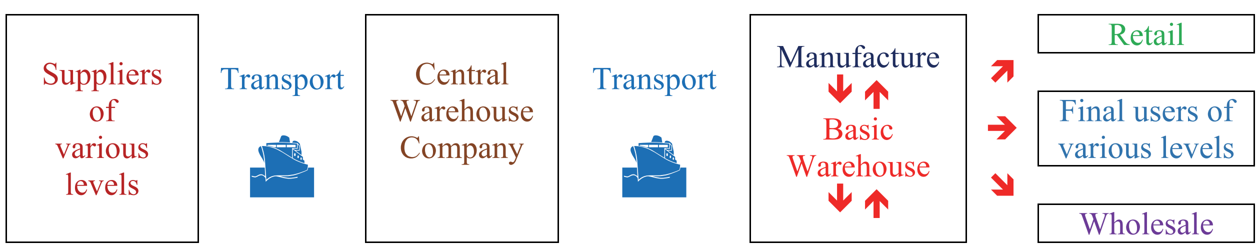
Source: Vaidyanathan, 2005.

Many authors point out four key competencies of SCM (*Supply Chain Management*) which decisively contribute to creating added value: speed, response capability, minimizing the cost and quality of services. *Logistic channel* (or tube) is a term used regarding the concept of logistic chain. It is often identified with the marketing channel where physical distribution is implemented: delivery (supplier), agent, the carrier, the insurance company, agencies, customs, other persons participating in the movement of goods and the consumer (user). Logistic channel can be understood as a distribution route between the specified points in the logistical goods flow. It is necessary to distinguish marketing and logistic channels. The first refers to negotiations, contracts and purchase operations, where participate agents of manufacture, companies, suppliers, pickers, wholesalers, and retailers.

The second refers to the network of connections, that should provide convenient movement and positioning of the stock, where participate carriers, storage operators, cargo processors, purchase analyzers and other persons who provide operations associated with the time and terms of delivery. In the practice of port and shipping organizations, there are often situations in which one entity simultaneously performs marketing and logistic function. Logistic chains and logistic channels are parts of *logistic network*, which is a set of interrelated logistic links in the company's distribution network. The major characteristics of the logistics network are: interconnection and dependency on logistic activity centers, which form a network structure, and the possibility of a graphical representation of planned activities and communications.

Figure 2.2 shows the conditional scheme of typical industrial company's logistics network. Arrows symbolyze the transport flows, linking suppliers with warehouses, then various types of manufacturing warehouses, and finally, the mentioned types of warehouses with the final consumer, retail, wholesale, and prospective export products. Unlike industrial companies, service companies have a completely different scheme of logistic network. However, logistic networks of port and shipping organizations are specific. Common for all of the logistics network is the existence of a connecting flows: material, information and capital. The port and shipping specificity consists of numerous intermediaries, large number of various storages (general and specific), port terminals, developed department of the port and shipping logistics, and a huge number of users of port and shipping services.

Figure 2.2. The logistics network of industrial company



Source: Sergejev 2005, s. 55.

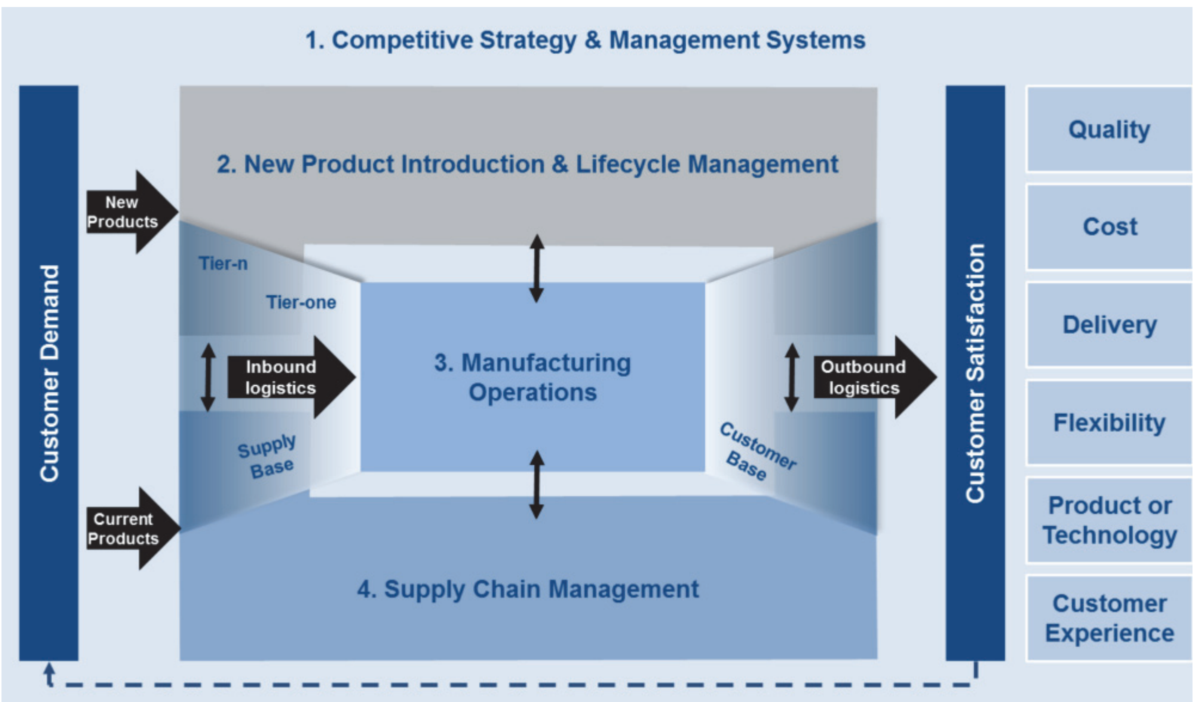
The concept of integrated marketing logistics includes the term *logistic cycle* to indicate repetitive logistical operations in time and space. As an example, here is the performance cycle of the order, called functional (complete) logistic cycle (*order lead time*) and represents the time interval from the moment of ordering to delivering the ordered goods or services to the final consumer (end user).

Before going into the definition of the different provider levels, a broader understanding of the whole supply chain is needed and of the important aspects in it. The chapter starts off by defining what SCM is and attributes that are correlated to the supply chain. An understanding of these topics is essential before moving on to the provider level and what activities they perform in the supply chain.

SCM based on the Council of Supply Chain Management Professionals (CSCMP, 2012) is defined as: "*Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities.*"

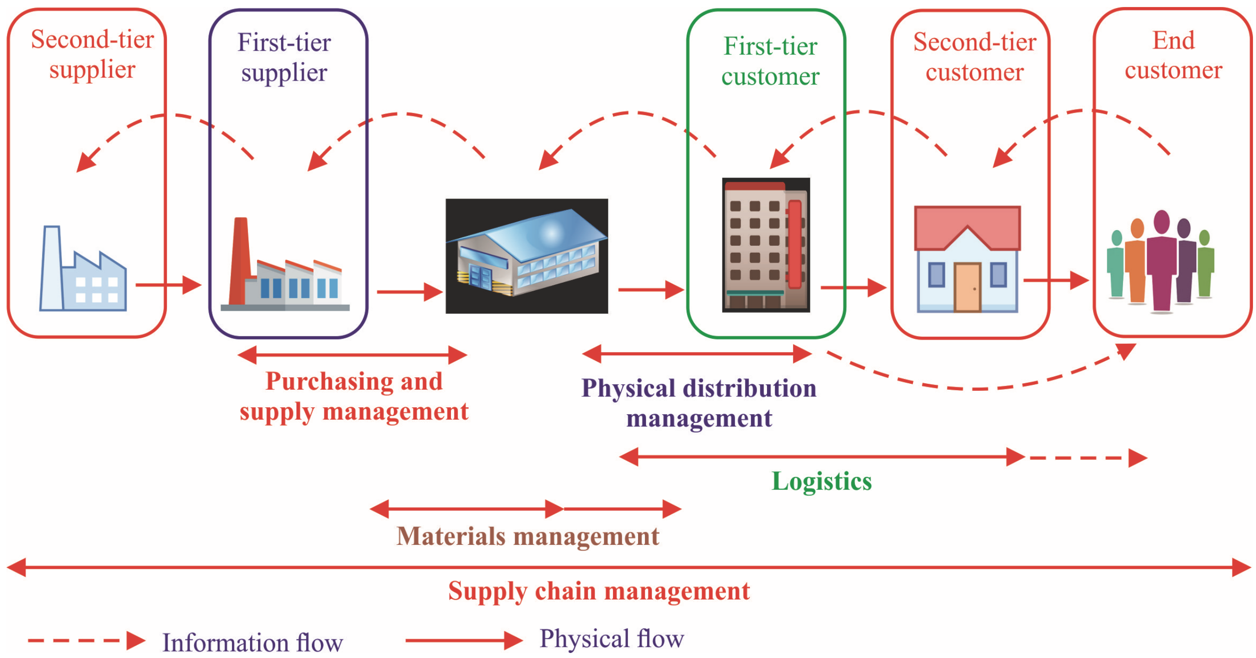
In other words, the supply chain management consists of the management of all parties that are involved in fulfilling a customer demand. This includes the manufacturer, the supplier, the transporters, warehousesvels, retailers and the customers, as seen in figure 2.3.

Figure 2.3. Supply Chain Management



Source: www.google.me

Figure 2.3.1. Model of Supply Chain Management

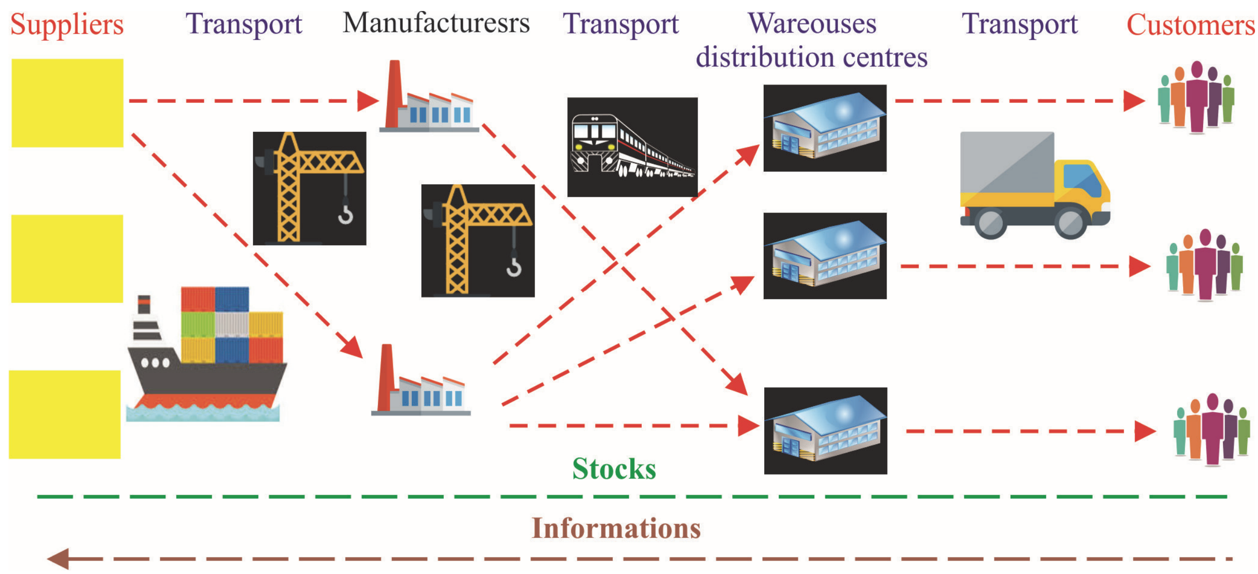


Source: Chopra and Meindl, 2010

Figure 2.4 shows logistics network consisting of four object levels. The production flow takes place from suppliers of raw materials to manufacturing plants, from manufacturing plants to distribution centers, and from distribution centers to the market. The logistics network can consist of an arbitrary number of objective levels. Sometimes the production flows operate in opposite direction, when semi-finished products or components are returned to the production facilities for completion, or when the products not ready for further use are returned from retail to the distribution centers for recycling. This way, the competition no longer occurs between individual companies, but between whole networks, and extra profit goes to entities who create better and more efficient logistic network. The operating principle is very simple: good network of relationships with key elements, supported by logistic operator as a factor of optimization of logistic activities within the network (Pupavac, Draskovic, 2007, p. 102). Logistics networks enable:

- lowering logistic costs (labor, taxes, duties, etc.),
- improving the effects of all participants in the logistic chain,
- quality production inputs of production and logistic services,
- creating new and distant markets, and
- improving their own performances based on the development of comprehensive cooperation and partnership with other members of the logistics chain.

Figure 2.4. Cooperation between the participants in the logistics network



Source: Pupavac, 2006, s. 89.

The subject of optimization in the logistic network could be the cost of materials, procurement, investment, production, distribution centers, stockholding, internal and external transportation, etc..

2.2 Transport Services in Logistics Networks

Transport is crucial in the system of movement goods, and therefore has the strategic role and primary importance in logistics networks, which can be seen from the previous scheme. It is the most important link in the logistic networks, because it includes activities of moving goods and passengers in space and time, and also support services such as packaging, marking, coding, labeling specifically, using unified transport, forming unit loads, palletising, containerization, etc.. The authors unanimously assess that the essence of transport logistics services is to create additional value through fast, efficient, timely and high-quality of freight and solving problems that are associated with cargo movement, using different means of transportation.

Transportation means linking different logistics functions in one system unit. In doing so, special attention is devoted to the category of time. Thus was created the management con-cept *Just-in-Time* – a fast and reliable transport, focused on reducing costs due to needlessness of storage. Much more rigid management concept is “JIC” (*Just-in-Case*), used to repeat one or a small circle of operations. It is a special *know-how* transportation with strict requirements in terms of low transport costs, constant availability, high frequency, and reliability.

Basic transport and logistics activities are: communication in the distribution channels, inventory control, customer service, demand forecasting, managing the raw materials, ordering process, procurement process, selecting location for production-service capacity (factory, workshop, service, shop, storage), packaging, transportation, storage, handling, etc. Applying the logistic principles in transport reduces risk, uncertainty and entropy of the system, using a high-quality and timely data and information support, reducing possible unfavorable situation, simplifying the logistics transactions and modeling logistics processes and logistic systems.

Basic elements of transport logistics are:

- choosing transportation mode,
- choosing transport,
- choosing logistics intermediaries, and
- selecting additional logistics intermediaries (Sergeyev, Ibid., p. 303).

In transportation mode, the choice is between unimodal, mixed, combined, intermodal, terminal, and multimodal transportation, while in the form of transport, the choice is between rail, sea, river, air, automobile and pipeline transport. Choosing logistic intermediary includes freight forwarders, agents, transportation-logistic companies, etc., while the choice of auxiliary logistics intermediaries relates to insurance companies, keepers, cargo processors, banks, information centers, brokers, and others.

Figure 2.5. Logistics essence of transport communications

Transportation process involves numerous entities, but the most important are: the carrier (ship operator), carrier representative, freight forwarder, shipping agent and other inter-mediaries performing certain actions in customs and controls. Transport-technological scheme of cargo delivery (dispatch) consists generally of a several *basic stages*, as follows:

- forming the cargo units (*Unit Load, Unit Cargo*) or transportation units (*Transport Unit*),
- loading the means of transport with formed cargo units,
- cargo transshippment to the terminal,
- consolidation of cargo unit that have a delivery address in the terminal,

– cargo transportation via various cargo transport routes,
– transport-storage operations during the cargo unload at the destination terminal,
– transport of cargo from terminal to the warehouse-distribution centers,
– cargo shipping to the final consumer, and
– supervision of the cargo shipment (delivery).

Table 2.1 shows the sequence of individual activities that accompany the transport delivery of cargo. The first phase analyzes the conditions and possibilities of delivery, followed by assessment of the competitive variants of delivery and then the preparation of economic calculation. The fourth step involves the selection of a particular delivery variant, and the fifth is contracting and assembling the transport instructions. After that, the delivery of cargo is completed, followed by calculation of the transportation services.

Table 2.1. Sequence of the transport-technology cargo delivery

1	analyzing the delivery conditions and existing constraints	⇓
2	development of delivery variants	⇓
3	assessing the competing variants of delivery and preparing the appropriate economic calculations	⇓
4	selecting the particular delivery variants	⇓
5	contracting and assembling the transport instructions	⇓
6	shipment realization	⇓
7	calculating the performed transport services	⇓
8	control and analysis of realized shippment	

Source: Kurganov, 2006, p. 81.

Final stages are the control and analysis of comleted delivery cargo. Particularly significant for logistic transportation are certain operations in stages of preparing the cargo for shippment and consumption. Uploading precedes formation and completion of the cargo packaging, measuring, stacking, counting, marking, grouping by destinations, sealing and assembling the appropriate documents. Spending precedes unpacking, and in the event of cargo damage should refer to the complaint.

2.3 Specifics of the Port and Shipping Services in Logistics Networks

Logistics and logistics activities are specifically related to transportation activity and maritime business within it (port and shipping services), since they are daily, complex and dynamic. It is proved that cutting logistic costs, efficient logistics system and successful integrated marketing logistics significantly affect the increase in volume, quality and effectiveness in port and shipping services, and thus affecting the price, create a competitive advantage and overall business results. The influence of logistics on the business success of port and shipping organizations has led to a growing aspirations for the construction of integrated logistics systems through the global network of maritime organizations.

Integrated transport logistics in the logistics networks detects and eliminates internal weaknesses in the transport and supply systems, and thus neutralizes the so-called "*intolerant costs*" (untimely and inaccurate procurement, incorrect choice of the means of transport and/or transportation routes, damage or loss of cargo during transportation, inadequate supplies, deficiencies in transport insurance, improper manipulation of goods, poor and untimely information on the condition of the goods during transportation, unprofessional and untimely performance of customs and other formalities, and the like (Pupavac et al., 2003, p. 63).

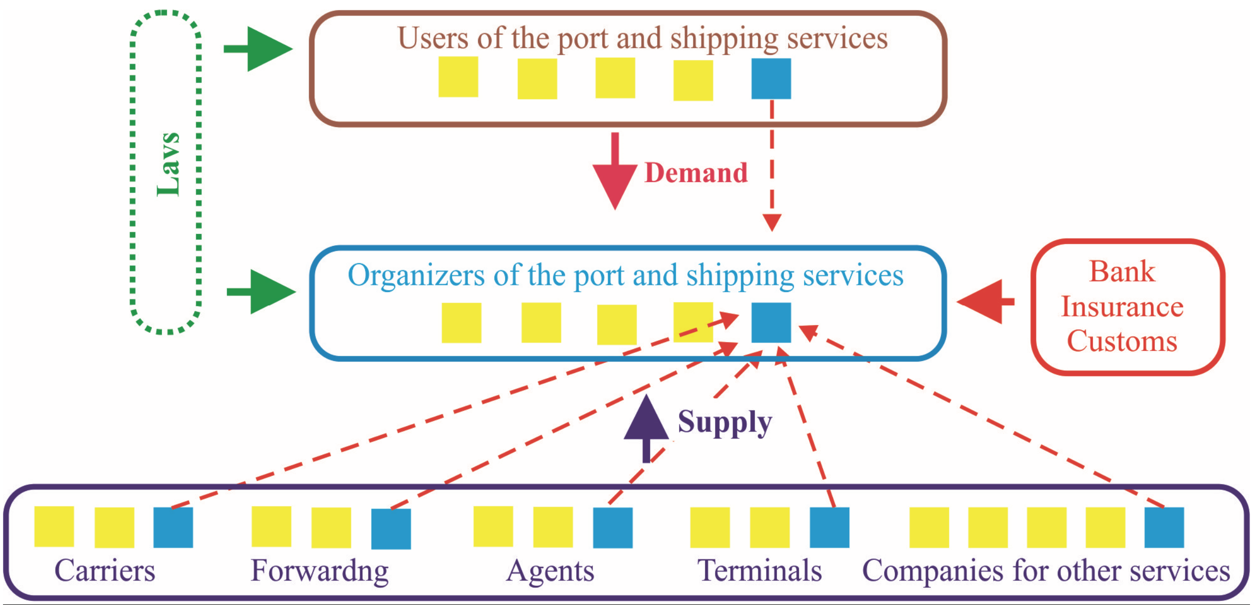
It solves numerous and continuous non-compliance (*gaps*) in the supply between businesses (*business-to-business*), between business entities and consumers (*business-to-consumer*), between market relations of supply and demand in port, and shipping services. Finally, it integrates marketing, managerial, engineering, technological, organizational and information activities aimed at the efficient distribution (transfer) of various resources.

Specifics of port services in logistics networks consist of the fact that ports combine rail, road, and water transport. This complicates the basic logistical functions, since the continuous adjustment of their characteristics is crucial. A special role in port services belongs to the terminals, where sorting and consolidation of cargo (shipments) is taking place in the central terminals, as well as cargo pickup and delivery in the supporting terminals (under Roca, 2004, p. 98). Port terminals have a number of specifications, stemming from the character of marine transport and port services. In recent decades, container terminals have experienced great expansion.

Next *differentia specifica* of port and shipping services is extensive, complex, distinctive, and very defined legal documentation accompanying the cargo (due to sales property rights). In terms of integrity of port and/or shipping services in logistics networks, the marketing logistics has a number of specific requirements, such as: standardization parameters of technical port resources (barge), bandwidth and service capabilities of interacting transportation systems in the port (shipping) system, the homogenous port-transport and shipping technology, complementary of information on the content, form submission, transmission speed and schedule of delivery from one transport form to another (due to decision making), homogenization of legal and economic regime of port and shipping systems, etc.

The logistic cycle in seaports is very complex, because it involves a num-ber of sub-cycles: placing order cycle, order processing cycle, the cycle of organizing purchase and scheduling orders, the cycle of procurement and delivering resources, the cycle of preparing production of port services and documentation, the cycle of analysis and preparing accounts, manufacturing (operational) cycle of port services, the cycle of packaging and integrating cargo, cargo shipment cycle, the cycle of goods transportation, cargo handling cycle, cargo storing cycle, cargo processing cycle, the cycle of goods receipt, etc. It is similar to shipping organizations.

Figure 2.6. Market forming the logistics network of seaports and shipping companies



Source: adapted to the practice of ports and shipping companies, and the theoretical model of Mirotin 2003, p. 330.

The port and shipping organizations, as well as other companies, are developing logistics network in order to gain the information, resources, markets and technology, and to achieve the effect of economies of scale. They represent the top-level range of inter-logistic management, or logistic chain management, since they enable a quick response to changes in demand. The assumption for a quick response is timely and quality decisions of all participants in the logistics network and their superb cooperation (chart below).

The main tasks of port and shipping services in logistic networks are: increasing and accelerating the flow of cargo in the port, better and faster supply of vessels in port, reducing the detention of ships in the harbor, rationalization of the port operations (spatial, temporal, communication), rationalization of cooperation with land transport system, good cooperation with the port hinterland and optimization of information support, good communication among the subjects in the port system, minimizing idle time, delays etc., and improving the quality of port logistics (transport means, information and control systems, human resources, coordination, etc.).

Application of integrated marketing logistics as a complex system of planning, organization and control of cargo flows in the port and shipping services assumes the use of port and/or shipping logistic network, in addition to contemporary electronics, communication, transport and information technologies, etc.. This makes transport and logistic activities complete, from input to output, technical means of logistic systems transport, technological phases, subjects of the logistic system, logistic information, and communication channels and chains. They are an integral part of the port and/or shipping management as a comprehensive system of planning and decision-making on the use of resources, monitoring the system performance, harmonization of support elements, and creation of competitive advantage.

2.4 Integrated Logistics Strategy in the Marine

In order to reduce logistics costs (and transport costs within the same), in order to increase awareness and faster ordering processing, organizational forms of supply chains and the entire organizational structure of the maritime industry have endured transformation. The strategy of global logistics in the part of the organization is based on centralized planning and control, and decentralized operating function (Stock, Lambert, 2001, p. 516).

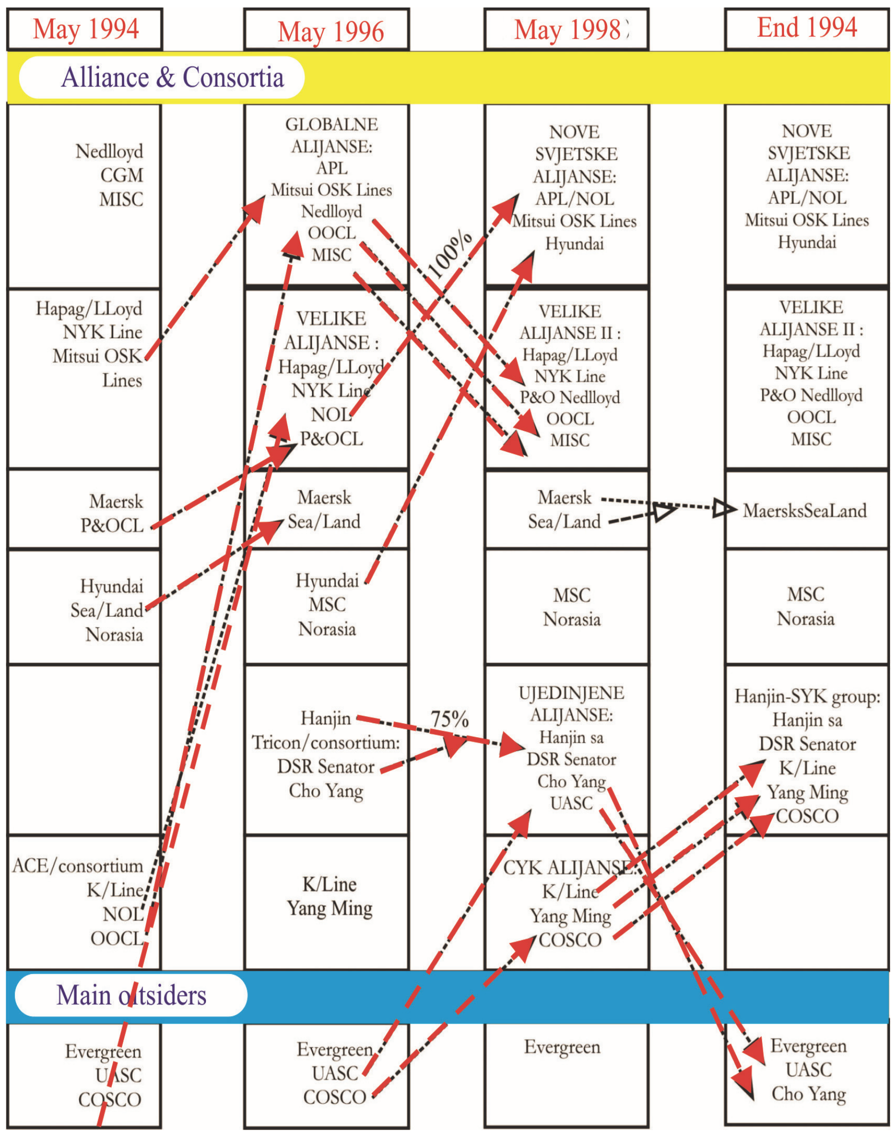
The main goal of organizational improvement was integration of logistics functions. Therefore, it is possible to isolate two complementary directions of organizational changes, which have been focused on mergers, acquisitions, and outsourcing in the maritime industry. Integration strategy consists of more partial strategies: functional specialization, virtualization, business networking, orientation on processes, orientation on market, orientation on delivery channels, and other (Ibid., p.p. 542-546).

The global economy was and still is a promoter of integration in maritime (see more in: Meersman, H. et al., 2008). We are witnessing a significant scale horizontal cooperation and/or mergers and acquisitions. In addition to the flow, outsourcing of terminal operators and logistics operator of 4PL type are increasingly developing. All this contributes to the steady optimization of the supply chain as a whole, changing the balance of competitive forces in the shipping market. There has been a significant evolution of organizational structures within the seaports. Traditional stevedoring companies were developed and perfected according to more complex types of operator terminal intermediation (TOCs - *terminal operating companies*), not so much because of the lack of working capital required for merger, but as the greater need for logistical efficiency.

The trend of horizontal and vertical integration of shipping companies, seaports, and TOCs is growing. The main reason for the integration is increase of competitive position and creation of business competence. In the last ten years, there are two notable trends:

- shipping companies have become larger through mergers, acquisitions and organic growth, which have led to higher concentrations;
- the creation of much closer cooperation through strategic alliances.

Table 2.2. Mergers, acquisitions, and strategic alliances in the trade between Europe and Far East



Sources: composed according to the annual reports of companies; Notteboom, 2004.

Table 2.3. Mergers and takeovers between terminal operating companies

	1996	2001	2003	2006	2008
1	PSA	HPH	HPH	HPH	HPH
2	HPH	PSA	PSA	PSA	PSA
3	P&O Ports	APM Terminals	APM Terminals	APM Terminals	APM Terminals
4	Maersk	P&O Ports	P&O Ports	DP World	DP World
5	Sea-Land	Eurogate	Eurogate	Cosco Pacific	Cosco Pacific
6	Eurokai	DPA	Cosco	Eurogate	Eurogate
7	DPA	Evergreen	Evergreen	SSA Marine	SSA Marine
8	ICTSI	Cosco	DPA	APL/NOL	APL/NOL
9	SSA	Hanjin	SSA	HHLA	HHLA
10	Hamburger Hafen und Lagerhaus Aktiengesellschaft (HHLA)	SSA	APL/NOL	? Hanjin	Hanjin
11	Pacific Ports Co.	HHLA	HHLA	MSC	MSC
12	Ceres Terminals Inc.	APL/NOL	Hanjin	NYK	NYK
13	Europe Combined	NYK	MSC	OOCL	OOCL
14	Bremer Lagerhaus Gesellschaft	Hyundai	NYK	CSXWT	CSXWT
15	NYK	CSXWT	OOCL	Mitsui OSK Lines	Mitsui OSK Lines
16	APL/NOL	Mitsui OSK Lines	CSXWT	Dragados	K Line
17	OOCL	OOCL	Mitsui OSK Lines	K Line	TCB
18	Hanjin	K Line	Dragados	TCB	ICTSI
19	Mitsui	Dragados	K Line	ICTSI	
20	Evergreen	TCB	TCB		
21	K Line	MSC	ICTSI		
22	Cosco	ICTSI	P&O Nedlloyd		
23	CSXWT	Yang Ming Line			
24	Terminal Contenedores de Barcelona (TCB)				
25	Yang Ming Line				
…	Hyundai				
…	Hessenatie	Hessenatie			
…	Noord Natie	Noord Natie			
…	Contship Italia sa				
…	Sinport Sinergie Portuali				
…	Egis Ports	Egis Ports			

Source: Van de Voorde, E., Vanelsander, T. 2008, p. 14.

The top three carriers in the market: Maersk, MSC and CMA CGM accounted for 36.9% of total market share in 2015 and still continue to expand (Alphaliner, 2015). The previous subchapter discussed the diverse alliances that these carriers have taken part in. This sub-chapter focuses on the soloist strategies of the top three carriers. These strategies enabled them to become the largest players in the market and to remain in that position for years now. Striking is that the strategy of MSC differs significantly from that of Maersk and CMA CGM. Both Maersk and CMA CGM have successfully shaped their business by means of M&A activity while MSC on the other hand has grown organically. A complete overview of M&A activity and alliance participation of the top three market players is presented in table 6.8.1. M&A usually leads to a rapid increase in market share of the acquirer except for the top two firms, Maersk and MSC. Here a negative effect on market share is noted (Luo et al., 2014). This is reflected in the falling market share of Maersk Line after 2006, due to difficulties faced by the acquisition of P&O Nedlloyd. Gains from M&A seem to have an inverted Ushape, which seems logical since agency related issues emerge as firms get bigger (Yeo, 2013)

Table 2.3.1. A complete overview of M&A activity and alliance participation of the top three carriers in the market

<table>
<tr><th>Year</th><th>Maersk</th><th>MSC</th><th>CMA CGM</th></tr>
<tr><td>1999</td><td>Safmarine, CMB-T, Sealand</td><td></td><td></td></tr>
<tr><td>2002</td><td>Torm Lines</td><td></td><td>United Baltic Corp., MacAndrews & Ellerman, Liberian, Delom SA</td></tr>
<tr><td>2003</td><td></td><td></td><td>ANL Container Lines</td></tr>
<tr><td>2004</td><td>Royal P&O Nedlloyd</td><td></td><td></td></tr>
<tr><td>2005</td><td>P&O Nedlloyd</td><td></td><td>Sudcargos</td></tr>
<tr><td>2006</td><td></td><td></td><td>Delmas</td></tr>
<tr><td>2007</td><td></td><td></td><td>US Lines, Cheng Lie Navigation Ltd, CoManav</td></tr>
<tr><td>2012</td><td></td><td colspan="2">MSC - CMA CGM Alliance</td></tr>
<tr><td>2014</td><td colspan="3">P3 Alliance failed Ocean Three Alliance</td></tr>
<tr><td>2015</td><td colspan="2" rowspan="3">M2 Alliance</td><td rowspan="3">Neptune Orient Lines The Ocean Alliance</td></tr>
<tr><td>2016</td></tr>
<tr><td>2017</td></tr>
</table>

Source: pp. 39-40.

The container shipping industry thrives on economies of scale and by means of M&A shipping capacity and market share can be expanded quickly. In this sector incumbents continuously strive to become larger than their direct competitors. They try to become a price setter instead of a price taker. The market power hypothesis serves as an explanation here as more market power increases the firm's ability to influence prices and makes it easier for firms to respond to industry shocks. In order to acquire market power firms have to expand more aggressively than their competitors. This driver of M&A activity is especially attractive during periods of overcapacity or in anticipation of overcapacity and accompanying low freight rates. Overcapacity reduces the market power of individual operators. This incentive was observed in take-overs that were done by Maersk and CMA CGM, when they took over large companies in the top 20 to shake off their direct competitors. Maersk took over P&O Nedlloyd in 2004 and CMA CGM is in the process of taking over NOL. In press releases covering acquisitions by

Maersk, also anticipated synergies seem to play a conclusive role in M&A decision-making. These synergies were not only expected to arise from economies of scale due to capacity enlargement, but also from being able to cut back on onland administrative labor costs. Maersk has been very successful in downsizing costs, looking at the profitable position in which they find themselves anno 2016 contrary to other market incumbents. The characteristics of the container shipping industry such as its high fixed/variable cost ratio and its institutional rigidity make it very vulnerable to industry-wide shocks. Technological progress and the lust for ever greater economies of scale have led to the deployment of ultralarge vessels by the top-twenty carriers. From a single-firm perspective this seems admirable but collectively the sector suffers from prolonged issues of overcapacity and concurrent low freight rates. Overcapacity issues do not necessarily arise from larger vessels, but from the combination with weak consumer demand and less options for market incumbents to exchange market information due to regulatory changes. High risks are involved with the deployment of these ultra-large vessels, especially in times of oversupply. This further facilitates the urgency of risk-sharing by means of collaboration. In this sense the current 45 consolidation efforts in the market are indeed a response to changes in underlying economic factors, as suggested by neoclassical theories (Chee, 2016).

In both cases the main goal is the optimal use of economies of scale (cost reductions) within the limits set by antitrust laws. Integration involves process orientation of organizational structures, dominated by the manager of integrated logistics, who manages the project teams, as follows:

- generation and realization of orders (reducing the cycle of order realization),
- logistics coordination (reducing the total logistics costs), and
- integrated distribution - reducing the inventory levels in the distribution network (Sergeev, 2005, p. 855).

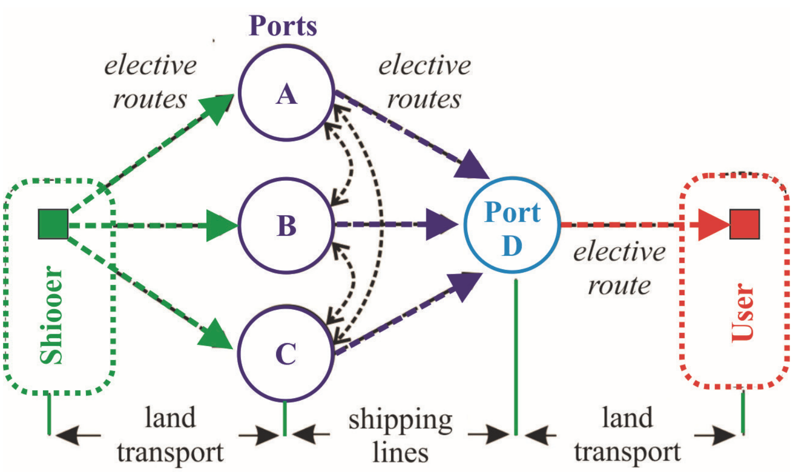
The outsourcing strategy represents giving particular (or all) of logistics functions to external partners, mostly logistics operators. It began to develop in the early 1980s, through organizational formation of the first *logistics service providers* (LSP), which quickly grew into 3PL operator type. In the early 1990s began organizational development of 4PL operator type, which, in addition to logistics integration of 3PL operator type, and other logistics companies, deals with logistics consulting, process management and logistics management supply chain, logistics infrastructure building, mediation, technological development and financial engineering. Thanks to the optimization of network integrator function, operator 4PL has the capability to reduce logistics costs, and to provide better information, complex logistics services, minimized idle time, quick and flexible adaptation, better planning of logistic activities, better use of logistics infrastructure, competitive prices, organized appearance on the market, strategic positioning, reduction of logistics risks and minimization of idle time.

Organizational structure of the logistics system helps implementing logistics strategy, logistics functions and company operations. Organizational structure always implies a certain set of services (departments) and delegated responsibilities in the company. The evolution of organizational security logistics management has gone through several stages, which can conditionally be marked as fragmentation, functional aggregation and process integration (Sergeyev, Ibid., p. 828). Modern conditions of managing the logistics business in the global relations have removed the organizational differences between national and international logistics. New organizational strategies are adapted to the global environment (external source - *sourcing*), and to the new conditions of competition, based on a multi-national marketing strategy and rapid development of the global financial system.

2.5 New Approaches in Modeling Port and Shipping Global Logistics Network

With the progressive integration of seaports and shipping companies into delivery chains (i.e. logistics networks), it became clear that cargo shippers do not choose the port and shipping companies according to their essence (general competencies: efficiency, location, port tariffs), but according to the quality of their logistics service packages. In other words, crucial is the connection between the port and shipping company in the logistics network that extends from origin to the final destination of cargo.

Figure 2.7. The concept of the logistics network in the port and shipping organizations

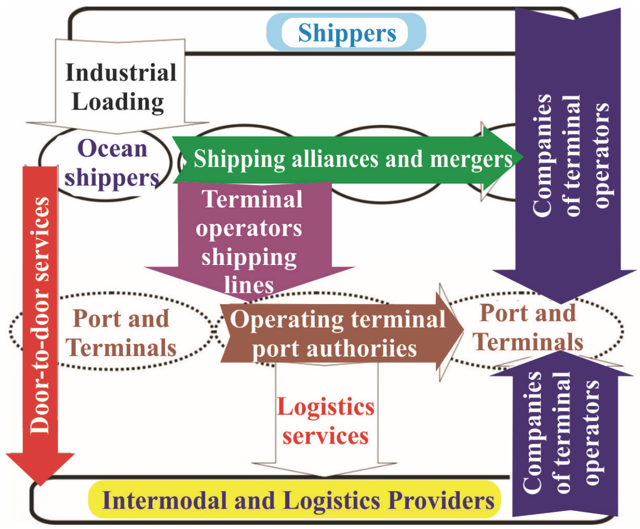


Source: Bichou and Bell, 2007, p. 35.

Practice indicates that logistics networks are the most reliable and the most efficient market methods for maximizing the cargo value, both for suppliers and for customers. Optional direction is a combination of optimal logistic operations (storages, ports, forwarding services, etc.). The shipper has the possibility to choose a route that will be the most optimal for transporting the cargo to the user (Figure 2.7). Clearly, this choice is influenced by spatial, temporal, organizational, pricing, financial, and other logistical factors.

Global strategies of vertical and horizontal integration in the last decades have been implemented in the ports and shipping. They have directly influenced the structural changes of the participants in the port and shipping service market, as well as the structures of the logistics channels and logistics networks. New operational logistics structures have emerged in seaports and shipping organizations, with a growing share of global operators who fulfill the function of networked services in the field of port and shipping business. The emergence and development of the logistics networks in this area have directly affected the overcoming traditional conflicts of interest between individual and free strategies of port and shipping organizations (Bichou and Bell, 2007, p. 37).

Figure 2.8. Dominant structural logistics changes in the global shipping and port business



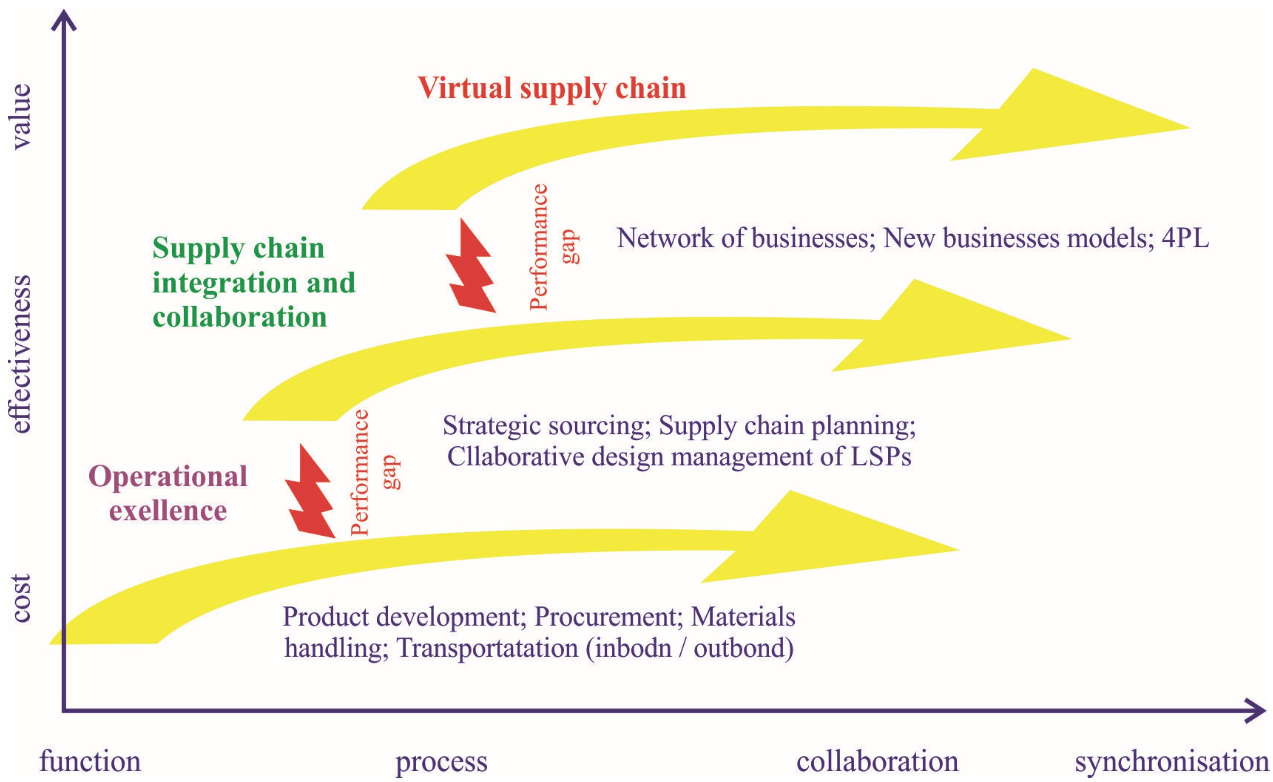
Source: Bichou and Bell, 2007, p. 38.

This conflict was particularly noticable in the required retention time of the ship in seaport. Figure 2.8 (below) shows the basic integration processes that have contributed to the development of logistics networks in the field of port and shipping business. These structural logistics changes of horizontal and vertical type tended to overcome the conflict and the gap between seaports and shipping companies, as well as reducing the number of intermediaries in the logistics and distribution channels, whose functions are increasingly transferred to a large and global logistics operator, who operates predominantly within logistics networks of the port and shipping business.

2.6 Outsourcing Strategy of Logistics Operator

Globalization of logistics industry (integration of mergers and acquisitions) led to the formation of companies that use outsourcing strategy, whose main characteristics are providing organizational integration of a large number of logistics functions, technology development, increasing business flexibility and security, risk distribution and efficient functioning of the entire supply chain (which is becoming more complex, and its elements are increasingly specializing in key competencies). Figure 2.9 shows that companies, while trying to improve business effectiveness and to create added value in the supply chain by increasing total logistic costs, must adapt their strate-gy to the contemporary outsourcing trends. That involves transition to operational excellence (step 1), followed by increased collaboration and integration in the supply chain (step 2), and finally the strategic virtual logistic networking of 4PL type (step 3). In doing so, they move to a higher level characterized by the "performance gaps" related to their competiton. Greater focus on the strategy of the logistics outsourcing generates greater opportunities for cooperation and synchronization processes, resulting in greater business efficiency and profitability.

Figure.2.9. Evolution of the logistics outsourcing



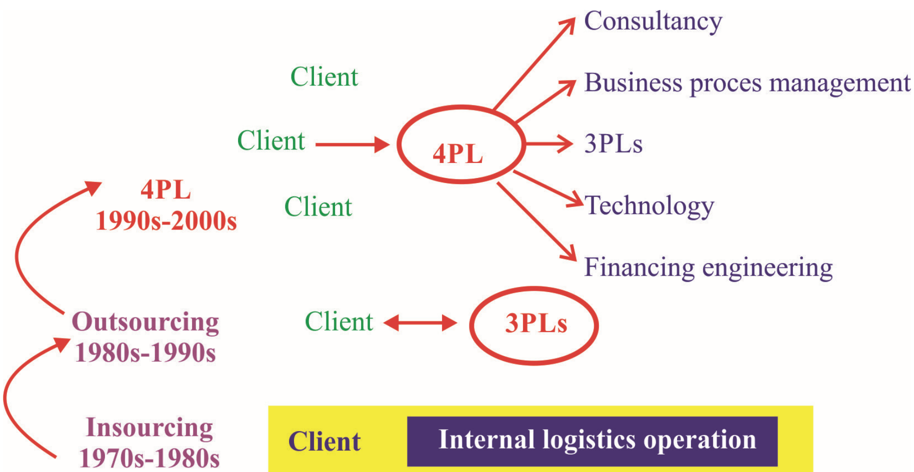
Sources: Gattorna, Selen and Ogulin, 2004, p. 13: Bajec, 2008, p. 3.

4PL is the highest organizational level of outsourcing, since it is an integrator that:

- gathers logistics resources, capabilities and technology of its own and others (complementary) organizations for the designing, constructing and launching the comprehensive logistics supply chain,
- combines the controls and operational processes, technology, management processes and resources, (i.e. all logistic flows material, information and financial in the supply chain),
- offers the widest range of logistics services, the highest technological capabilities, better flexibilities, information, data exchange and communication,
- allows better use of logistics capacity and reduces inventory, and
- takes responsibility to realization of all logistics flows in the complex supply chain. All of that enables competitive advantages in the global market and customer satisfaction. Practice has shown that outsourcing is the most suitable way of adapting to customer needs, (i.e. satisfaction of the growing and specific requirements).

In addition to these reasons, the motivation of numerous clients for engaging the external logistics intermediary (operator) of 4PL type is the increase of profits, reducing various operating costs, reducing the working capital and fixed capital, improving the quality and increasing the speed of logistics services, better planning, the availability of new logistics services, shortening the logistics cycle time, improving the customer service, and strengthening its own core competencies. Generally speaking, it is about the use of synergistic effects of logistics organisational partnership, which presupposes better cargo consolidation and reduction of logistics suppliers and intermediaries.

Figure 2.10. Evolution from in-house logistics to various outsourcing models



Sources: Gattorna, Selen and Ogulin, 2004, p. 15; http://www.innvall.com, p. 6.

Focusing on the model managing of strategic processes instead on the non-local control of the operative tasks, allows creating the added value of logistics services with the same or higher quality. The desired result is achieved with a minimum investment of time and assets. Intensification of the logistics integration creates new opportunities for locating the production in the countries with cheaper labor and lower tax rates, as well as access to cheaper resources and new markets.

The contemporary importance of logistics is that its application in business practice enables companies to significantly decrease in inventories, to accelerate the flow of working capital, to reduce the cost of products and logistics costs, to fully meet the user needs, etc. Marketing and management aspire to the complex comprehensive logistics (compliance and integration of logistics functions), considering it a strategic resource (like information), which greatly influences the creation of competitive advantage. Integrated marketing logistics has a huge application potential in the realization of port and shipping services. On a global scale, the development of network business connections provides opportunities to exploit advantages of economy of scale and growing number of logistics operators.

Table 2.4. Functional modification of logistic approach

Criterion	*Period*		
	1985-1995	1995-2000	after 2000
logistics funkctions	some	multifunctional	integral, intensive
connection	only business	longterm cooperation	strategic partnership
approach	local, regional	interregional	global, delivery „from door to door“
competitive advantages	partial	formed by aliance	very large aliances, specific operators
competition	assets division	accent on information	accent on information management, integration knowledge and information technology
value for the user	reduction of costs	avoiding costs	optimisation of costs and services

Source: Parashkevova 2007, p. 17

Expanding logistics network with the crucial support of information technology leads to the rationalization of the transport and distribution networks, inventory decrease and supply chain optimization. The integration of seaports and shipping companies into logistic networks is a recent phenomenon, enabling overcome of their long standing fragmentation, uncoordination, and inefficiency. Logistics networks represent a pragmatic change in the development of port and shipping activities.

Modern logistics outsourcing strategy of port and shipping organization is based on a clear logistics concept/technology of integration and logistics competencies, which are globally interrelated. It is focused on the optimization of port and shipping services through managing the basic and additional logistics flows, which can be carried out by forming a logistics networks that reduce the number of intermediate links, increasing the importance of logistics operators type 4PL. It represents a long term commitment to the network logistics development of maritime (port and shipping) business, which ensures minimization of overall logistics costs, improves the quality of logistics services, logistics optimization of port and shipping infrastructure, risk deployment, and greater profitability.

3. EVOLUTING OF SYSTEMIC LOGISTICS PROVIDERS

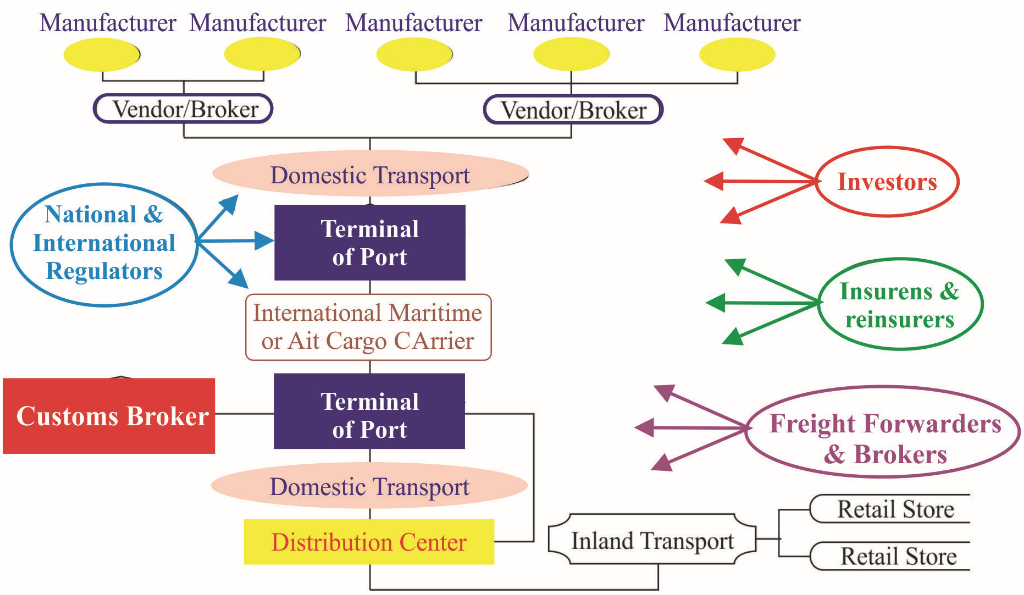
The functioning of a port and shipping system must be perfect in order to provide a competitive advantage and stable position in maritime market. The importance of logistics in business success of port and shipping organizations in contemporary conditions has become crucial. Due to that fact, more and more efforts are put in the designing of integral logistics systems. Thanks to a complex, systemic and networking approach, logistics today is improving the speed and efficiency of operations and significantly influences cost reduction and therewith fulfills one of the basic strategic functions, anticipating necessary key competences of the firm. It is a resource framework for the overcoming of strategic limitations and a method for the enhancement of the competitive position and all marketing and management functions.

In addition to that, the integration of partners requires, by rule, a consistent restructuring of the total chain dedicated to the creation of added value, i.e. reengineering of logistics and production business processes. Flexible and small structural units are created, cooperating among each other in a decentralized manner, retaining their key competences and strategic significance for the integral network dominated by a single leading firm as a center of the system, i.e. focus of the supply chain. The next study analyzes the formation of new logistics and marketing paradigm of the beginning of the new century and millennium, anticipating the overcoming of the traditional 3PL three-party logistics concept and formation of contemporary 4PL concept.

In the period of globalization, gaining competitive advantage is manifested in a specific and original way, through increased cooperation between firms, in order to share business, risk and corporate responsibility, as well as higher specialization of business activities. In the last two and a half decades there have been paradigmatic changes in the logistics supply chain, primarily thanks to the technological advances in the field of information technology, communi-cations and transport. These changes are generated in the creation of a growing trend of leaving the logistics activities to specialized intermediaries (operators, service providers). It all began with the formation of large storage facilities and specialized transport equipment (primarily maritime shipping), and later the creation of powerful information systems.

They enabled numerous advantages in the logistics business, mainly based on the rationalization of various logistics costs, higher qualification of personnel and faster, better and cheaper logistics services. On the other hand, the companies released a certain amount of invested capital and returned it by performing its core business. At the end of the 90s, logistics began to realize complex coordination in international relations in the fields of planning, regulation and control of material and information flows.

Figure 3.1. Multiple Actors in Global Supply Chains



Source: Kleindorfer and Visvikis, 2007, p. 11.

Application of the SCM (*Supply Chain Management*) concept was combined with business planning resources of ERP (*Enterprise Resource Planning*), extended calendar planning of APS (*Advanced Planning and Scheduling*) and electronic data interchange of EDI (*Electronic Data Interchange*). This resulted in the optimization of process logistics chains, elimination of the inefficiencies within and between participants chain for creating added value, and thus an increase in the productivity of the entire logistic system.

Development of logistics outsourcing has led to a growing demand for manufacturing enterprises of logistics services, but also for their increasing demands. This has had a crucial influence on the system of logistics 3PL operators to start organizing and suggesting the additional logistical operations (in a package), which increases the value of total logistics services: development, introduction, and the use of information and communication systems, cargo tracking, help with logistics planning and other. Accordingly, the logistics provider takes greater responsibility for the realization of a complete logistics order, which means monitoring the issuance and processing of the offer, payment, transport, aftersales service and other.

Evolution of the system logistics integrations has continued parallelly with the development of information and communication systems, and the term 4PL (*Fourth-Party Logistics Providers*) was firstly suggested in 1996 by the company *Andersen Consulting* (which now operates under the name *Accenture*). This company has defined the 4PL provider as a "*supply chain manager who integrates and coordinates its own and partner's logistical resources, capacities and technologies in order to deliver complex solutions of delivery chain to the client*" (Solomatin, 2006, p. 46). Only the rare companies were able to afford large investments in various forms of infrastructure, without which the realization of complex logistics services was not possible.

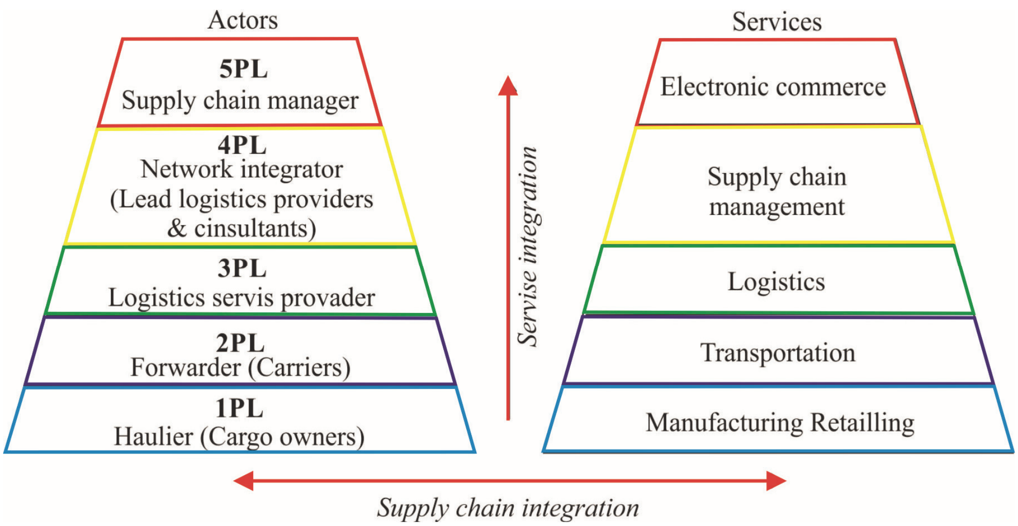
3.1 Concept of the 3PL Provider

The principle of third-party logistics in historical and functional sense represents a highly important logistic concept, because the operators of 3PL services have improved the efficiency of logistics management supply chains, expanded the range of logistics services and increased the capacity cargo carriers and shippers. Large transport companies (as 1PL) have been providing their limited services throughout the whole transport chain. Those were isolated physical transport services. In time, through the expansion of forwarding logistics (2PL), the field and variety of logistics services (providing additional services) have expanded. This trend has continued, so today the advanced services are increasingly affirmed.

They are better, faster, more complex, more reliable and more flexible. One of the most important links in the service chain is probably the accountability of the contemporary providers in the growing part of transport chain, from production to the customer delivery. At the same time, the nature of transport services is extremely identified with the nature of logistics, which enables offering complete and efficient logistics solutions. This has allowed clients (primarily suppliers) to focus on their core business instead of on organizing and managing the material and information flows. On the other hand, efficient management of the supply chain management (SCM) has become the main source of competitive power from national to global levels. Several innovations has enabled the development of provider logistics systems. Among them, in addition to the SCM, allocate:

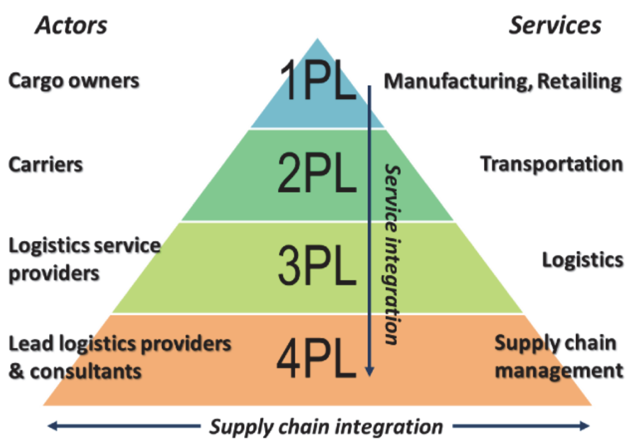
- modern hardware in the form of intermodal terminals with efficient transport capbilities,
- planning software for truck and rail routes with an intelligent transport system (ITC) and global positioning system (GPS), and
- thirdparty logistics (3PL) and the latest fourth-party logistics (4PL).

Figure 3.2. PL pyramid / Different kinds of logistics service providers



Sources: adapted from Vasiliauskas and Jakubauskas 2007, p. 69; Cerasis, 2013.

Figure 3.3. PL pyramid



The concept of 3PL is the starting point for transport and logistics activities of independent operators (providers) as well as foreign companies that are neither uploader nor the recipients of the goods. It usually involves several connected, mutually conditioned, coordinated and complementary activities, such as storage, wholesale, and transport. This concept began developing during the period of deregulation of transport industry in the '80s and' 90s, parallelly with the boom of information and communication technologies. At the same time, many authors (such as Vasiliauskas and Jakubauskas) viewed this concept as a transitional stage to the PL pyramid from 1PL to 5PL, enabling the key changes of the function of transportation logistics (Figure 3.3).

Many small companies that buy and sell in the same markets, are also the transporters (or hire transporters), performing all the logistics operations alone (1PL operators). Cargo transporters organize transportation of goods, choose the way of transport, and independently cooperate with warehouses, customs, dispatchers, packaging services, etc. As the business steadily expanded geographically, boundaries of logistics have broadened, and some individual logistics operations were taken by distributors or shippers of goods as 2P providers. Generally speaking, the transport-shipping enterprises and wholesale operators performed the logistics services for an individual or for a small number of functions in a complex and long supply chain.

They were faced with a small recovery of goods, had significant business holdings and low limit enry. With increasing customer demands, during 90s, many 2PL began to develop into 3PL operators, adding new logistical features and functions into its existing array of services. So there has been a merger of several logistics operations and additional logistics services, the formation of significant equity capital, with the expansion of contract logistics in SCM supply chain and acceptance of major duties and responsibilities.

Integrated service provider (ISP) or so-called "Integrators" perform entire business of logistics services, which includes and implies the satisfaction of most (and preferably all) logistical requirements of the customers. Integrators offer the performance of all services in the entire transport chain, from reception to delivery, and this in a simpler, faster and more reliable way than before. Transportation chain has become absolutely transparent for customer, who no longer needs to engage in choosing the transport modes, routes and numerous related administrative tasks related to the implementation of logistic operations..

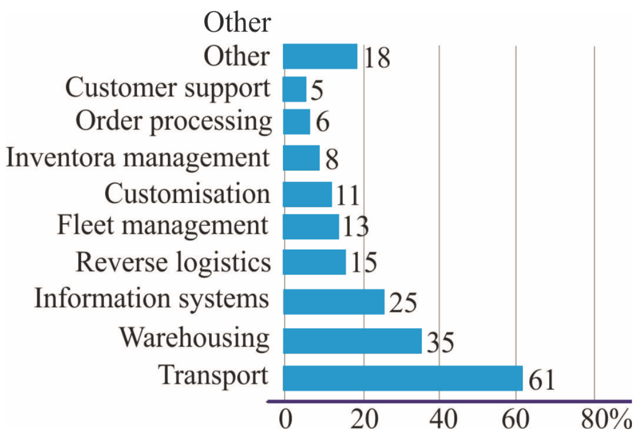
Advantages of the 3PL concept are resulting from economy of scale, possibility to combine the expanded scope of work, better technological equipment, larger databases, material flexibility, expert and specialized personnel, greater possibilities for coordination, reduced financial risk, possession of large distribution centers and information networks, etc. However, the 3PL concept has several disadvantages, primarily as a consequence of the impossibility to control the numerous contracts and lack of organizational centralization, which reflects negatively on the operator's reliability.

Therefore, the problem is shared risk. In the literature (eg. Skjott-Larsen, 2000 p. 114) describes four categories of the 3PL provider:

- *standard* (basic form), that performs basic logistics functions,

– *service provider*, offering advanced and cost-effective transport services, monitoring, storage, docking, packaging or unique security system,
– *client adaptor*, who at the client's request takes complete control of the logistic activities in the company, in order to improve logistics, but without the development of new services, and
– *improver* of the customer services as the highest level of 3PL provider, which integrates with its customers and takes over all logistical functions.

Figure 3.4. Transmission level of certain logistics functions to the operators in the European market



Source: Vasiliauskas and Jakubauskas, Ibid., p. 71.

There is a wide range of activities and logistic operations that companies transferr to its 3PL operators. According to the results of an extensive research, a transfer of activities is performed as shown in Figure 3.5 below. Transfer of logistics functions to the 3PL operators saves time, releases the financial resources (focused on company's key activities), logistic operations are performed faster and with higher quality, responsibility is shared on management and business risks, and all this ensures the creation of competitive advantages in the market. Even with possession of their own warehouses and vehicles, 3PL operators perform marking, reservation, orientation, calculation, transport organization, researching the financial and operational terms of delivery, market analysis, distribution and transport routes analysis, negotiation, etc. In addition, they meet many other client requirements. Figure 3.5 shows the relative importance of the 15 key criteria for 3PL selection.

Figure 3.5. Criteria for 3PL selection

Source: Aguezzoul, 2012, p. 20.

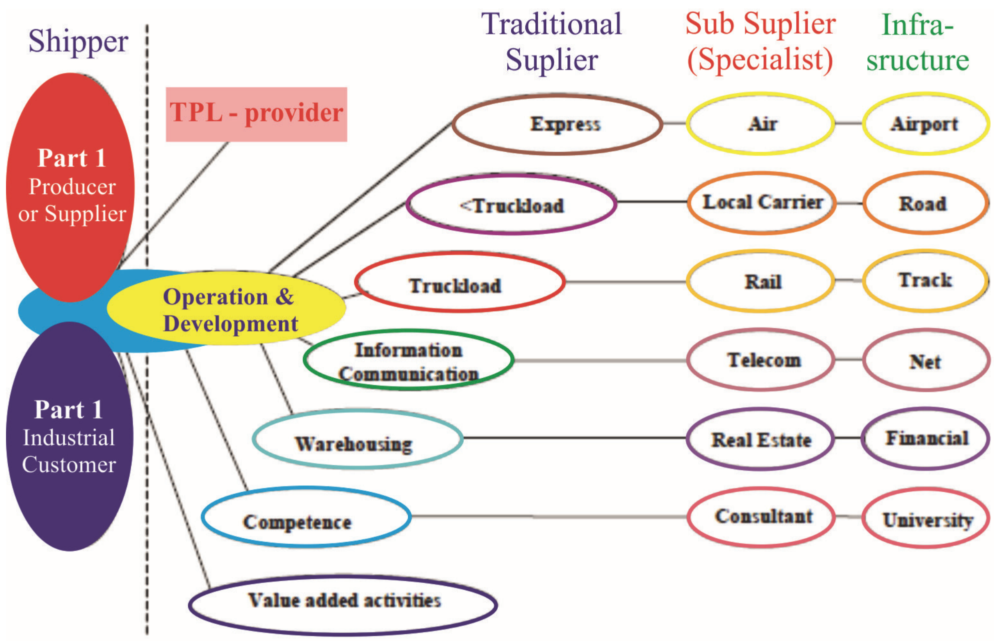
Table 3.1. Activities associated with 3PL

Logistics processes	*Activities*
Transportation	Road rail air sea, intermodality management, shipping, forwarding, package express carrier, customs brokering, (de) consolidation, perishable/hazardous goods management, freight bill payment/audit
Distribution	Order fulfilment and processing, picking, sorting, dispatching, post-production configuration, installation of products at customer's site
Warehousing	Storage, receiving, cross-docking, (de)consolidation, perishable/hazardous goods
Inventory management	Forecasting, slotting/lay out design, location analysis, storage/retrieval management.
Packaging	Design, labelling, assembly and packaging, palletizing.
Reverse logistics	Pallets flows management, recycling, reuse, remanufacturing disposal management, repair, testing and products serving, return shipment management

Source: Aguezzoul 2012, p. 19; Bottani & Rizzi, 2006, p. 297.

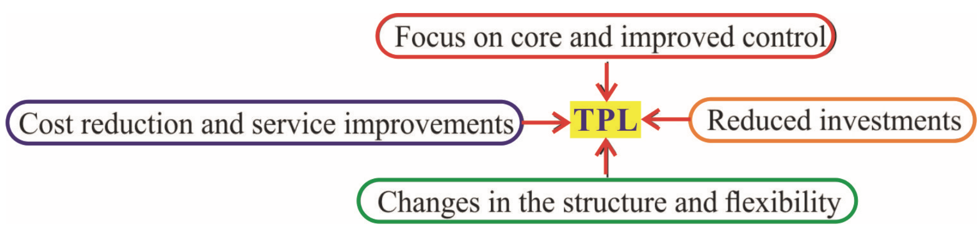
The 3PL can perform the logistics functions of their customer either completely or only in part and currently, they have their own warehouses, transport fleets and their credits are often deployed throughout the world. Most 3PL have specialized their services through differentiation, with the scope of services encom-passing a variety of options ranging from limited services to broad activities covering the supply chain. An overview of supplied logistics activities is shown in table 3.1.

Figure 3.6. Tiering of the supply of TPL services, based on Abrahamsson and Wandel 1998



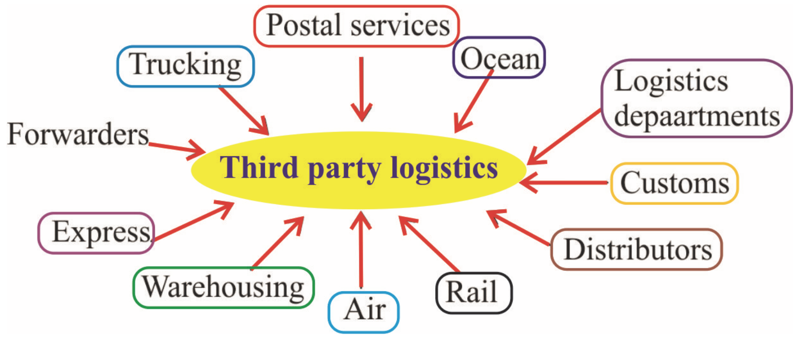
Source: Ojala, Andersson and Naula, 2006, p. 9.

Figure 3.7. Driving force behind and effects of the use TPL-services



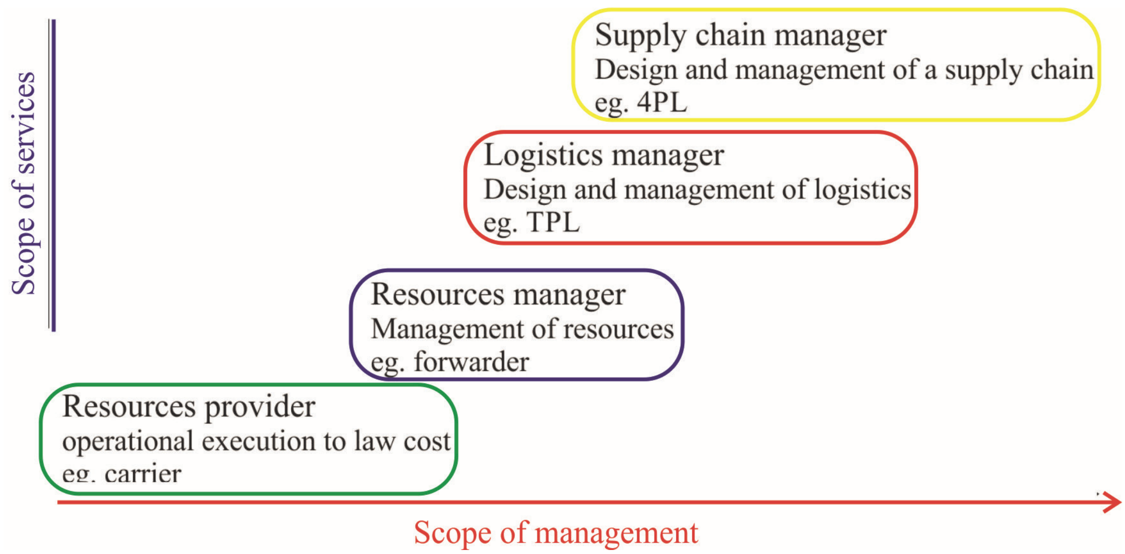
Source: Andersson, according from Ojala, Andersson and Naula, 2006, p. 11.

Figure 3.8. Origins of Third Party Logistics providers



Source: Bergliund, according from Ojala, Andersson and Naula, 2006, p. 15.

Figure 3.9. Different clusters of TPL service providers



Source: Ojala, Andersson and Naula, 2006, p. 16.

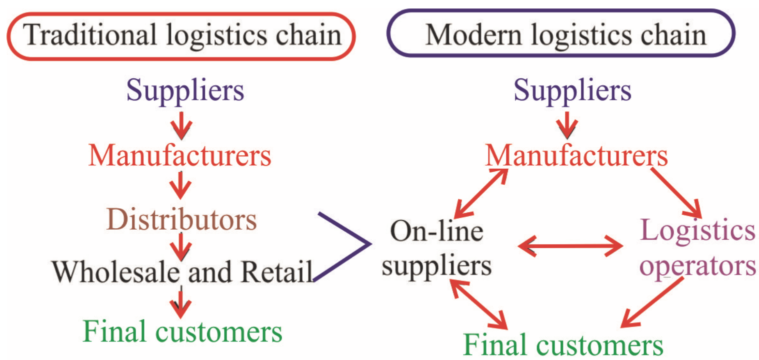
3.2 Concept of the 4PL Provider

Up to date, there are two kinds of logistics intermediaries: 3PL (*Third Par-ty Logistics*) - third-party intermediaries as partial (incomplete) operators and 4PL (*Fourth Party Logistics*) – fourth-party intermediaries as complete logistics operators, which cover the entire supply chain. The 4PL logistics provider, as a base logistic integrator, is a senior organizational management form of logistics mediation, because it meets all or most of the logistics requirements of its customers and is responsible for all contracts of various 2PL and 3PL providers, for their final assembly and management solutions (see Figure 3.5). It is believed that the 4PL are providers of the specialist company with best managing of the resources, capacities and technologies of those service-logistic organizational forms that function within a supply chain (Bade&Mueller, according from Acimovic, p. 115).

Today, 4PL provider is increasingly emerging as a *new paradigm* of integrated logistics management, or as a *network integrator*, compiling and combining available resources (financial, information, transport), human capabilities and technologies, in order to designed, built and implemented an efficient logistics solutions for its customers in a complex supply chain. The 4PL providers offer the greatest *added value* for producers, because they have more service options, such as planning, ordered transportation, tracking, logistics consulting, applied solutions, financial services and a very close relations with all the clients. Improving provider's activities has resulted in creating a new logistics concept of 5PL, focused on providing complete logistics solutions around the SCM chain. It represents an advanced SCM management as the integration of all activities associated with the flow and transformation of goods in modern logistics networks.

Pupavac (2006, p. 292) argues that the transformation of large shippers and marine transporters into the logistics operators 3PL, and later 4PL, has significantly contributed to the observed trend. Their development had a crucial contribution to designing the new structure of the logistics chain, where traditional distributors and dealers (wholesale and retail) are replaced by logistics operators and online suppliers (who create virtual logistics network - Figure 3.10).

Figure 3.10. Structure changes of the logistic chain



Source: Adapted from Pupavac, 2006.

Logistic providers of the new generation are increasingly taking on the various logistics and other complementary services, which contributes to the perfection of supply chain management (5PL), impeccable information support, speed, quality and reliability of delivery.

Four significant factors have significantly contributed to the affirmation of the 4PL concept, namely:

- Internet B2B economy,
- reverse logistics, ie. managing the returned products to distributor, manufacturer or retailer (approximately one fifth of all purchased products are returning annually),
- the development of timely operational support and management information, in order to maintain the precise timetable of delivery,
- developing the technological solutions that contribute to the timely flows of goods, reduce costs and increase customer satisfaction.

Naturally, forming a new paradigm of innovative management operating logistics support was influenced by a number of other added factors, some of which are listed in a comparative review in Table 3.2 below.

Table 3.2. Factors of logistical paradigm change

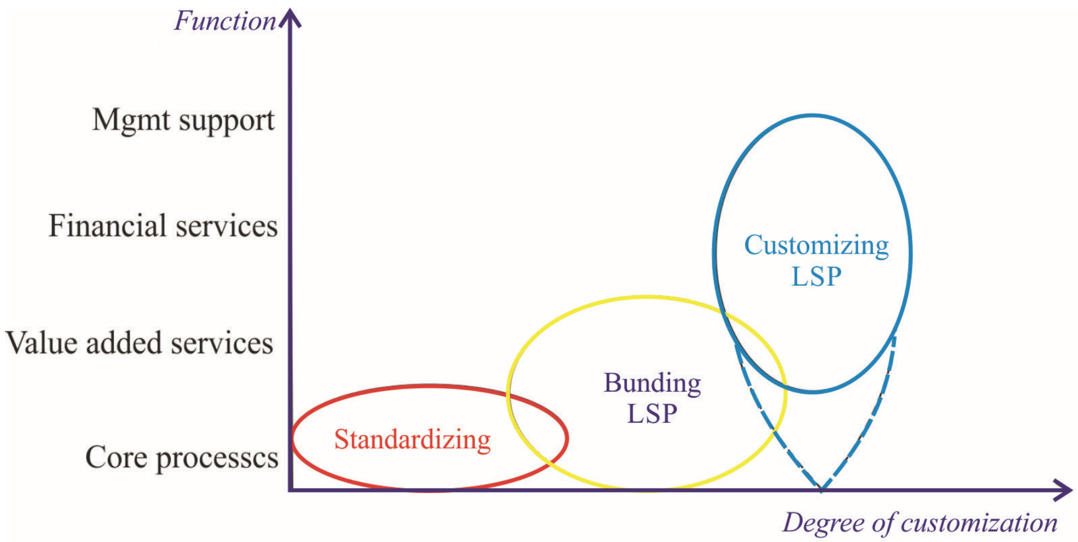
Fakctors	*Old logistic school*	*Logistics today*
orders	predictable	small, variable
time of order	weekly	dayly, during hour
consumer	strategic	wider base
customer requirements	strict	flexible
availability	on schedule	timely
distribution model	transportation to stocks	transportation to customer specification
request	stable, consistent	circular
purchase quantity	bigger	smaller
destinations	concentrated	geographically dispersed
storage	weekly, monthly	continuosly
international trade approval	with queing	automatski

Figure 3.11 is a graph which symbolizes the upward line of integrating the logistics service activities (compared to pyramid PL - Figure 3.3, p. 65). It depends on two general but probably dominant characteristics (factors) of integration: ability to solve logistic problems and ability to adapt to customer requirements. Level 4PL logistics providers are specialized in supply chain management, logistics planning, organization and control of material, financial and information flows, consulting for the network structure of the company and monitoring of cargo in continuous mode with the help of information security and integration of all participants in the logistics chain, as well as external clients who work closely with each other. Introducing logistics innovations is aimed at lowering logistics costs. So, by integrating logistics and inter-

mediary functions, and operations, 4PL operator creates logistical competency and reinforces the trust of its many partners.

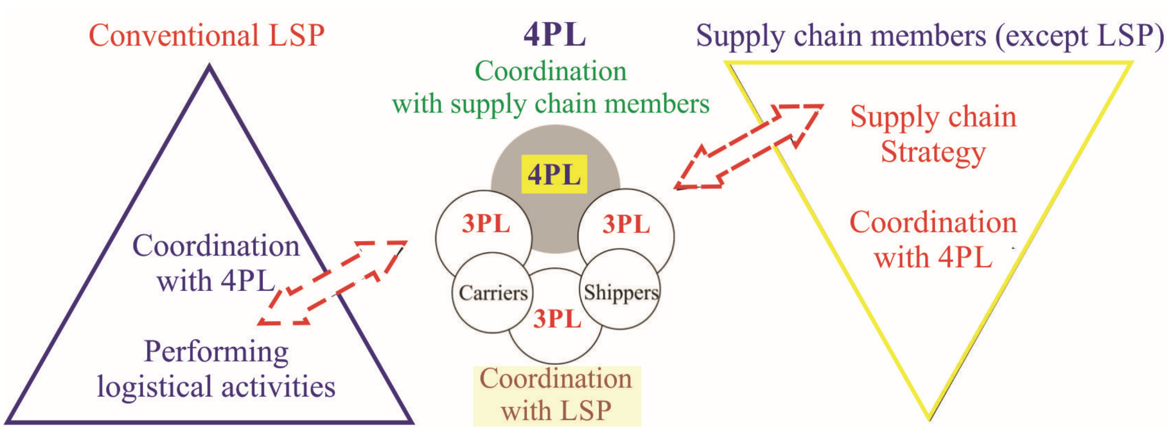
Figure 3.11 symbolizes the essence of 4PL concept and its functional coverage.

Figure 3.11. Development of provider's logistics activity



Source: Adapted from Delfman et al., 2002, p. 207.

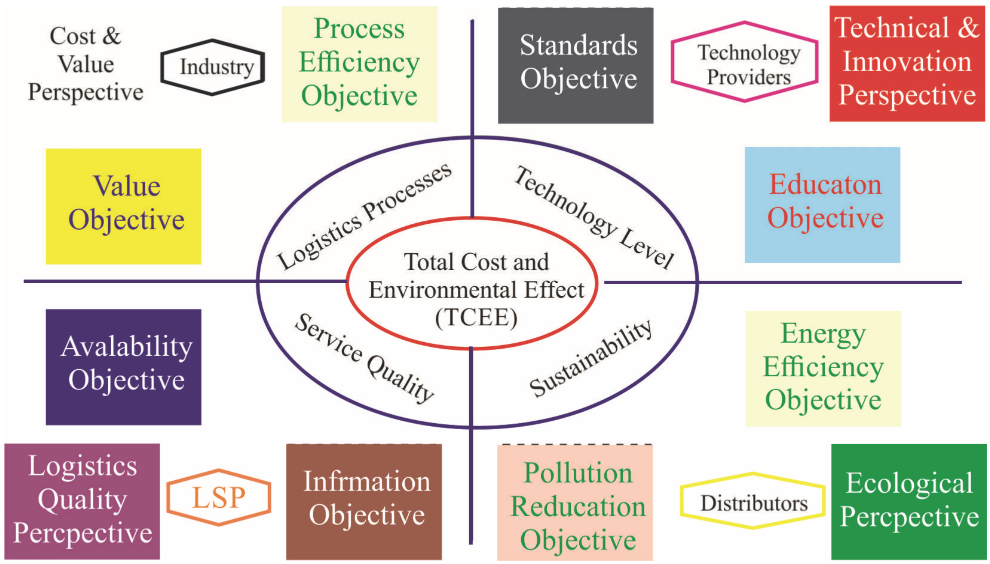
Figure 3.12. The essence of 4PL concept



Source: adapted from Van Hoek cited in Saglietto et al., 2007.

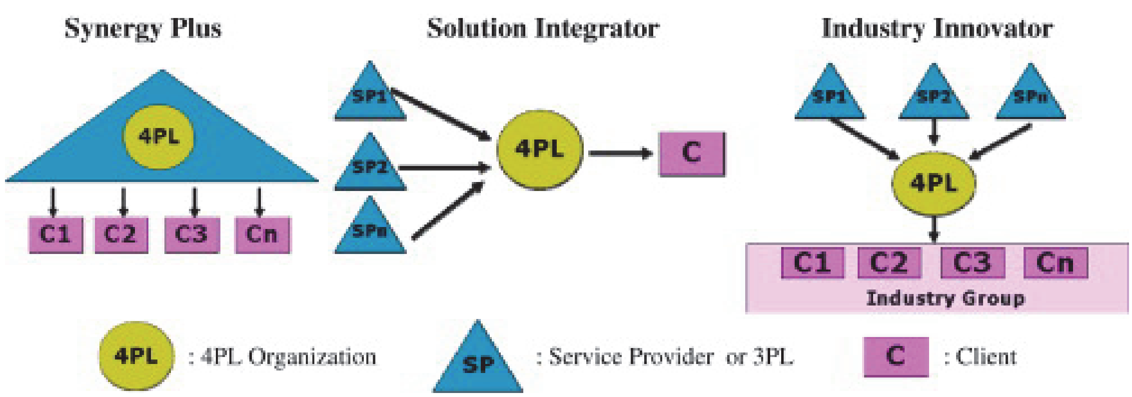
An integrated perspective with a joint analysis of technology innovation and sustainability improvements should help especially in the logistics sector: improve technologies and therefore efficiency and also, to provide an economic cost reduction in order to enhance ecological efficiency at the same time. The following analysis scorecard may contribute as a first suggestion to this concept improvement in managing logistics innovation and sustainability in logistics (figure 3.13).

Figure 3.13. Technology Innovation and Sustainability Assessment in Logistics



Source: Klumpp and Ostertag 2008; Jasper and Klumpp, 2008.

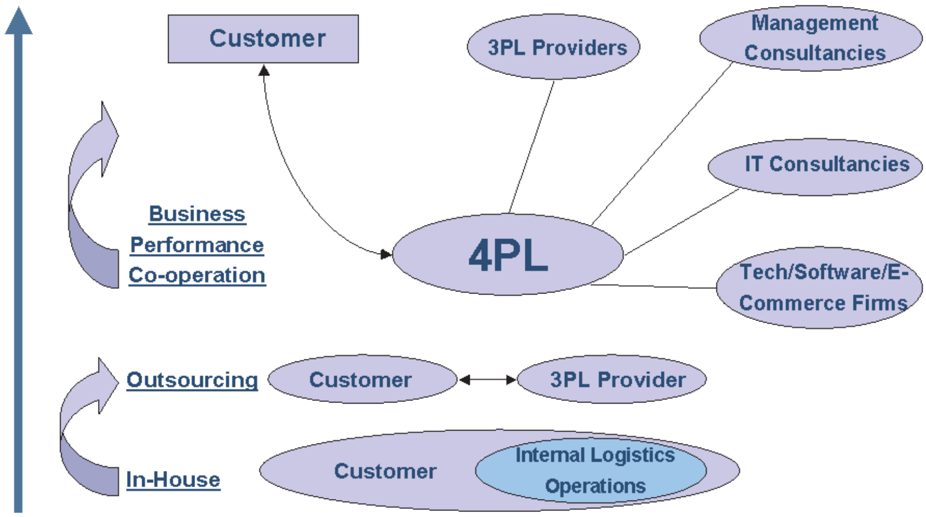
Figure 3.14. 4PL working models



Source: Büyüközkan, Feyzioglu and Ersoy, 2009, p. 115.

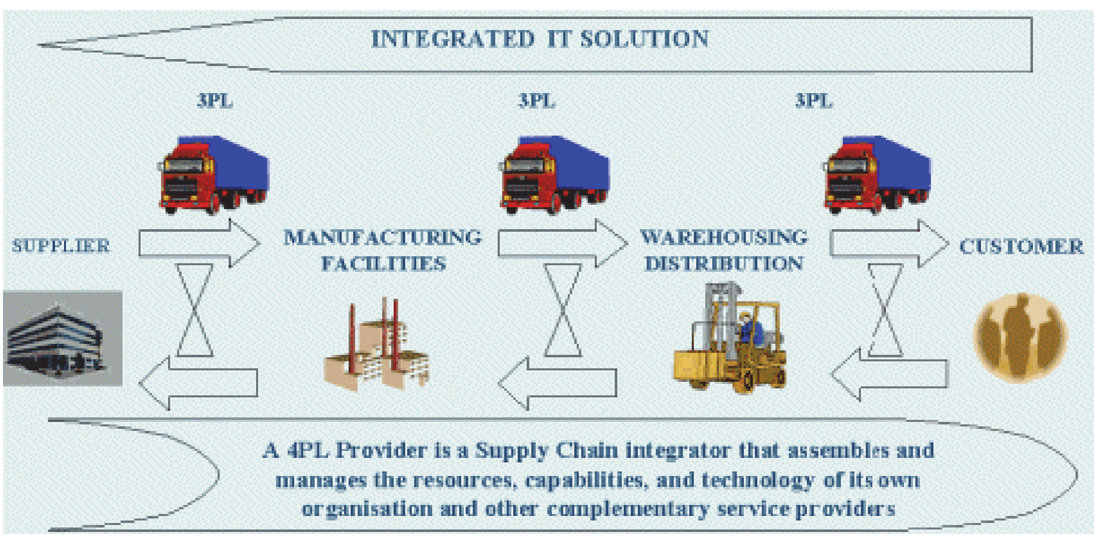
Yongbin and Qifeng (2011) or Büyüközkan et al. (2009) summarize that there are three different 4PL working concepts (Figure 3.14) which are all tailored to the client's requirements.

Figure 3.14.1. Evolution of the market



Source: Frost and Sullivan, 2004.

Figure 3.14.2. 4PL Partnership



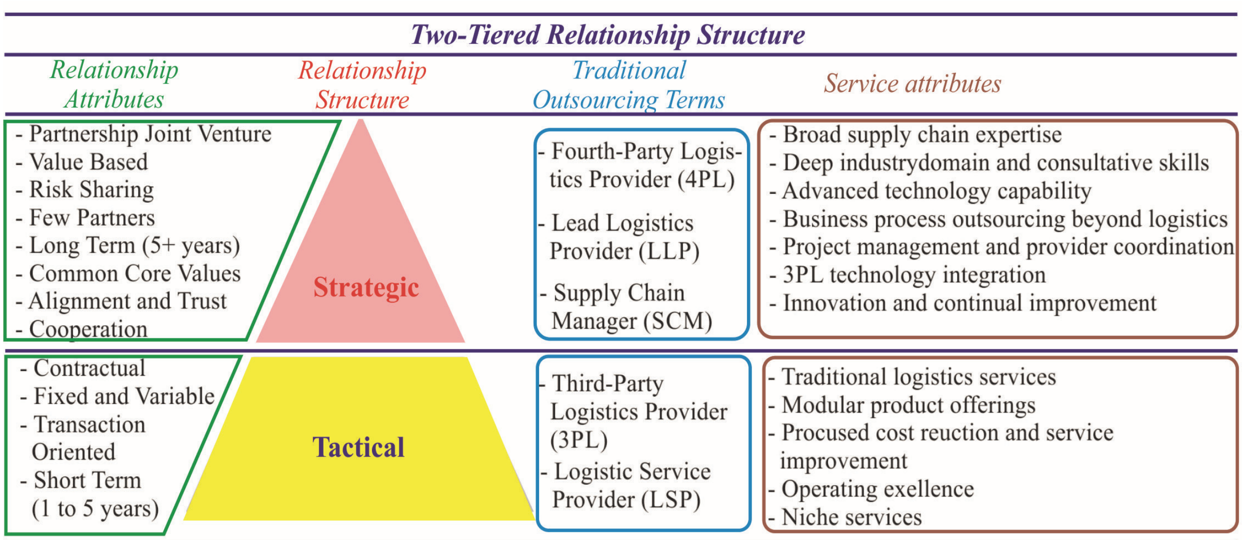
Source: Frost and Sullivan, 2004.

Table 3.3. Difference between 3PL and 4PL

Factors	*3PL*	*4PL*
Invilment in services in the supply chain	Phisical movement and execution	Operation and administration
Intensity of assets to provide services	High – vehicles, storage equipment	Low – information and communication systems
Intensity of konowledge	Low – standards	High – organization of product flow
Dependence of the manufacturer to supply the demand	Medium – low cost change and several service providers	High – the manufacturer has orders to fill and depends on its suppliers
Contact point at the manufacturer's	Negotiated contract	Dedicated contract and strategic coordination of the supply chain
Performance	Possibly limited in gains and result	More wide-ranging measures, involving client service and result in the supply chain
Shared information	Limited because it impacts only the execution	More wide-ranging, including clients and supplyers, policyes and priorities

Source: Vivaldini et al., 2008.

Figure 3.15. Difference between 3PL and 4PL



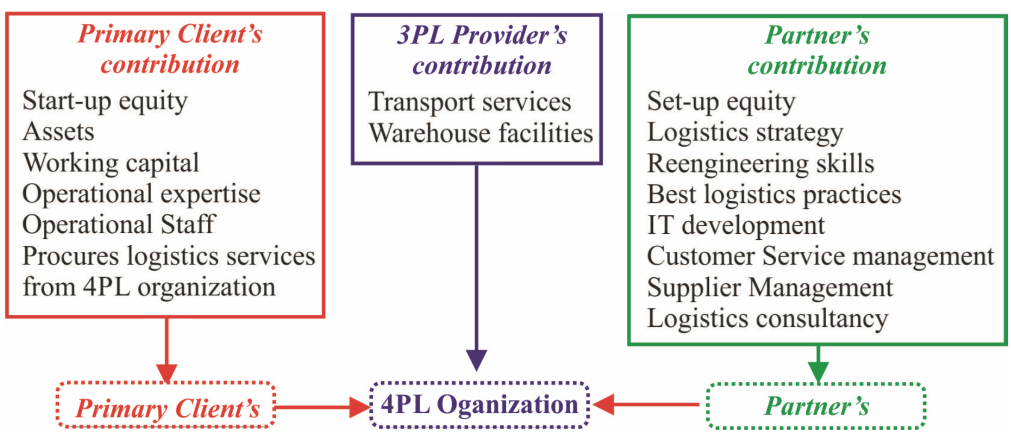
Source: Win, 2008.

Table.4. 4PL's service portfolio

Supply chain planning	***Supply chain execution***
- Strategic Planning (Sourcing strategies, strategic network design) - Collaborative product and process development (collaborative design) - (Collaborative) forecasting and demand planning - (Collaborative) production and procurement planning - (Collaborative) transport planning - Implementation of vendor managed inventory - Global availability checks for all necessary resources of a customers supply chain	- Taking over value adding services in the production - Procurement - Warehouse management - Transportation inclusive customs clearance and brokerage - Document management - Quality control - Picking and Packing - Retour management - E-Business Support (Web-shops, market place)
Supply chain monitoring	***Supplementary services***
- Supply chain Event Management (Trackong and Tracing) - Continuous performance measurement (sevice provider evaluation) - Benchmarking - Supply chain controling - reporting - Contract Management - Service provider auditing	- Invoicing and Insurance - Market analysis - IT - consultancy - Application Hosting - Software development - Outsourcing consultancy - Accounting - Usr training (e.g. for SCM Software) Service Center

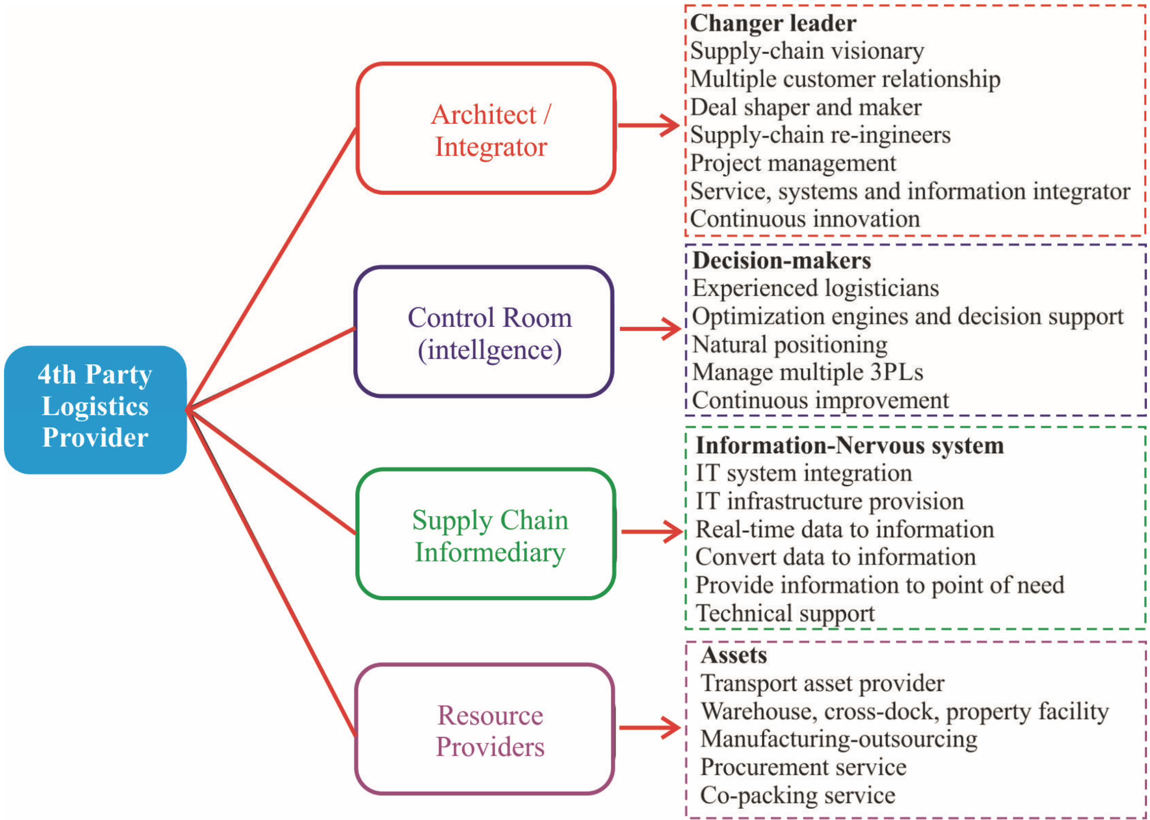
Source: Nissen and Bothe, 2002.

Figure 3.16. 4 PL concept and its partner's contribution to the client's Supply Chain



Source: Eko 4 Log, p. 24.

Figure 3.17. Key components of a 4th PL Provider

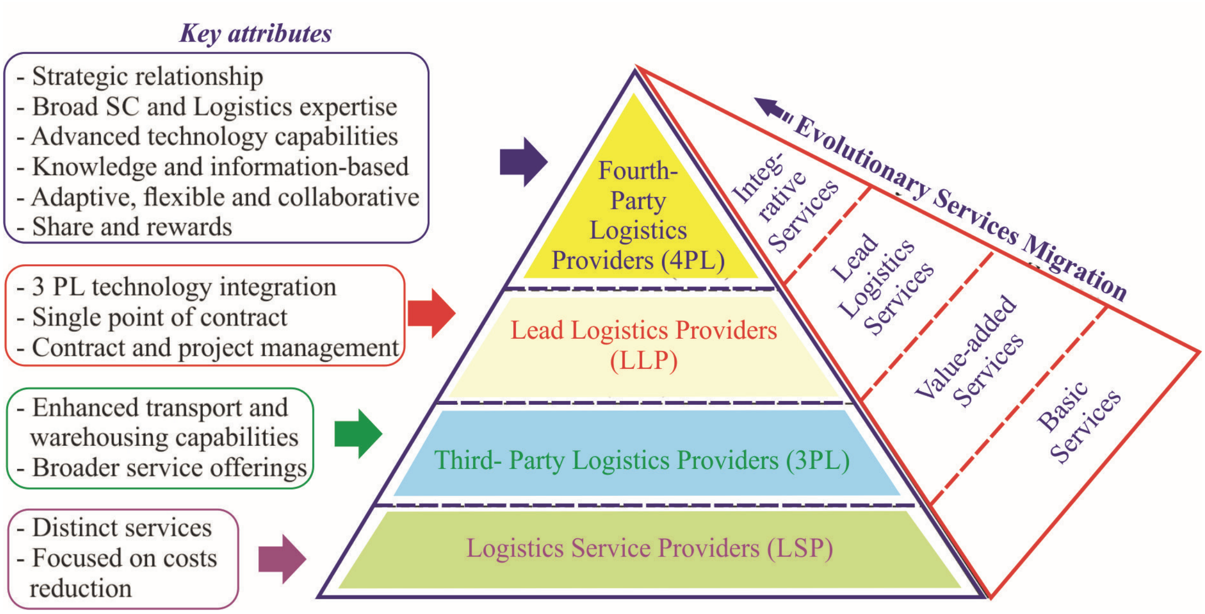


Source: Eko 4 Log, p. 26.

A 4PL as business model is defined as: "*an integrator that assembles the resources, capabilities and technology of its own organisation and other organisations to design, build and run comprehensive supply chain solutions, and which have the cultural sensitivity, political and communication skills, and the commercial acumen, not only to find value, but to create motivating and sustainable deals that offer incentives to all the parties involved*" (Langley et al., 2004).

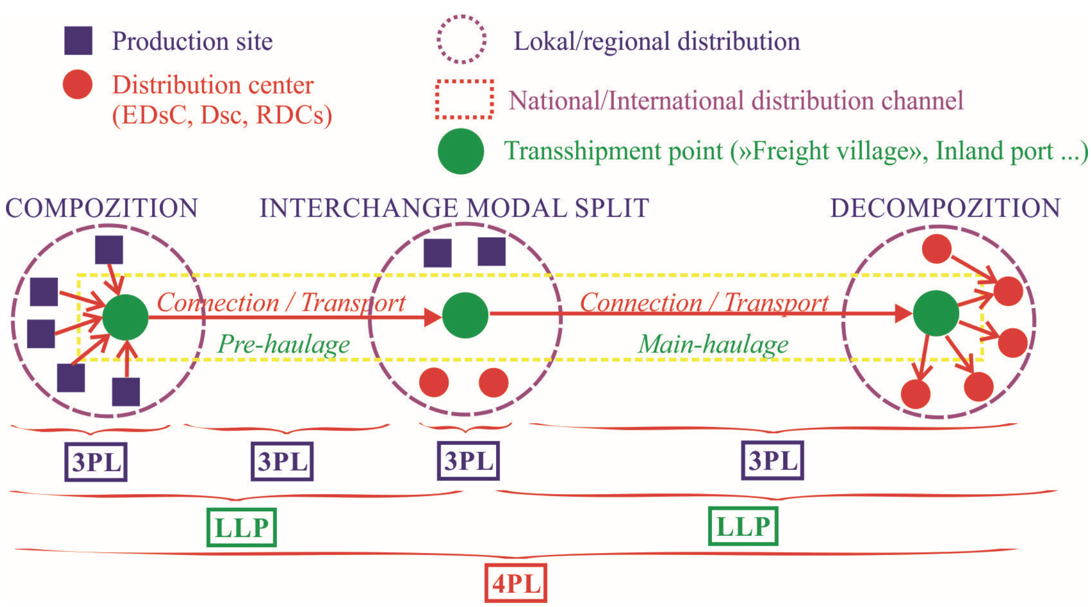
Fourth-Party Logistics Providers, or 4PLs, are so to speak integrators that manage a company's supply chain from end to end, often hiring subcontractors. In accordance with this original definition by Accenture, a Fourth Party Logistics Provider represents an external supply chain integrator that assembles, manages and combines resources, capabilities and technologies of its own organisation with those of complementary service providers, to deliver a comprehensive supply chain solution to the client. The prototypical 4PL have several other distinguishing characteristics: it does not only locate and manage specialised service providers, but also advises on the design of the entire supply chain and relies on sophisticated information technology systems to link up closely with the shipper's organisation.

Figure 3.18. Key atributes od LSPs, 3PLs, LLPs and 4PLs



Source: Eko 4 Log, p. 32.

Figure 3.19. The role of 3PL, LLP and 4PL in intermodal transport market

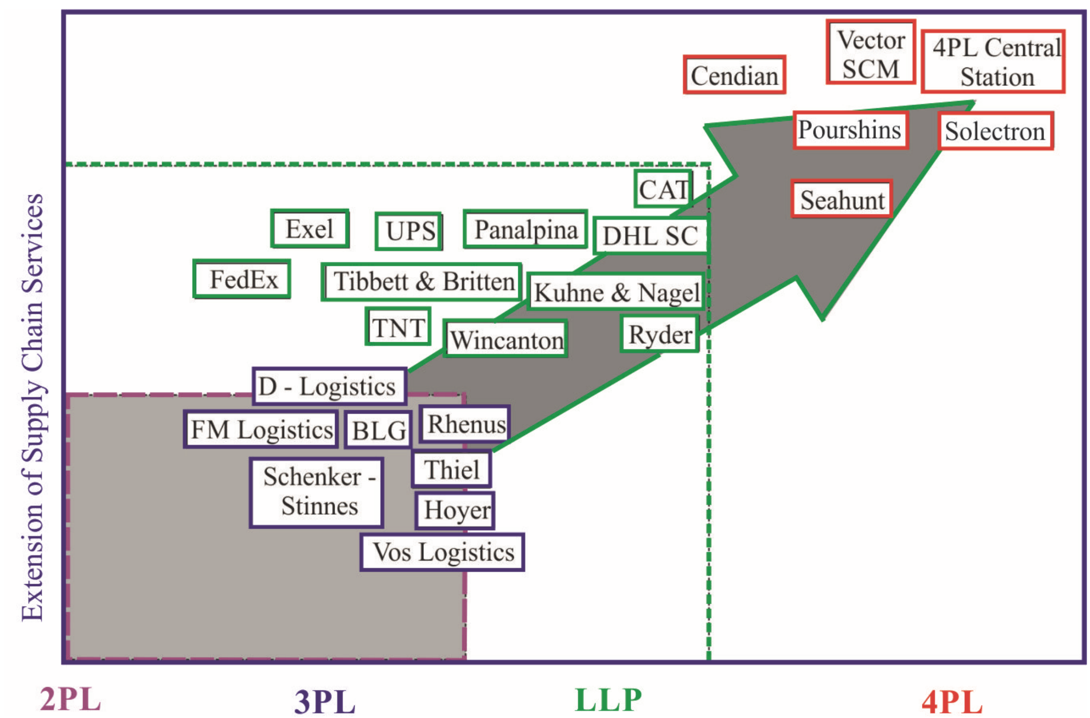


Source: Eko 4 Log, p. 33.

Via the 'control room' provided by the 4PL organisation, the experience from client's and partner's side collaborate to maximise the benefits of their knowledge and industry expertise. Using optimisation engines and decision support, the 4PL's business strategy is furthermore to act as a general, impartial and neutral contractor, offering comprehensive supply chain management services from a single source, in order to provide end-to-end logistics solutions for the entire supply chain. This implies a neutral positioning, which 3PL Providers that are closely tied to physical assets (warehousing and forwarding ca pacities) are not able to ensure.

The 'Supply chain infomediary' component in order to link information and data Technology is the key of the nervous system of a 4PL organisation. Sophisticated integration, communication and supply chain systems are required to enable the 4PL, its logistics partners, suppliers, customers and manufacturers to communicate in real-time across disparate systems and platforms. 4PLs generally develop around a problem or capability deficiency. This makes the concept attractive for the new member states of the European Union that usually lack a modern transport infrastructure and feature sometimes relative fragile supply chains. The solution provided by a 4PL is a combination of capabilities that enhance the clients' business and make its supply chain more flexible.

Figure 3.20. Summary of Logistics Provider categorisation



Source: Eko 4 Log, p. 33.

3.3 Example of Metro Group Logistics

It is believed that the 4PL providers are the most widely used in automotive industry and trade. That's why we decided to represent a German trading company Metro Group Logistics, one of the largest in the world. It was organized in 1996 as a result of merging several leding trading companies. It has its commercial subsystems in 30 countries, a clear professional-expounded portfolio managed by the holding company METRO AG. Only in Germany, it has approximately 1,700 commercial branches (department stores) with annual turnover of 27.5 billion €, more than 8,000 suppliers and more than 1 million of commodity items. Over 1,000 logistics operators (http://www.metro-mga.de) are ensuring the supply. Functional system requires an established logistics center of the internal 4PL providers.

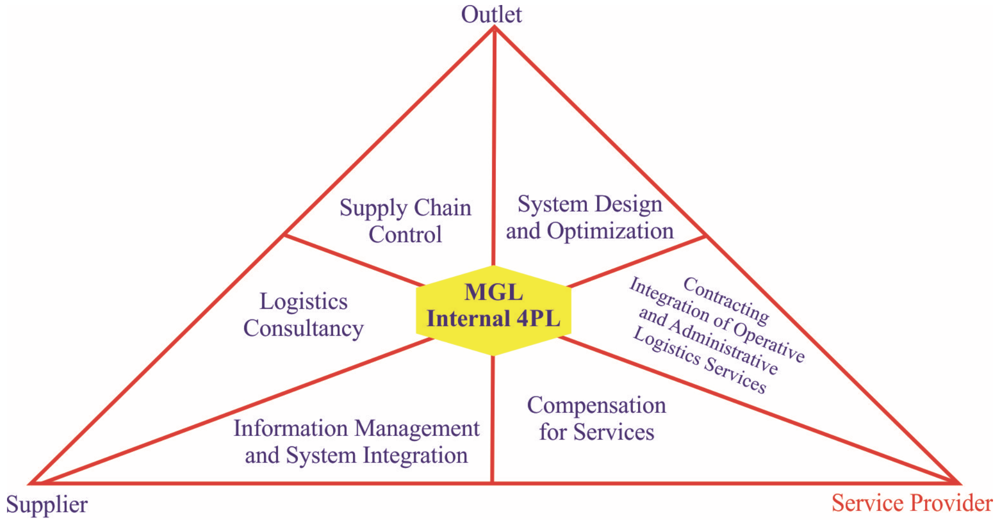
It includes all authority and necessary information, through which it projects the logistic processes, operations and manages the supply chain. Operational exploitation of logistic network has been entrusted to qualified providers, which operate independently and responsibly. The link between sales channels and their subsidiaries is established through the central mediator (Figure 3.21). In this way, the trade affiliates and suppliers are relieved of the necessity to solve bilateral problems of operational logistics.

Table 3.5. Tasks of the 4PL provider

planning, management and optimization of supply chains
strategic network planning
transport planning
tracking routes and information about the cargo origin (*Tracking & Tracking*)
efficient managing the product selling (*Revenue Management*)
submitting information-accounting resources and services (*Application Service Providing*)
financial services
integration of information-transportation systems
managing the warehouse business and inventory
planning and optimization of transportation routes
tracking order status and geographical location of cargo (*Order Tracking*)
managing documentation and its circulation (electronic, paper)
finding and delivering personnel on hire (*Personal Leasing*)
consulting

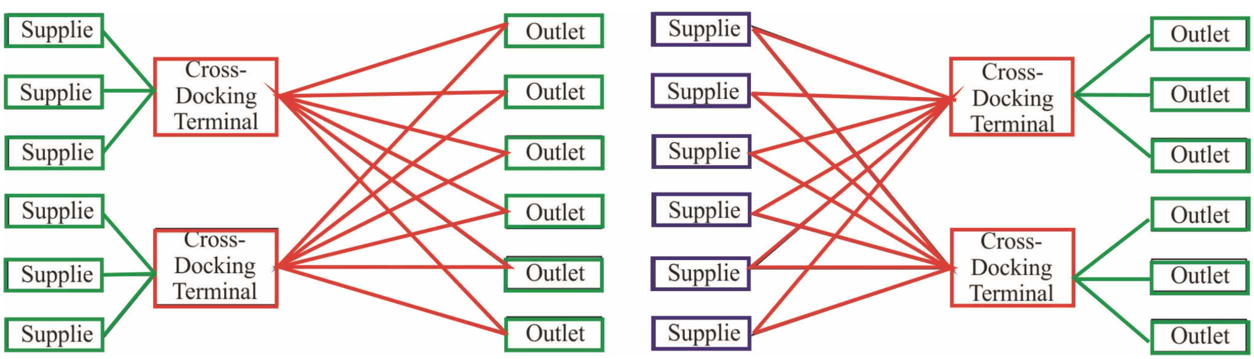
Source: www.metro-mga.de

Figure 3.21. Role of internal providers in the METRO Group Logistics



Source: Ibid., p. 25.

Figure 3.22. Origin-oriented and oriented cross-docking concept



Source: Ibid., p. 17.

The largest share of cargo flows between suppliers and trade branches is established without forming stocks, through network Cross-Docking terminals, which accomplish a dual task of supply concentration and distribution. By applying the Cross-Docking concept, the volume of storage reserves is reduced to the minimum level. Thanks to this logistics concept, the goods and materials are directly loaded and unloaded from the transport means on the freight terminals without forming the stocks. This is possible only in case of the staple cargo for various geographic regions, the completed deliveries from various sources and optimum shifts of various transportation means. Type solution of Cross-Docking trade is shown in Figure 3.22, where in practice are possible different solutions related to the role of Cross-Docking terminal. But their goal is always the same and includes deliveries of a large number of terminals from various geographical regions, and focuses on the different branches of trade.

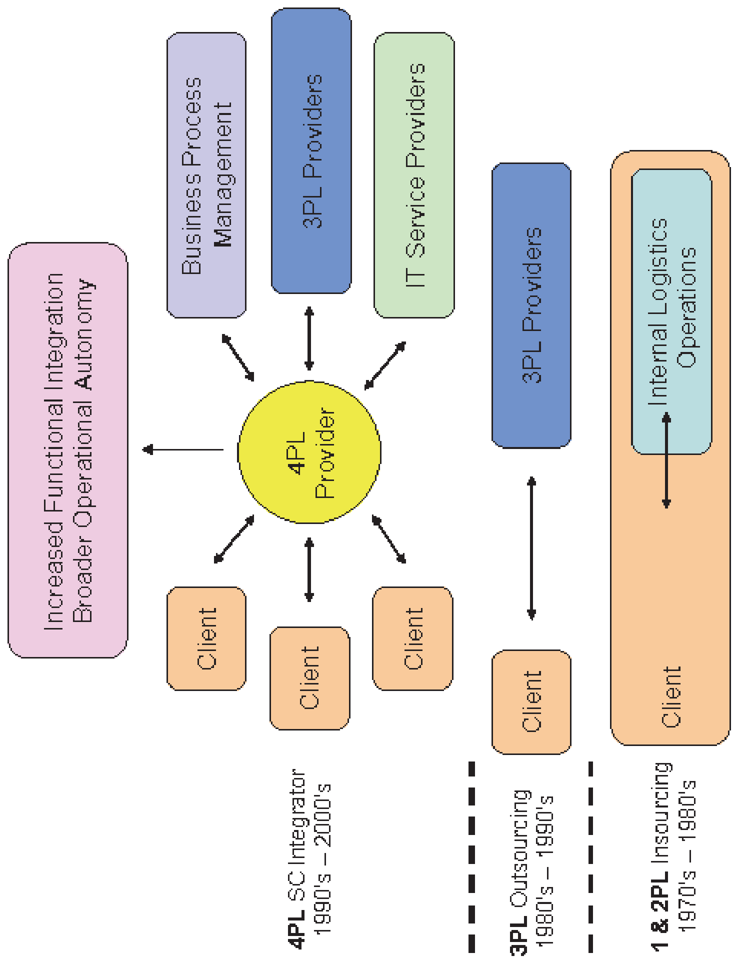
Logistics network of METRO Group Logistics contains around 4,000 suppliers and over 1,700 retail outlets, which means that there are countless variants of the transport network organization. Therefore, investments are not directed to the construction of its own terminal, using the existing network of logistic operators with many nodal points in all German regions. This involves the openness of the listed logistics networks for the inclusion of new companies. Introduction of a central operator has led to replacing the distribution of logistic suppliers with integrated supply logistics, whereby all suppliers were guaranteed that logistics costs will not be increased. According to new rules the supplier was bound to notify about the cargo in a reasonable time, and the packaging must comply with regulations that help avoid cargo damage during transport and handling. This has allowed a significant reduction in logistical administrative costs, particularly in terms of complaints, reduction in transportation costs per tonne of production, the optimal workload of transportation was ensured, the waiting time of transport equipment was reduced, etc.

Very few companies today can create a competitive advantage based on lower costs and prices. Speed, accuracy, completeness of order processing, timely delivery and reliability are essential factors that can provide much needed diversity in today's global economy. Key business success and competitiveness are achieved only through timely management of operational logistical support and supply chain. According to the *Council of Logistic Management*, logistics is the part of the service chain process that plans, implements and controls the efficient flow and storage of products (goods, services and resources, including information) from the point of source (production) to the point of consumption (use), with an aim to increase the satisfaction of customer demands.

To achieve this, transportation, distribution, warehousing, supply and order management organizations must work closely together. It is not a simple nor easy task, especially in a turbulent global environment with increasing demands, with clients who expect their products to be supplied better, faster, and in accordance to their specific instructions. Engaging external providers is an option that is becoming more refined and improved, because it helps the companies to survive in the market. The reasons are numerous, from reducing costs and inventories, through increasing service quality and business in general (by overcoming internal deficiencies), to reducing capital investment and achieving better business results. Forming 3PL providers as third-party provider meant providing additional logistics services to the customers. However, that concept had certain weaknesses and limitations, especially in regard to a variety of customization to the needs of its clients.

This led to creating the 4PL – fourth-party providers, who take on the greatest number of logistic activities, tasks, responsibilities and functions, and give a lot more attention to technology, knowledge, experience and management. It is not only a question of reducing costs, but rather a direct contribution to the overall business results. Using the most advanced organizational, information and transportation technology improves the overall system of complex interactions with the customers. Successful 4PL providers have tactical and strategic capabilities, with global knowledge and extensive experience in logistics. Thanks to a new concept of 4PL, modern logistic networks are characterized by a small number of participants and the dominance of logistic operators, offering not only transport services but also the storage, information support, and often global performance. Unlike 3PL, with a focus on function, realization of tasks and direct interest in concrete agreements on transport, 4PL focuses on integrated logistics process, engaging management and neutrality with respect to individual customers, because meeting the needs of all clients is a priority. The 4PL, as a modern logistic intermediary alternative, emphasize on averages, personnel and technologies.

Figure 3.23. Evolution from 1 & 2PL to 4PL Models



Source: Hamilton et al., 2003, p. 3.

4. POSSIBILITIES OF LOGISTICS PARTNER COOPERATION BETWEEN THE SEAPORTS

"*The last frontier of management to conquer is logistics and supply chain management*"

P. Drucker

The following study elaborates an original idea to attract Chinese investors, shippers, logistics providers, bankers and other business entities in order to expand the port of Bar, modernize its infrastructure, increase the depth of its draft for receiving the largest ships and the creation of intermodal logistics and distribution centers in the closer and wider hinterland.

This would allow huge amounts of Chinese goods to be partly shipped to the closer and wider region whereas the rest would be shipped through the port of Koper to Europe. Main idea is that the creation of integrated logistics supply chain would attract a significant portion of China's import of goods to Europe and increase the competitiveness and advantages of the ports of Bar and Koper, through economy of scale, increase of quality of logistics service, reduction of total logistics costs and achievement of higher added value of all port and logistics services in these seaports.

The last decade of the new millennium has brought major paradigm changes in the field of integrated logistics and sea ports. They were followed by numerous theoretical and practical innovations. The importance of sea ports and the application of integrated logistics in them are increasing. Seaports must adjust to the changes at global maritime market through the increase of the size of the infrastructural and supra structural capacity followed by continuous technological and information advancement, cooperation with logistics providers and the integration of its logistics functions. In addition, geographical location, size and level of infrastructure and supra structure of seaports determine the final model of integrated logistics.

The changes that have occurred in recent decades in the global shipping market caused a significant increase in the number of sea ports and their capacities (infrastructure, supra structure, transportation, logistics, terminal and other). The investments had the biggest role in this, whose flows were continuous and dynamic. It dominantly influenced the overall modernization of port infrastructure and the increase of the level of logistics services, particularly in terms of container transport. The fact that over 90% of cargo transported by sea speaks says enough about the importance and need for continuous development of seaports, expansion of range and improvement of the quality of port and logistics services, which are being provided to increasingly demanding customers. This is particularly important for transition states in which an economic and social crisis are being reproduced for a long time, in which the maritime industry is a priority, but very underdeveloped.

In modern business conditions, according to M. Draskovic (2011, p 37), the advanced sea ports tend to integrate all functional areas of logistics to the greatest possible extent, in order to significantly shorten the time of executing orders of port services, accelerate and streamline logistics flows, reduce total logistics costs, reduce the time of logistics operations and achieve the appropriate complete and quality customer satisfaction in the part of the port logistics services. The global complexity of market relations, increasing competition, information and business risk as well as financial, information and other relations between the partners are the key factors why the sea port are accepting the integration of logistics functions.

Every day the speed, intensity and complexity of material, financial and logistics information flows are increasing while the reduction of intermediate links, and insurance (reserve) stock is getting stronger. In such circumstances, the only way to ensure stability of functioning of the system of sea ports and their logistics systems is their further integration. Therefore, the modern logistics systems in seaports are increasingly viewed as a whole in terms of integrated marketing and management functions, through which the process of cargo handling is being implemented. It is being insisted on full integration of primary and supporting logistics flows. It is a continuous logistic chain that gradually adds value to port and logistics services, which must be performed in timely manner, with high quality, reliably, functionally and synchronized, which are the basic attributes of logistics integration.

Integrated logistics of sea ports assumes the systematic and process approach, as opposed to the fragmented one, applied by smaller ports such as the Adriatic ports of Bar, Ploce, Split, and in larger part Rijeka and Koper. Looking for big investors and global logistics providers, they fail to significantly reduce the amount of total logistics costs, or to engage in significant integration of logistics processes. Their development in the future will directly depend on the acceptance of changes in the global environment and application of logistics concepts whose core competence is - *integration*. Therefore, this paper starts from the idea of partnership performance of ports of Koper and Bar in seeking and finding the big Chinese investors and providers, in terms of modern logistics trends and flows of world merchandise trade.

Why Chinese? Share of logistics in GDP - U.S. 10% China 20%, and India 13%. A large part of global trade shifted from Asia to the EU and surpassed the China-US trade. Annual Chinese import into the EU is estimated to 160 billion U.S.$ (http://hercegbosna.org/forum/post306384.html). Current trade route goes from Suez channel across the Mediterranean to the Gibraltar and then northwards to England and Denmark. Main ports that receive Chinese goods are English and the port of Antwerp. The duration of this route is 14 days longer than the road to the Adriatic Sea, which is a natural extension of the Suez Channel.

The Chinese are very interested in the port of Rijeka because of the depth of its draft. Germany, Sweden and Eastern European economic zone lobby for Rijeka to become China's main stock of cargo (mainly containers). So far the British had for many years opposed to this. However, for more than two decades, the Chinese have been showing great interest in the port of Bar as well. Political and other causes have contributed to failure of the realization of this important business and logistical arrangement. With high probability we can assume that the establishment of partnerships between the port of Koper and the port of Bar would decisively contribute to easier, faster and more constructive entering of Chinese Investors (shippers, logistics providers, banks and other businesses) into the port of Bar.

Part of the above mentioned 160 billion of US dollars profit pie may be significantly be allocated to the ports of Bar and Koper through their partnership relationship and joint logistics approach. The idea might be easily transformed into practical implementation in relatively short time frame through quality project elaboration. The motivation to find the way out of the deep economic crisis that threatens to further reproduce and spread, with all the accompanying positive developments: the growth in employment, living standard, the state budget, productivity, easy servicing of external debt and so on, contributes to the feasibility of the idea.

China has huge foreign trade surplus and investment potential. It publicly shows it interest in the modernization of certain sea ports at the Adriatic and in the opening of the logistics and distribution centers in its hinterland. This interest is followed by offering concessions expressed in billions of U.S. $ and looking for a decades-long period. This is a big chance that the Montenegrin port of Bar obviously can not utilize without the participation of another partner Adriatic port, with a higher level of infrastructure development, logistics knowledge and experience. The Chinese are also much more interested in terms of logistics in cost effective investment in which two Adriatic ports would participate in partnership. We assume that out of number of reasons the Port of Bar would achieve an ideal business and logistical cooperation exactly with the Slovenian port of Koper. The primary reason could be the geographic location of the port of Bar, the depth of its draft, opportunities to significantly increase its depth and very large and unused opportunities for opening intermodal logistics centers that the broader background of the port of Bar offers.

The profit of sea ports that unload Chinese containers is huge. It is believed that the accompanying business activities around the harbor are very profitable: For each 1 U.S.$ that the port earns, other services around the harbor of Port earn $ 11USA (trade, carriers on land and others.). The size of the profit pie in the game may be illustrated by the fact that Italy is offering to the Chinese the port of Bari and free transport to the north of Italy, if the port of Bari is selected as the main entrance gate of Europe.

4.1 Theoretical Approach to the Significance of Integrated Logistics Supply Chain

Integrated logistics supply chain is the term used to characterize the system of advanced sea ports. This refers to the set of all types of providing logistics port services (reception and processing of orders, designing and manufacturing of port services, sales, service, distribution, resource management and supporting logistics functions of the port), which are necessary to meet user demand of port services - from initial momentum of ordering port services, through providing information on logistics flows to the final delivery to the user.

Logistics management as defined by the Council of Supply Chain Management Professionals (www.logisticsservicelocator. com/resources/glossary03.pdf, p. 89): "*Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements. Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply/demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution-strategic, operational, and tactical. Logistics management is an integrating function which coordinates and optimizes all logistics activities, as well as integrates logistics activities with other functions, including marketing, sales, manufacturing, finance, and information technology*".

SCM as defined by the Council of Supply Chain Management Professionals (Ibid., p. 138): "*Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies. Supply Chain Management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted* *above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology*".

SCM has risen to prominence in recent years in both academic and commercial circles. However, there is still no universally accepted definition of what SCM is (and, indeed, is not). As pointed out in a widely cited article by Mentzer et al. (2001, p. 2): "*Despite the popularity of the term Supply Chain Management, both in academia and practice, there remains considerable confusion as to its meaning. Some auhors describe SCM in operations terms involving flow of products and materials, some view it as a management philosophy, and some view it as a management process*".

Mentzer et al. (Ibid.) ese definitions and, based on their analysis, provide a definition of their own. From this representative sample of SCM definitions, Mentzer et al. suggested that three definition categories can be identified. Firstly, many authors define SCM as a *management philosophy*. In this context, SCM adopts a systems approach to viewing the supply chain as a whole, from the supplier to the ultimate customer. A chain-wide collaborative approach, driven by a strong customer focus, aims to synchronise intra-firm and inter-firm capabilities. Secondly, ma-ny authors consider SCM as a *set of activities to implement a management philosophy*.

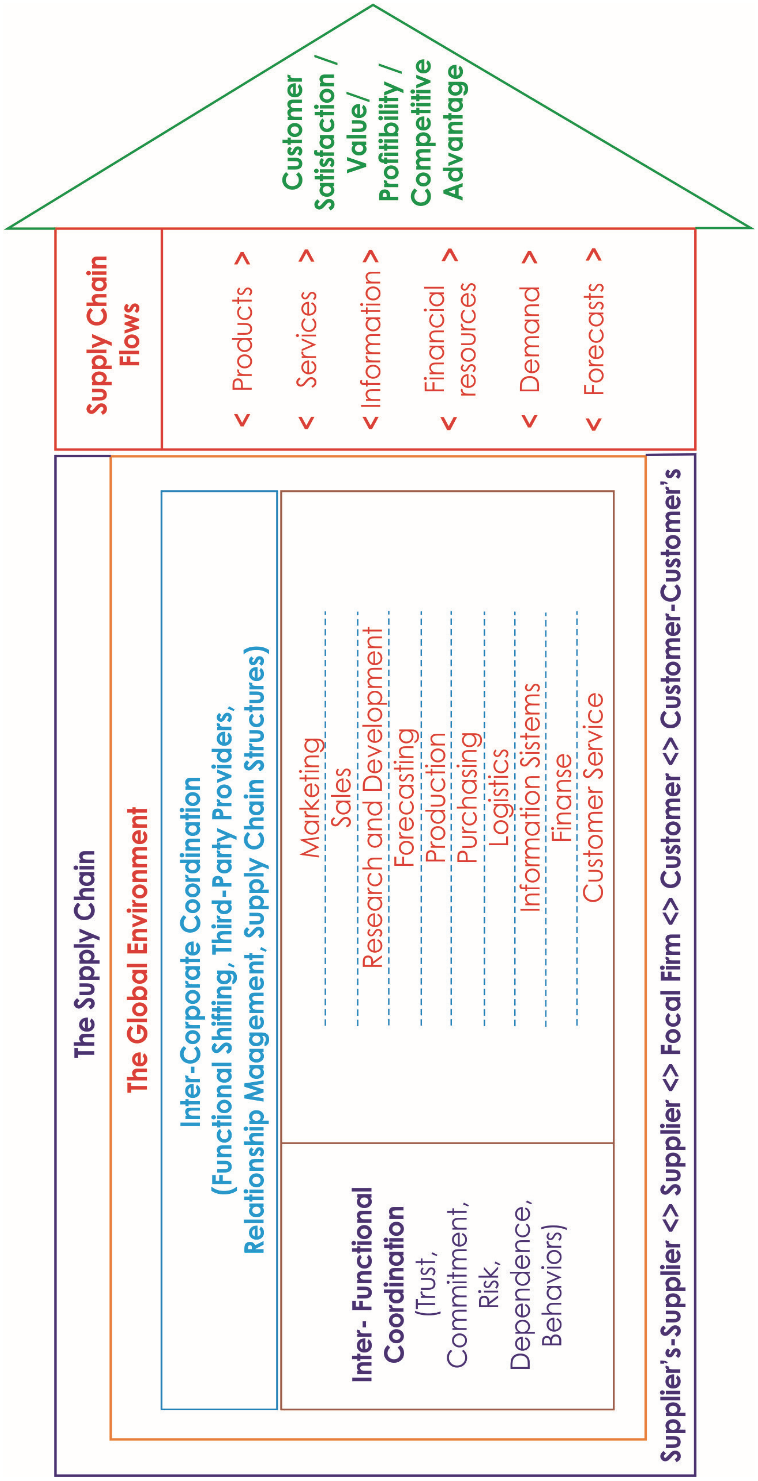
Seven activities are proposed, based on the earlier research, which appear necessary in the successful implementation of the philosophy:

- integrated behaviour in customer and supplier firms,
- mutually sharing information,
- mutually sharing risks and rewards,
- cooperation among supply chain members,
- the same goal and the same focus on serving customers,
- integration of processes, and
- partnerships to build and maintain long-term relationships.

These activities are aimed at creating added value of port and logistics services, durable competitive advantages and core competences for performing of certain activities. According to this definition, SCM involves multiple firms and multiple business activities, as well as process orientation to coordinate activities across functions and across firms within the supply chain. This definition led to the development of a conceptual supply chain management model as pictured in Figure 4.1 below.

Mentzer et al. suggested, SCM can be regarded as a management philosophy then this philosophy is concerned first and foremost with integration. The widely cited work of Bowersox, Closs, and Stank (2000) and his collaborators at Michican State University, which describes a framework of six competencies (the *Supply Chain 2000 Framework)* that lead to world class performance in logistics and SCM, supports this view. These competencies, grouped into three areas (opera-tional, planning and relational), are all concerned with integration.

Figure 4.1. The Mentzer Model



Source: Adapted from Mentzer et al., 2001.

The work of S. Fawcett and G. Magnan (2002) identified four levels of integration in practice: internal cross-functional integration, backward integration with valued firsttier suppliers, forward integration with valued firsttier customers, and complete backward and forward integration ('from the supplier's supplier to the customer's customer'). Most businesses - certainly manufacturing- based business - can be described in terms of the five functions: buy, make, store, move and sell. This is what is referred to as the internal (or micro- or intra-firm) supply chain as shown in Figure 4.2.

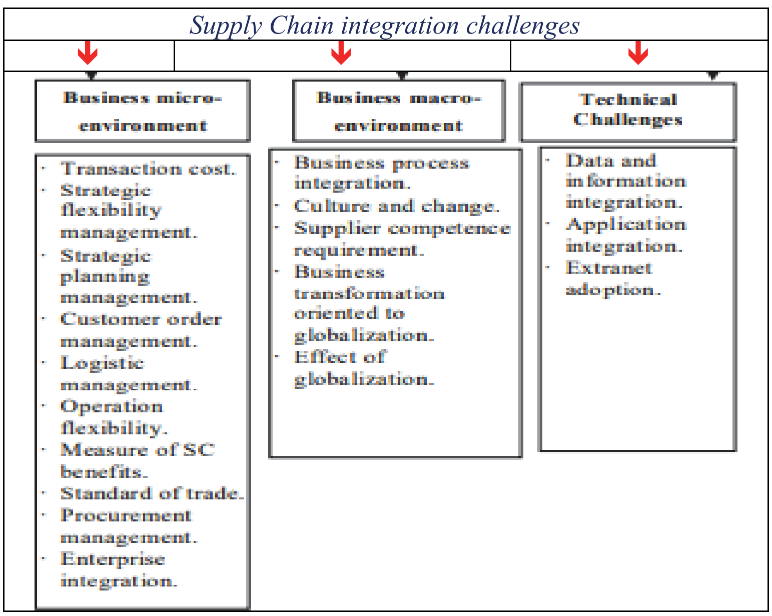
Figure 4.2. The internal (micro) supply chain integration

buy ⇔ make ⇔ store ⇔ move ⇔ sell

Source: Sweeney 2011, p. 40.

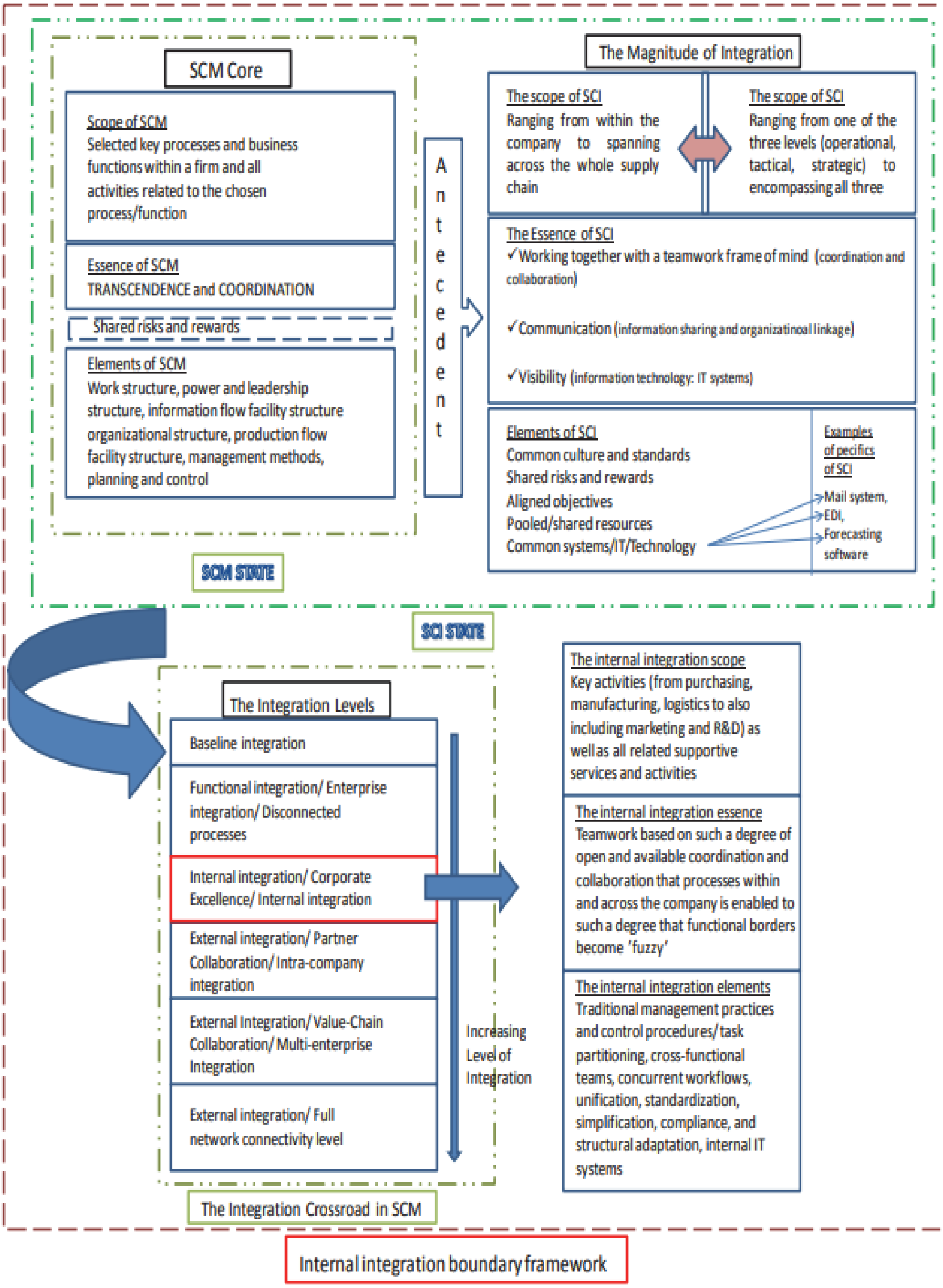
Our goal in this research is to integrate all challenges in a single comprehensive source and then classify these challenges in three main parts that deal with all previous perspectives and includes all the available supply chain challenges, our classification will be in three parts; first: the Business Micro-environmental challenges, second: the Business Macro-environmental challenges (relationships), and third: The Technical challenges of Supply Chain integration. Table 4. 1 presents our classification for the challenges.

Table 4.1. Classification of SC integration Challenges



Source: Awad and Nassar, 2010, p. 53.

Figure 4.2.1. The boundary framework of internal integration

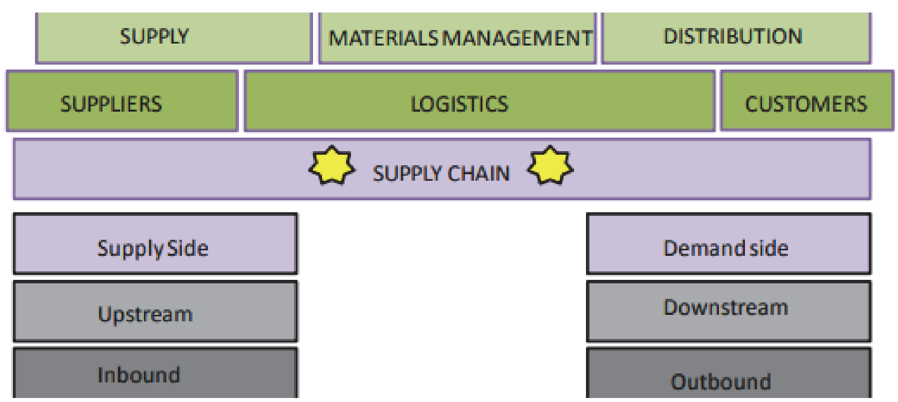


Source: Toivo, 2009, p. 101

And with that the boundary framework of internal integration can be completed, as seen in figure 4.2.1. As can be seen in figure 4.2.1. internal integration is made up by more than just its own state. It also holds characteristics of SCM and SCI, which combined with its unique integration state, gives it a boundary that not only reflects the levels and degrees of possible integration, but highlights the difficulty of equivocality in supply chain management today. Looking at this indicative boundary framework internal integration becomes somewhat untangled from the concept of collaboration and coordination.

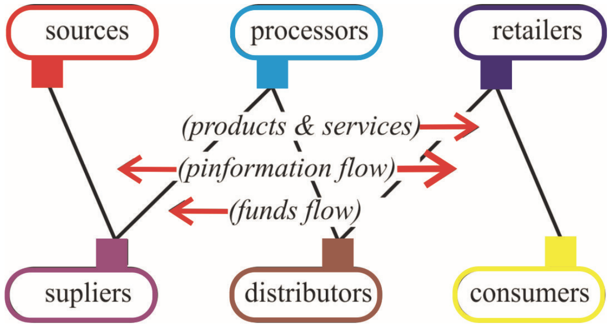
Rushton et al. (2006, p. 7) believe there is a difference between logistics and supply chains, this difference being shown in the figure below. In words, the clear delineation of logistics from SCM is missing, as logistics is stated as being supply, materials management, and distribution. It concerns physical and infor-mation flows just like SCM, but is distinguished from SCM by logistics partners being seen as fragmented units, rather than one whole chain; focusing on operational systems rather than strategic planning processes; dealing with inventory in very different ways, and the acting in isolation for each of the components where SCM focuses on using integrated information systems suspended throughout the entire supply chain. The simplistic representation in Figure 4.2.2 of the external (or macro - or inter-firm) supply chain shows materials flowing from the raw material source through the various stages in the chain to the final consumer. Money (i.e. funds) then flows back down the chain. The point is that every link matters and that value is added, and profit generated, at each link along the way.

Figure 4.2.2. Logistics and SCM



Source: Rushton et al., 2006, p. 5.

Figure 4.3. The external supply chain integration



Source: Sweeney, 2011, p. 40.

Table 4.2. Supply chain integration dimensions

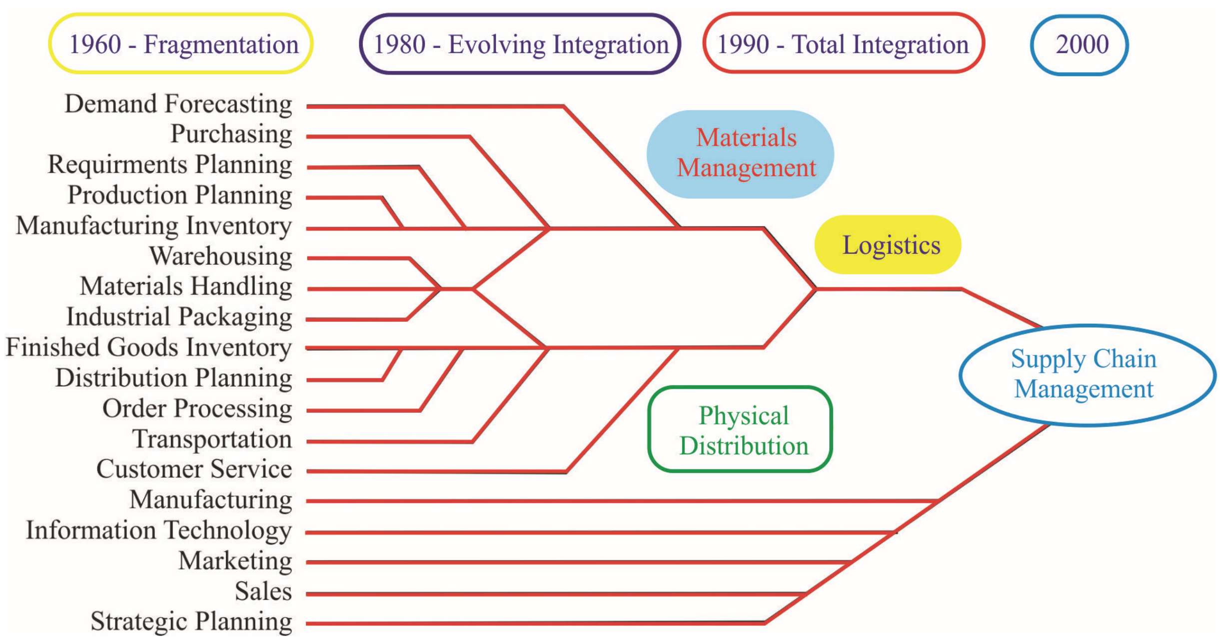
Dimension	*Elements*	*Benefits*
Information Integration	Information sharing & transparency Direct & real-time accessibility	Reduced bullwhip effect Early problem detection Faster response Trust building
Synchronized Planning	Collaborative planning, forecasting & replenishment Joint design	Reduced bullwhip effect Lower cost Optimized capacity utilization Improved service
Workflow Coordination	Coordinated production planning & operations, procurement, order processing, engineering change & design Integrated, automated business processes	Efficiency & accuracy gains Fast response Improved service Earlier time to market Expanded network
New Business Models	Virtual resources Logistics restructuring Mass customization New services Click-and-mortar models	Better asset utilization Higher efficiency Penetrate new markets Create new products

Source: Lee and Whang, 2001, p. 3.

But talking about integration dimensions, Lee and Whang (2001) identify four key dimensions of supply chain integration. The four dimensions increase by degree of integration and coordination. First come information integration, which focuses on data and information that can influence actions and performance of ot-her members in the supply chain (such as demand data, inventory, capacity, schedules and plans, both in realtime and online). The second is called planning synchronization, where the step up in coordination and integration now is expressed through product introduction, forecast, replenishment coordination through joint design and execution. Actions are coordinated through focusing on what is done with the information (such as order fulfillment).

The third dimension is called workflow coordination, which focuses on how to use the information. Workflows are streamlined and automated through the information shared. Examples are procurement and supplier, accuracy, time, and cost. The fourth dimension is known as new business models, where a whole new approach to conducting business is found. This step includes finding new business that previously was unavailable. There is change possibility in roles and responsibilities among the chain partners, such as adopting new products, or mass customization.

Figure 4.4. SCM Evolution



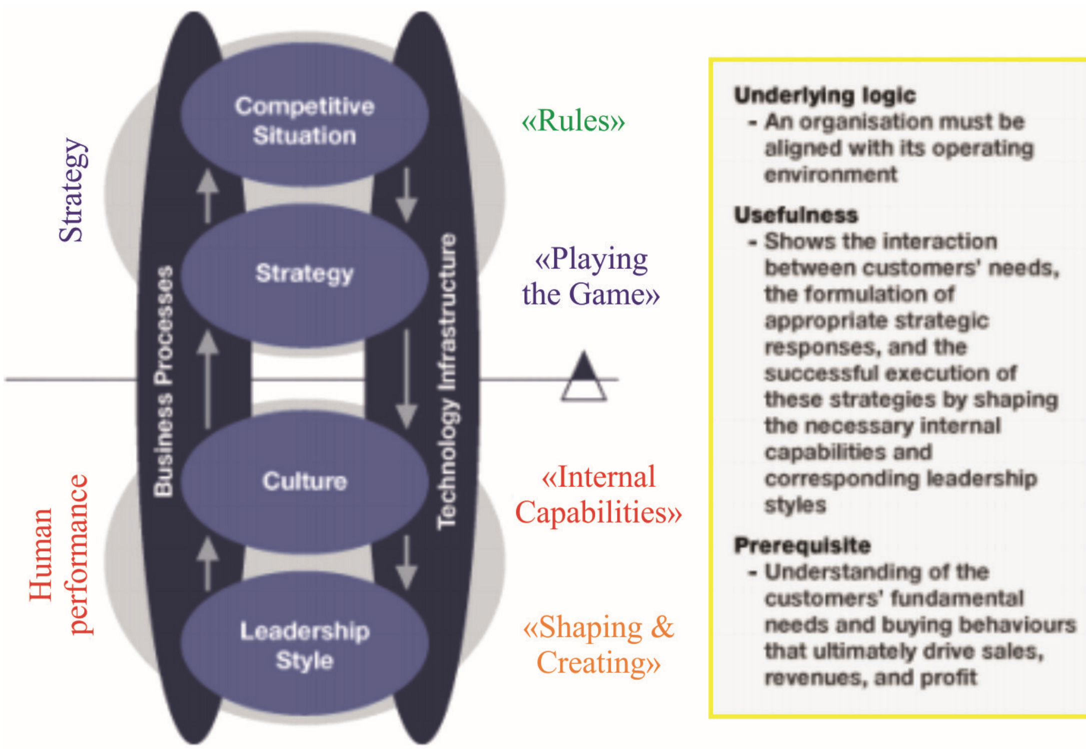
Source: Adapted from Battaglia 1994, p. 49.

Battaglia (1994) developed a model which indicates the way in which SCM has evolved from its main constituent functions from the 1960s to date (see Figure 4.4). It indicates that the evolution has involved a shift from highly fragmented to much more integrated approaches with the 1990s characterised as the decade of "Total Integration". During the 'Evolving Integration' decade (the 1980s) various functional areas became integrated into *materials management* and *physical distribution* – these then became further integrated under the *logistics* umbrella. SCM extends this integration further by linking logistics with manufacturing, information technology (IT), marketing, sales and strategic planning. The model provides a useful visual representation of the way in which companies have attempted to move away from the functional stovepipe or silo approach to more integrated approaches, facilitated by IT. It is interesting to note that this model is analogous to two other 'three phase' approaches to logistics evolution.

Graphical representation of Gattorna's 'Strategic Alignment Model' is shown in Figure 4.4.1. (Gattorna et al., 2003). He argues that empirical evidence is mounting to suggest that if organisations are to achieve sustained high levels of financial and operating performance, the four elements shown in the diagram must be dynamically aligned. Alignment in this context means:

- An understanding of customers' buying behaviour;
- Corresponding value propositions to align with the dominant buying behaviours;
- The appropriate capabilities (or cultural capability) embedded in the organisation to underpin the delivery of these specific value propositions; and,
- A composite leadership style at the executive level to ensure the appropriate subcultures are in place as required.

Figure 4.4.1. The strategic alignment model



4.2 SCM Frameworks

SCM frameworks should serve as a point of reference for researchers and managers. In our review, we include four frameworks: the Supply Chain Operations Reference (SCOR) model, the Global Supply Chain Forum (GSCF) framework, the Collaborative Planning, Forecasting, and Replenishment (CPFR) tool and a framework developed by Mentzer et al. (2001). In a previous article, Lambert et al. (2005) reviewed five SCM frameworks. In our review, we include three of the same frameworks, although we do expand our discussion of one of them (the Mentzer framework – Figure 4.1). We also exclude two frameworks due to lack of significant detailed level description (frameworks by Srivastava et al. 1999 and by Bowersox et al. 1999). On the other hand, we added one more framework/tool - the *Collaborative Planning, Forecasting, and Replenishment* (CPFR) tool. In the following sections we describe each of the four frameworks (cited and adapted from: Naslund and Williamson, 2010, p. 14).

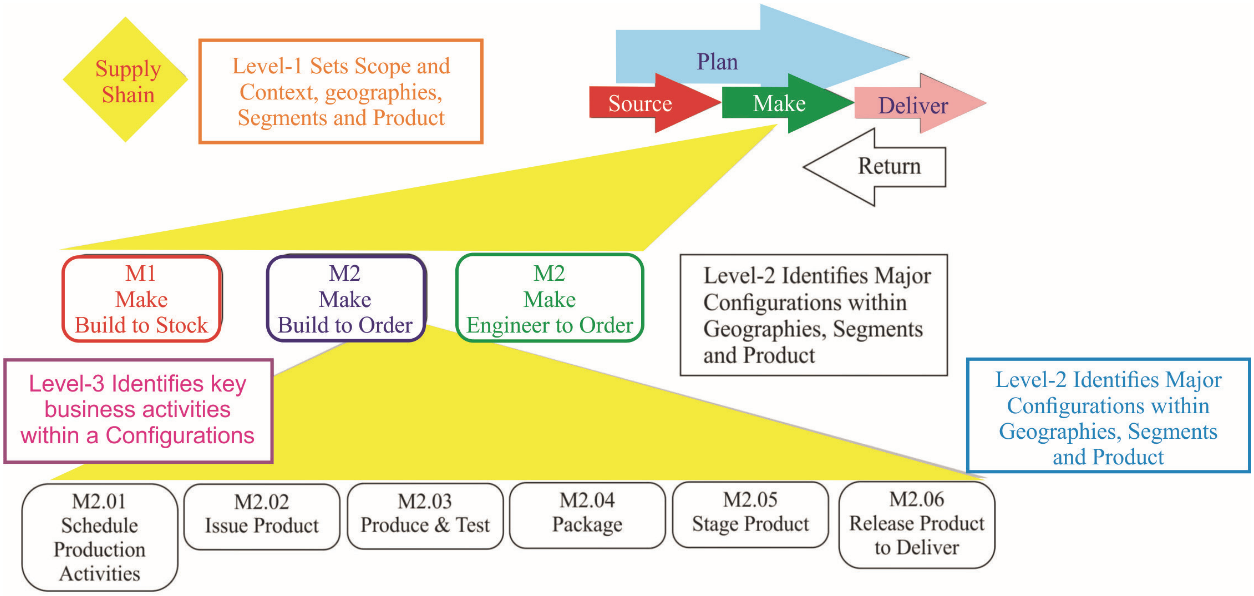
The *Supply Chain Operations Reference* (SCOR) model, developed by the Supply Chain Council (SCC) and AMR Research in 1996 is the most commonly cited SCM framework (Lochamy and McCormack, 2004). SCC describes itself as "*an independent, not-for-profit, global corporation with membership open to all companies and organizations interested in applying and advancing the state-of- the-art in supply chain management systems and practices. The SCOR-model captures the Council's consensus view of supply chain management*." (www.supply-chain.org).

The SCOR model *"provides a unique framework that links business processes, metrics, bestpractices and technology features into a unified structure to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities*" (Supply Chain Council, 2009). According to the SCC, SCOR is used to identify, measure, reorganize and improve supply chain processes through a cyclical process that includes (Ibid., p. 14):

- Capturing the configuration of a supply chain,
- Measuring the performance of the supply chain and comparing against internal, external industry goals, and
- Realigning supply chain processes and best practices to fulfill unachieved or changing business objectives

Through the completion of the steps outlined above, the SCOR model (Figure 4.5) aims to integrate well-known concepts such as business process reengineering, benchmarking, and process measurement into a cross- functional framework (Huan et al., 2004). When originally developed in 1996, four core business processes - plan, source, make, and deliver - served as the foundation of the SCOR model. Later, in 2001, a fifth process - return - was added to enhance the validity of the model. Each of these processes is implemented through four individual levels. The first level defines the scope and content of the model itself, as well as specifying basis for competition performance targets. At level two, companies implement their operations strategies dependent upon the configurations they choose for their supply chains.

Figure 4.5. The SCOR Model



Source: Naslund and Williamson, 2010, p. 15.

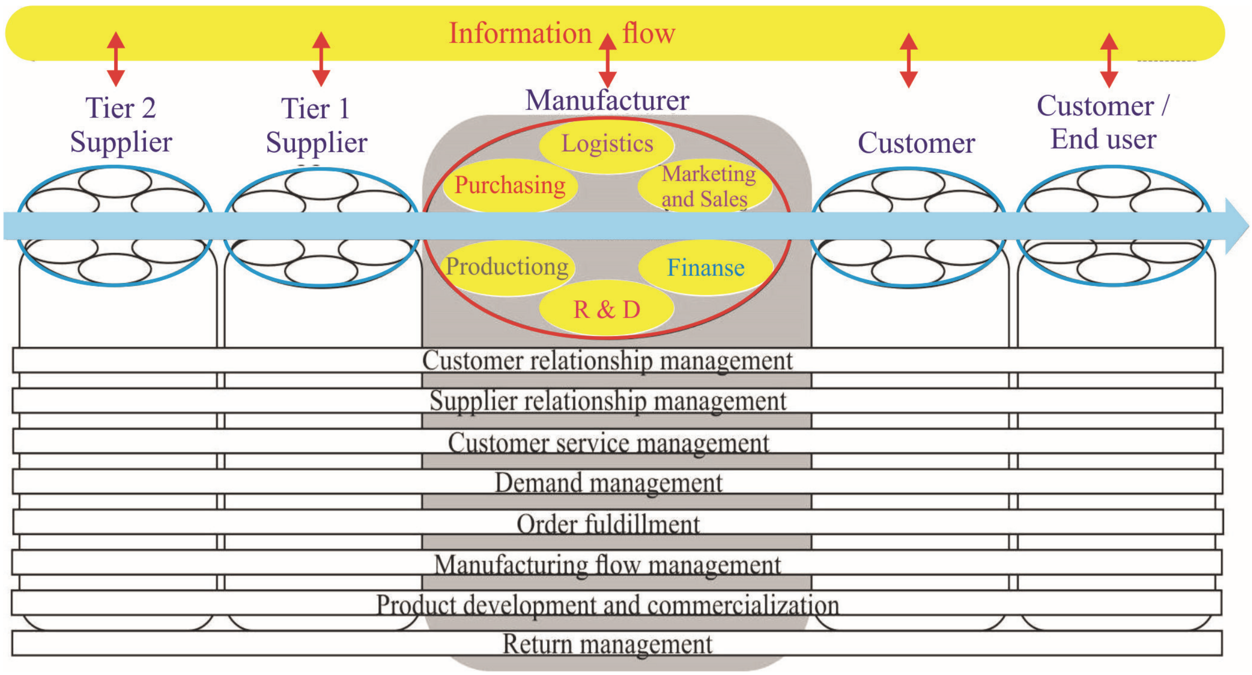
Level three defines inputs, outputs, and flows of each transactional element, and finally, level four defines the implementation of specific supply chain management practices (Lockamy and McCormack, 2004). The source, make, and deliver processes of the SCOR model create a continuous chain of activity throughout a company's internal operations and, potentially, across the whole inter-organizational supply chain.

One also could argue that the framework includes a high level planning process, which balances aggregate demand and supply to develop a course of action that best meets the requirements of the source, make, and deliver processes (Lambert et al., 2005).

The second most popular framework is developed by the Global Supply Chain Forum (GSCF) (Lambert et al. 1998). The GSCF framework (Figure 4.6) identifies eight key processes that form the foundation for supply chain management (see Figure 2 based on Lambert 2008). Common definition and shared understanding of processes is thus of significant importance (Croxton et al., 2001).

The eight key business processes are; *Customer Relationship Management, Customer Service Management, Demand Management, Order Fulfillment, Manufacturing Flow Management, Supplier Relationship Management, Product Development and Commercialization and Return Management* (Cooper et al., 1997).

Figure 4.6. Global Supply Chain Forum Model



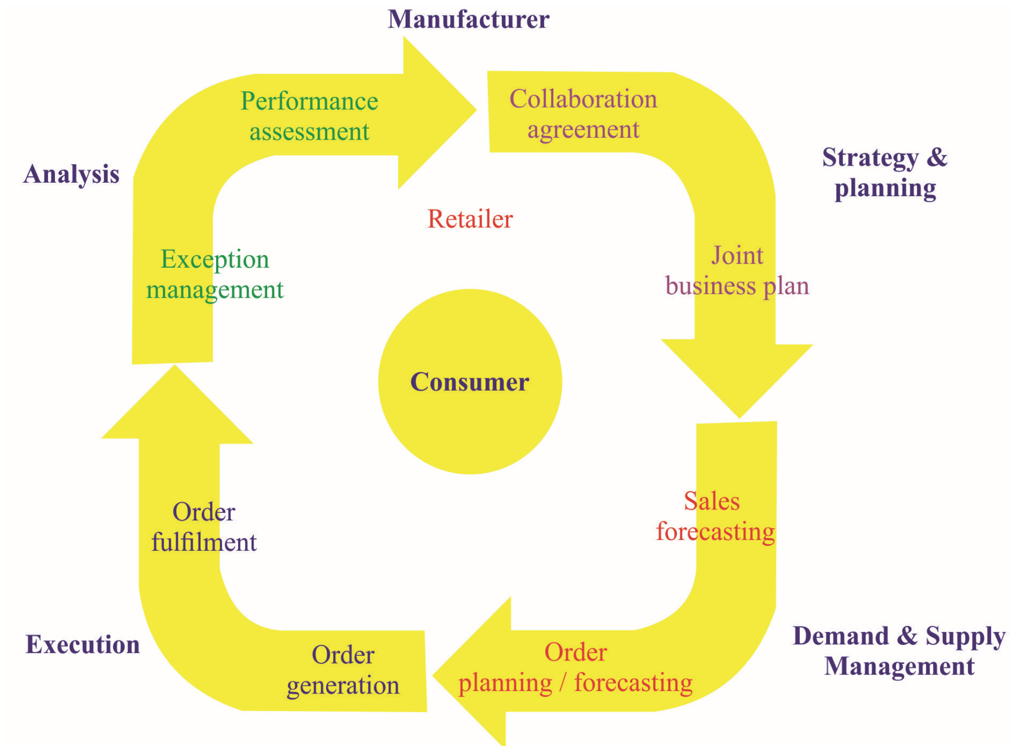
Source: Naslund and Williamson, 2010, p. 16.

Each process runs cross-functionally, cutting through functional silos within each organization. Functional silos are defined, for example, as marketing, research and development, finance, production, purchasing, and logistics. Each process is furthermore broken down into a series of strategic subprocesses, thus providing the blueprint for implementation of the framework (Lambert et al., 2005).

Of the eight processes, customer relationship management and supplier relationship management provide a crucial link to external companies within the chain. Although the processes should be considered by all companies in each supply chain, the significance of each process may differ (Croxton et al., 2001). Some companies may need to link just one key process while for other companies it is appropriate to link multiple processes. It is thus crucial to analyze which key processes to integrate and manage in each specific case (Cooper et al., 1997) – cited from: Ibid., p. 15.

Another framework, or rather a conceptual tool, is the *Collaborative Planning, Forecasting, and Replenishment* (CPFR) method (Figure 4.7). CPFR is described as a web-based format created to coordinate various activities between supply chain trading partners, such as production and purchase planning, demand forecasting, and inventory replenishment. In 1998 the Voluntary Inter-Industry Commerce Standards Association (VICS) established a committee to identify best practices and create design guidelines to be applied to CPFR.

Figure 4.7. Collaborative Planning, Forecasting, and Replenishment

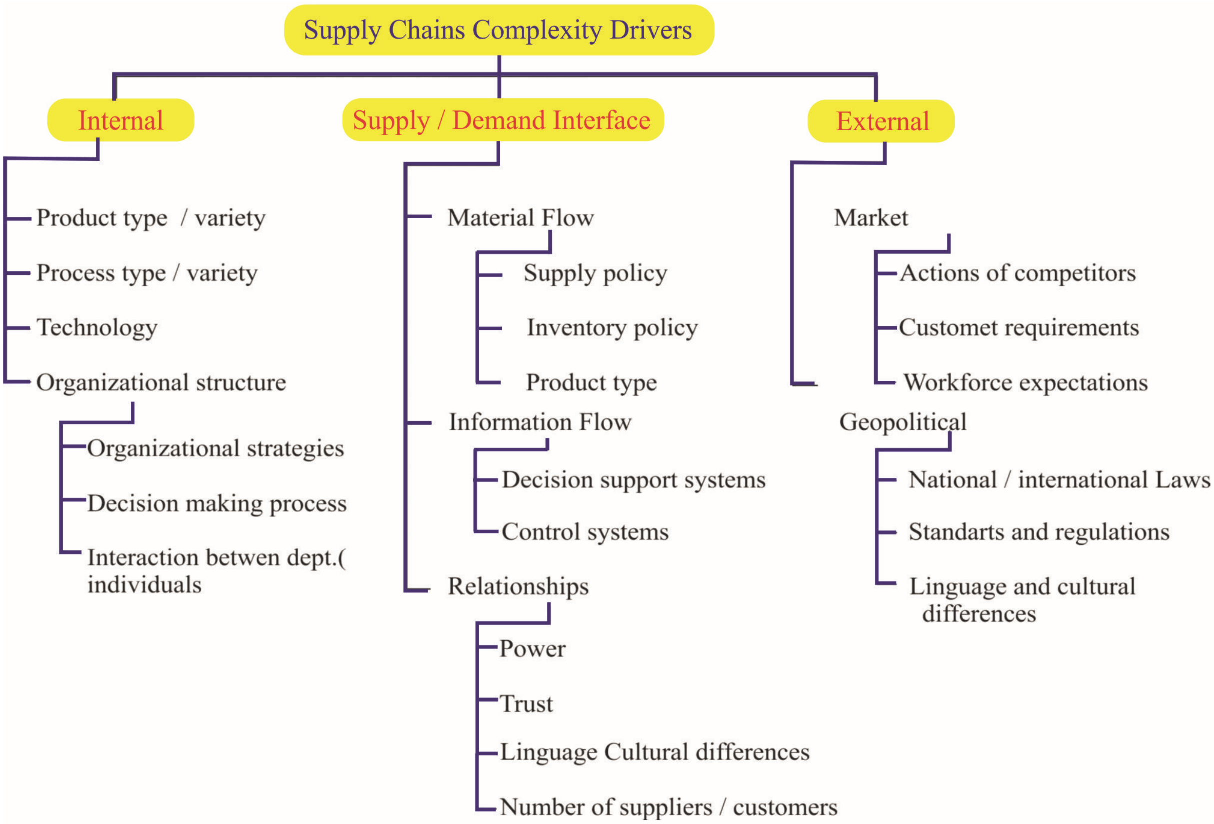


Source: Naslund and Williamson, 2010, p. 16.

Supply chain (SC) is a complex network of business entities involved in the upstream and downstream flows of products and/or services, along with the related finances and information. SCM is the systemic and strategic coordination of these flows within and across companies in the SC with the aim of reducing costs, improving customer satisfaction and gaining competitive advantage for both independent companies and the SC as a whole. The complexity is inherent in the SC, in form of static complexity that is related to the connectivity and structure of the subsystems involved in the SC (e.g. companies, business functions and processes) and dynamic complexity that results from the operational behaviour of the system and its environment. The complex nature of SC adds to difficulty of managing the SC so that it becomes almost common sense to say SCM is about managing the complexity inherent in the SC (Serdar-Asan, 2012 , p. 792).

In figure 4.8 reviews the typical complexity drivers that are faced in dif-ferent types of supply chains and presents the complexity driver and solution strategy pairings, in the form of a matrix, extracted from real-life supply chain situa-tions gathered from multiple existing sources; such as reports, archives, observations, interviews. The decision matrix of complexity management approaches would assist decision-makers in formulating appropriate strategies to deal with complexity in their supply chains.

Figure 4.8. Classification of supply chain complexity drivers according to their origin



Source: Serdar-Asan, S. (2012

Another classification of drivers is according to their origin*:* internal, supply/ demand interface, and external/environmental drivers. Internal drivers are generated by decisions and factors within the organization such as the product and processes design. These drivers are relatively easier to leverage since they remain within the span of control. Drivers generated within supply and/or demand interface (in cooperation with suppliers /customers) are related to the material and information flows between suppliers, customers and/or service providers. These drivers are somewhat manageable since they remain within the span of influence and the level of coordination between SC partners plays a significant role when dealing with these drivers. Thus, power and trust mechanisms that affect the nature of supplier / customer relations are also important factors which need to be considered as complexity drivers. External drivers are generated through mechanisms that the company has little if any control over such as market trends, regulations and other various environmental factors.

Figure 4.8 illustrates complexity drivers according to their origin. Different approaches may be adopted to cope with the complexity drivers (e.g., for the internal-static drivers approaches may be: product modularization, reducing the product variety, mass customization, business process reengineering). Decisions targeting any of the drivers may have a positive or negative effect on another driver which then would shift complexity of the SC from one driver.

4.3 The Importance of Logistics Integration in Seaports

According to Sergeyev (2005, p. 49), an integrated logistics chain of the seaport in practice must be line edited for easier accounting and cost analysis, resource optimization, rational decision-making, more appropriate allocation of risks and benefits, faster and more complete information of all companies and better organization of monitoring of meeting the logistics plan.

Management of the logistics services chain in the seaport, as shown in the Table 4.1, represents the integration of the key logistics trends and operations. It includes:

- all key seaport logistics activities, which focus on physical movement of cargo in the port, the corresponding providing of port logistics services and their delivery to users,
- all providers of port services and
- all logistics port operators, which integrate their logistics performance in increasing the added value for final beneficiaries
- all final beneficiaries of logistics and port services and
- all logistics flows.

According to the theoretical concept of Mentzer et al. (2001, p. 18) and the practice of advanced seaports, the above integration is made, of systematic and strategic coordination of all logistics flows, activities and subjects aiming to improve their logistics and overall port service activities. It includes many port processes of transport, handling, storage, receipt and delivery of cargo, and performing a variety of logistics services to customers in the sea port by the port management, port agents and port operators. This includes the overall management of logistics with the logistics administration and information.

M. Draskovic (2011, p. 35) points out that the essence of integrated logistics in the maritime ports consist of synchronous execution of all logistics activities and the timely implementation of agreed logistic port services in a particular place, with a minimum total logistics costs, allowing the creation of added value. Minimizing total logistics costs can be achieved by adding certain logistical value to incoming cargo, which may be achieved in any of the following methods (Schroeder and Flynn 2001, p. 12): through a change that alters the structure of cargo in the port, transport, storage and additional terms of delivery.

Table 4.2.1 Matrix of logistics supply chain management based on the integration of logistics activities in seaports

Suppliers of port logistics services of different levels			*Port logistics providers*			*Users of logistics and port services at different levels*		
⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳
⇔	*Material flows*							⇔
⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳
⇔	*Information flows*							⇔
⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳
⇔	*Financial flows*							⇔
⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳	⇳
Core logistic activities of the seaport								

Source: Adapted from Stok and Lambert 2001, p. 52.

According to M. Draskovic (Ibid.), the importance of integrated logistics is multifaceted. It acts as a third subsystem of the logistics system[1], which is focused on the movement and storage of cargo in the port from unloading time to time of loading to the final consumer. Further, it seeks to overcome a variety of spatial and temporal inconsistencies and limitations, while reducing the number of intermediaries. In addition to *transportation* (to and from the Port) and *storage*, which are the two basic functions of integrated logistics, the seaports are trying to integrate as many other logistics activities such as handling, cargo handling, packaging, inspection, measurement, documentation creation, information and financial flows and others.

The formation of an integrated logistics system is a raising issue of development of sea ports. In this sense, according to (Roca, 2004, p. 27), the dynamics of development continually sets new demands on the integrated logistics system, which therefore must be very flexible and adaptable to growing changes in the environment in many segments, especially in the market, technological and transport segment. For evaluation of the effectiveness of the above mentioned system, a very important criterion is the reduction of the total logistics costs, which are directly related to service delivery in the seaports, logistical risks, the time of delivery of orders and increase of quality of logistics services. The essence of logistics integration in maritime ports has its own logic, to which each functional area should contribute to the overall maximum score that enhances the competence of the port logistics.

This entails overcoming local thinking and isolated ambitions of functional parts of seaports, which must necessarily be subordinated to the integrated inter-functional logistics coordination, in which all the links (from input to output) are equally significant for the total

[1] The first subsystem is a physical supply of production (transport of raw materials and other material) and the other is the internal movement of raw materials and finished products in the company.

score. The advantages of an integrated approach to logistics in maritime ports shall be provided through the following (adapted from: Sergeev, 2005, p. 77):

- unification and centralization of basic functional areas of logistics,
- overcoming the contradictions between the production, management and marketing,
- forming a unified, modern efficient information system,
- higher level of typization and compliance of logistics operations,
- increase of a general sense of responsibility within a single target logistic function - to create additional value, and
- increasing ' degree of inter-functional and inter-organizational coordination.

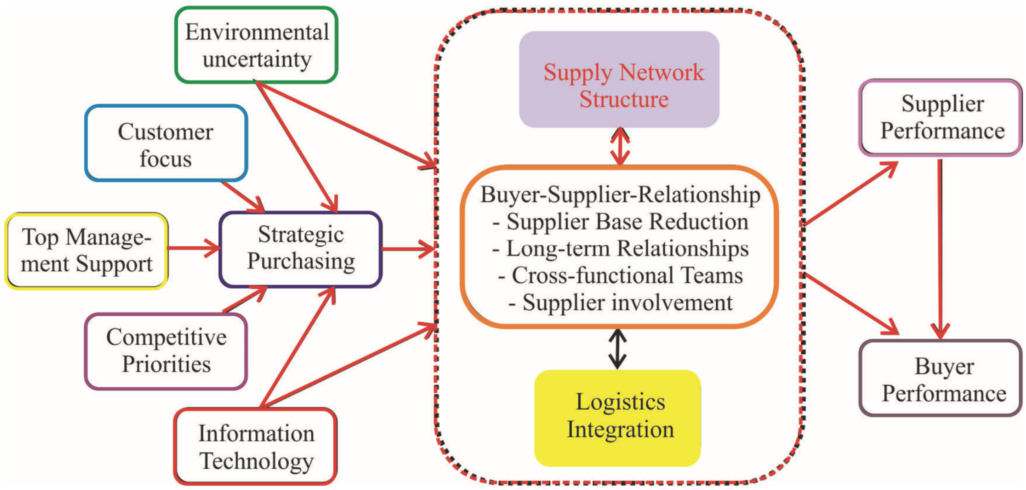
Lambert, Stock and Ellram (1998) find that all firms within the supply chain must overcome their own frameworks and adopt the principles of procedural organization of various logistics functions of supply. Relationships in the supply chain are long and involve significant strategic coordination. They start from the assumption of specific development of business co-operation, communication and partnerships, resulting in specific beneficial effects of the SCM concept. The basic prerequisites are a willingness of all participants in the supply chain for joint action, trust, commitment to complete tasks, inter-dependence, organizational compatibility, shared vision, participation in key processes, accepting joint leadership and management support.

They are necessary for integration and successful implementation of systematic, strategic and procedural approach. Their fulfilled provides numerous benefits that can be divided into two levels. The first level contains the exchange of information, sharing risks and rewards, cooperation, integration of key processes, longevity and stability of business relationships and quality cross functional coordination. The other level contains lower prices, greater customer value and satisfaction for customers, as well as the creation of lasting and sustainable competitive advantage.

Chen and Paulraj (2004) developed their prominent research framework of SCM as a response to various calls for theory building in operations management. They consolidate and integrate relevant findings of various previous works into a research framework (see Figure 4.9), emphasizing the interdependence of relationships within a supply chain and hence the need of aiming for collaborative advantage.

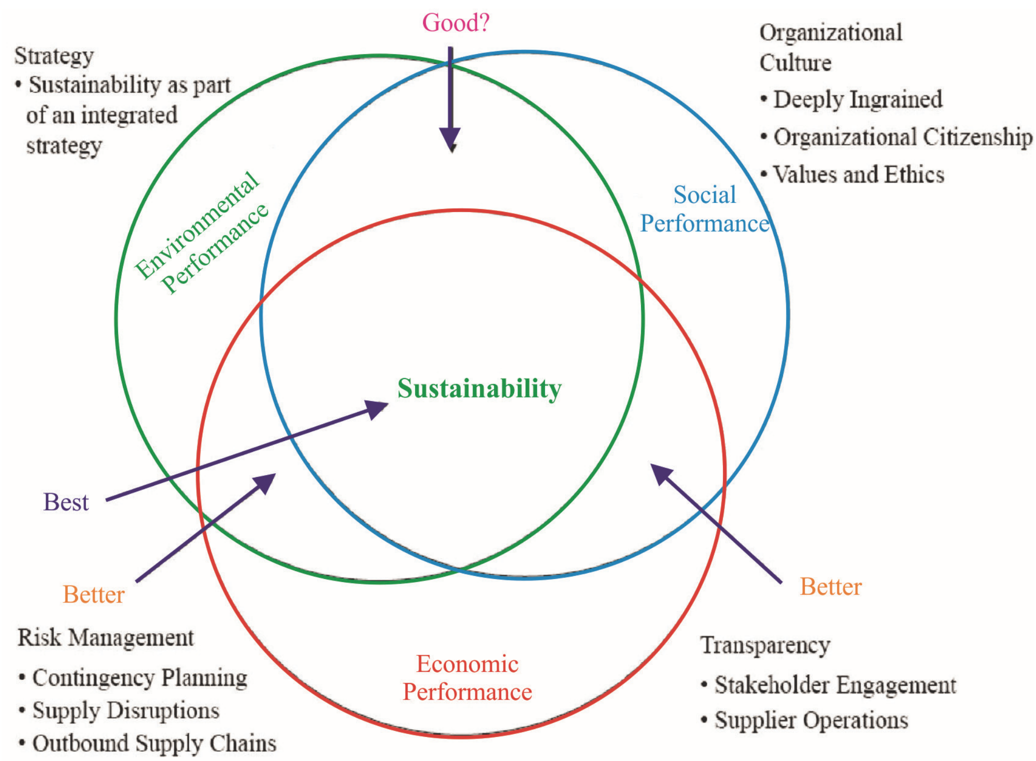
Carter and Rogers (2008, p. 368) identify four facets supporting the performance on the triple bottom line by means of a review of sustainability literature: risk management, transparency, strategy, and organizational culture (see Figure 4.10). On this basis, the authors define SSCM: "*as the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains*".

Figure 4.9. A research framework of supply chain management



Source: Adapted from Chen and Paulraj, 2004, p. 121.]

Figure 4.10. Sustainable supply chain management



Sources: Carter & Rogers, 2008, p. 369; Naslund and Williamson, 2010, p. 16.

From the point of introduction of integrated logistics and global logistics operators in seaports, descriptive definition of SCM management across its five core components is relevant (Cohen and Roussel, 2005, pp. 10-19): operational strategy, outsourcing strategy, the choice of marketing channels, strategy of consumer service and asset management (equipment selection, location, etc.).

Our final definition is provided by Stock and Boyer (2009, p. 706). Their definition is based on a synthesis of a wide range of suggestions provided by a variety of practitioner, academic and hybrid sources. They deconstructed the commonalities in all the reviewed suggestions in order to develop their definition of SCM as: "*The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction*".

4.4 Supply Chain Integration and Evolution of Port

Researches carried out by UNCTAD in 1992. have shown that there are three generations in the development of sea ports and that their evolution went through a fundamental transformation: from providing traditional services to value-added logistics services . According to the modern concepts, there are three stages of port development, which are determined by port development policy and strategy, differences in the method of approach, scope of the port's activity and expansion level, and the port's activity integration level (Table 4.3).

First generation port. Until 1960, ports played a simple role as the junction between sea and inland transportation systems. At that time, the main activities in the port region were cargo handling and cargo storage, leaving other activities extremely unrepresented. Such a way of thinking severely influenced related persons in the government and local administration. Also, it even influenced persons related with the port industry, so it was considered that it was enough to develop and invest in only port facilities, as the main functions of the port were cargo handling, storage and navigation assistance. It was for these reasons that important changes in transportation technology were neglected.

The second-generation ports. The second-generation ports are those built between 1960 and 1980, and had a system comprising of government and port authority, so the port service providers could understand each other and cooperate for mutual interests. The activities in these ports were expanded ranging from packaging, labeling to physical distribution. A variety of enterprises have also been founded in ports and hinterlands. Compared to first-generation ports, the second- generation ports have a characteristic that freight forwarders and cargo owners had a tighter relationship. We can say that the second-generation ports had begun to notice the needs customers, but when it came to keeping a long-term relationship with customers, they took a passive attitude.

The third-generation ports. From 1980, container transportation has been developed quickly, and the new intermodal transport system emerged. The activities of production and transportation have linkage to form an international network. The former services function has been enlarged to include logistics and distribution services. The environment protection facilities are becoming more important, so the ports are developing closer relationships with those in their surrounding neighborhoods. Compared to the past, today's port authorities are focusing on efficiency rather than effectiveness. In the third-generation ports, the needs of customers were analyzed in detail and port marketing has been actively engaged (UNCTAD 1992, p. 20).

Nowadays the contest in the efficiency of providing basic port services is no longer possible. Hence the necessity of seaports to look for new ways of achieving competitiveness. Users of port services are increasingly demanding. Providing value-added logistic services has become a powerful way for seaports to build a sustainable competitive advantage. Customers now demand that logistics value added services become an integral part of the overall port services. This creates a big challenge for logistics management of the port. Modern development of sea ports is based on the *Core SCM model*, which includes coordination, collaboration and integration as a major strategic component having in its environment the competitive priorities, supply chain structure, physical and technical infrastructure, e-business, location, and facilities.

These days, the commercial success of a port could stem from a productivity advantage in traditional cargo-handling service, from value-added service, or from a combination of the two. Productivity advantages come mainly from economies of scale and economies of scope, suggesting that the most productive ports will be those that are equipped to handle large cargo volumes and/or significantly reduce unit costs through efficient management. Shippers and carriers select individual ports not only based on their cargo handling service capabilities, but also on the benefits they are capable of "delivering". Unless a port can deliver benefits that are superior to those provided by its competitors in a functional aspect, port customers are likely to select ports based merely on price. This fact raises the question of how a port can achieve value differentiation.

In the 1970s, almost every port provided the same basic package of services to almost every customer. Nowadays, however, it is more difficult for ports to compete on the basis of cargo-handling service. There has been a convergence of technology within cargo-handling service categories. This means that though new technology may sometimes provide a window of opportunity for productivity improvement, in many cases that same technology is also available to competitors. It is no longer possible to compete effectively on the basis of basic, traditional functions. Thus, there is a need for ports to seek out new means of gaining a competitive edge.

Table 4.3. Evolution of port function

	First generation	*Second generation*	*Third generation*
Start period	*Before 1960s*	*After 1960s*	*After 1980s*
Principal cargo	Conventional cargo	Conventional cargo and bulk cargo	Bulk and unit cargo containerization
The port development position and development strategy	Conservative function point of the sea and inland transportation	Expansionism transportation and production centre	Industrial principle international trade base chain connecting transportation system
Activity scope	(1) Cargo handling, storage, navigation assistancepier and	(1) + (2) Cargo type change (distribution processing), ship related industry - enlargement of port regions	(1)+(2) + (1) Cargo information, cargo distribution, logistics activity - Formation of the terminal and distribution centres
Structure formation and specifics	- Everybody acts individually in the port - Port and its users maintain informal relations.	- Relations between port and its users become more close - Emergence of the slight correlation among port activities - Negative cooperation relations between port and self-governing community	- Formation of the port cooperation system - Trade and transportation chain concentration in the port - Relations between port and self-governing community become more closer - Extension of the port structure
Character of the produc-tivity	- Invention of the cargo distribution - Individual supply of the simple services -Low value added	- Invention of the cargo distribution - Cargo processing - Complex services - Increase of the value added	- The flow of the cargo and information - Distribution of the cargo and information - Combination of the diversified services and distribution - Value added
Core factors	Labour/capital	Capital	Technology and know-how

Source: Modified from UNCTAD, 1992.

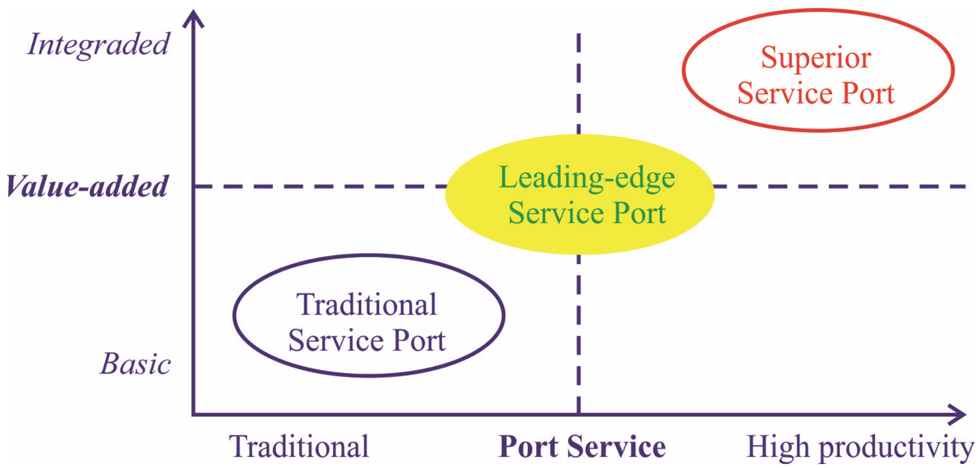
Table 4.3.1. Characteristics of seaports of the first, second and third generation

	I generation	II generation	I II generation
Limit dates	Until 1960;	After 1960	After 1980
Dominant factors	Labor and capital	Capital	Capital. Technology and know-how
Dominant tape of cargo	Dry bulk cargo, Other cargo nes,	Dry and liquid bulk cargo, Other cargo nes,	Dry and liquid bulk cargo, Large containers Ro-ro mobile
Main objective function	Transport	Transport, Industrial, Commercial	Transport, Logistics & distribution
The basic role of the port	Transport hub / note	Transport-industrial complex connected to commercial center	Distribution center / Logistics center / Logistics platform, Information center
Strategy	Conservative	Expansive	Market
Basic principle of the strategy	Seaport waiting for cargo	Port acquires areas, and stimulates the development of the port industry, thus obtains loads	Port co-creates supply chains
Range of service	Handling and storage services for the cargo. Simple administrative services, manipulation and control for cargo	Handling and storage services for the cargo. Processing and production of goods Complex administrative services, manipulation and control for cargo	Handling and storage services for the cargo. Distribution cargo Logistics services for cargo Gathering and processing of information Organization chain supply
VAL	Low	Higher	High
Operating principles the port environment (internal environment harbor)	Atomization Informal relationships with port users	There are no permanent links between deferent sectors port A close relationships with port users Ad hoc relationships with city	Unity of action sphere of operation Integration of organizational or capital sea port companies with its users Close relationship with the port city and region

Source: Montwiłł, 2014, p. 259.

The late 1980s saw the emergence of major changes. Customers began to ask ports to provide a greater variety of services. Providing value-added services is a powerful way for ports to build a sustainable competitive advantage. Shippers and port customers are becoming increasingly demanding. Customers now tend to look at value-added logistics services as an integral part of their supply chain. As a result, ports must attempt to satisfy these needs by offering differentiated services. This poses a particular challenge for port management. Studies show that the most successful ports are those that not only have a productivity advantage in cargo-handling services, but that also offer value-added services. Thus, there are several available options for ports to choose from, as shown in the simple matrix in Figure 4.11.

Figure 4.11. Matrix of competitive advantage



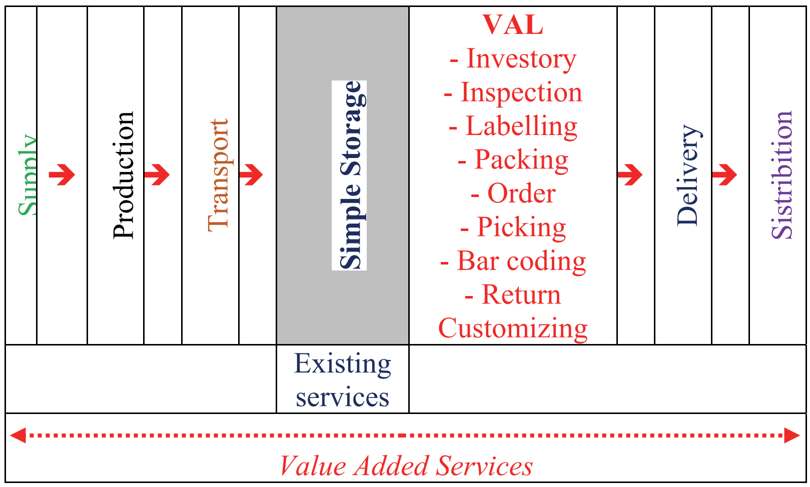
Source*:* UNCTAD, 1992, p. 21.

Sea ports providing traditional services from the lower left corner of the matrix do not differ from their competitors. The only option for them is to be shifted toward the right side of the above matrix, creating the key strengths (competencies) at the level of productivity, or upwards, i.e. by superior logistics services that create added value. In Singapore, which is a leading regional and international logistics facility in Southeast Asia, the logistics industry is developing value-added services as a strategic business sector. Logistics industry participated with 7% of GDP in Singapore in 2000. Year, and employed 5.1% of the workforce. European largest sea port-the port of Rotterdam has been particularly successful in creating a logistics center. Advanced ports around the world constantly emphasize the function of logistics centers, mainly due to high levels of global production and the need for value added logistic services.

Bot logistics companies and shippers agree that value added services in logistics centres are important in supply chain management, and this tendency is expected to continue in the future. Figure 4.12 shows that value-added logistics (VAL) services encompass far more roles and functions than the existing services. In many cases, these services overlap or include third-party services, such as inventory management, inspection, labeling, packing, bar coding, order picking and reverse logistics etc. The pressures of VAL services in the logistics chain have increased the demands of logistics centre behind port areas. The main VAL activities are (Ibid.):

- Receiving goods, breaking shipments, preparing for shipment, returning empty packaging,
- Simple storage, distribution, order picking,
- Countrylizing and customizing, adding parts and manuals,
- Assembly, repair, reverse logistics,
- Quality control, testing of products,
- Installing and instruction, and
- Product training on customer's premises.

Figure 4.12. VAL service of logistics centres in port area



Source: UNCTAD 1992, p. 27.

The advanced ports around the world have continuously emphasized the function of logistics centres mainly due to the high degree of global production and the need for value-added logistics (VAL) services. These trends in international logistics strongly suggest that the trend toward VAL in the ESCAP region is likely to continue into the future. Some ports are already modifying the warehousing function to include the VAL functions when they develop new ports or reshaping existing ports.

Table 4.4. Logistics centres evolution

1960s-1970s	*1980s-early 1990s*	*Mid 1990s -present*
		Materials management
		Distribution Services (national/global)
	Bonding	Import clearance Bonding Inbound transportation
Receiving	Receiving	Receiving
	Cross-docking	Cross Docking
Storage	Storage	Storage Inventory management and control Shipment scheduling
Order processing	Order processing	Orders processing
Reporting	EDI Reporting	EDI Reporting
Picking	Picking	Picking
Order assembly	Order assembly	(Product)subassembly Order assembly
(Re)packaging	(Re)packaging	(Re)packaging
	Stretch-shrink-wrapping	Stretch-shrink-wrapping
Palletizing/ unitizing	Palletizing/unitizing	Palletizing/unitizing
Label/mark/ stencil	Label/mark/stencil	Label/mark/stencil
Shipping	Shipping	Shipping
Documentation	Documentation	Documentation
	Outbound	Outbound transportation
	transportation	Export documentation FTZ operation JIT/ECR/QR services Freight rate negotiation Carriers/route selection Freight claims handling Freight audit/payment Safety audits/reviews Regulatory compliance review Performance measurement Returns from customers Customer invoicing

Source: Bolten, 1997, p. 19.

Logistics centres can be classified into three different categories or generations. It is based on the scope and extension of logistics activities as in table 4.4. Logistics firm in logistics centre behind a port area are able to perform basic value-added service and carry out other value-added logistics services at the same time. That is, logistics centres provide not only traditional activities such as storage, but also value-added logistics services such as labeling, assembly, semi-manufacturing and customizing. Logistics centres combine logistics and industrial activities effectively in major port areas to create country specific and/or customer specific variations or generic products.

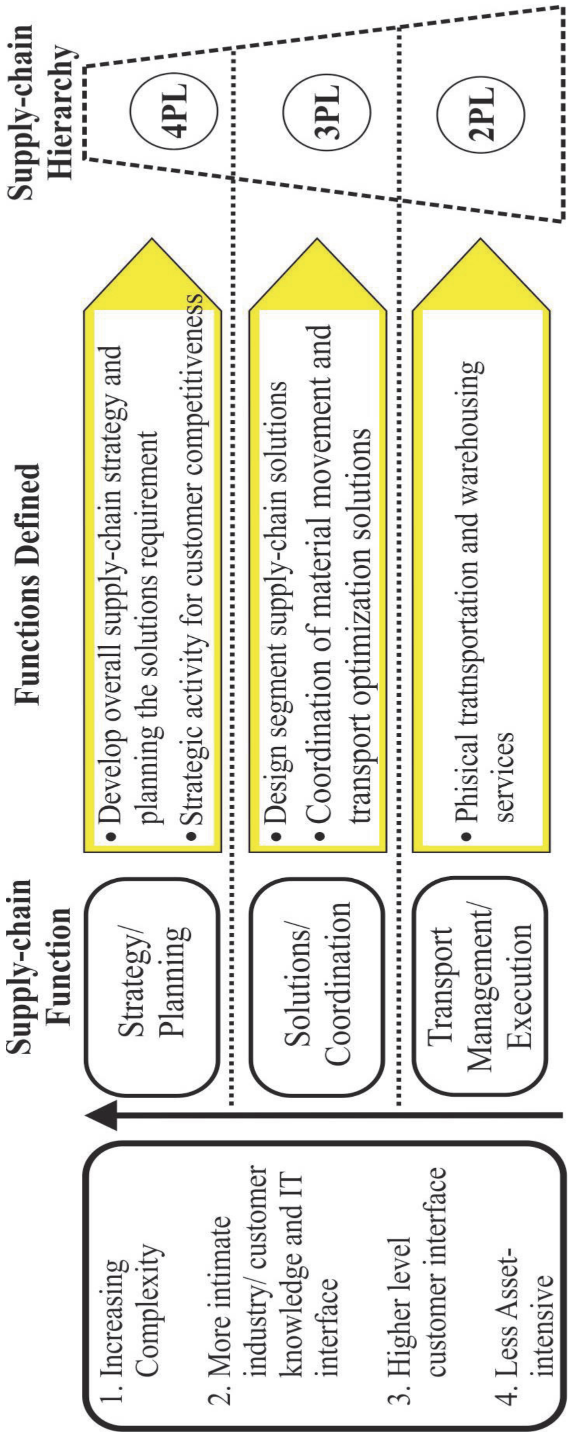
When logistics centres are grouped together in a common dedicated area, it is sometimes called a Distripark (distribution park). Therefore, a Distripark is a large-scale, advanced, value-added logistics complex with comprehensive facilities for distribution operations at a single location, which is connected directly to container terminals and multimodal transport facilities for transit shipment, employing the latest information and telecommunication technology. Rotterdam in the Netherlands, Bremen in Germany, and Singapore are examples of this kind of arrangement. Container ports are generally a preferred choice to set up Distriparks, since they are already closely located to various inland transport facilities and a highly skilled workforce.

Logistics centers are in the advanced ports grouped into “distripark”, which is a large, developed logistics complex, with full equipment for a variety of advanced logistics and distribution activities to individual sites. It is directly linked to the container terminals and multimodal transport equipment for transit. It uses the most advanced information and telecommunications technology.

Multimodal logistics operators are closely connected with the port logistics centers, because they both according to W. Delfmann (www.spl.uni-koeln.de, p. 14), are integrators of resources, skills, competencies, knowledge and technology of various organizations aiming to design, build and implement comprehensive logistics solutions in the supply chain Figure 4.13).

The development of multimodal logistics outsourcing is going towards strengthening provider types 3PL, 4PL and 5PL, whose services include practically the total supply chain.

Figure 4.13. Logistics integrated solutions



Source: www.concorindia.com/upload/news/pic164.pdf, p. 3.

4.5 Analysisi of the Curent Level of Service in the Port of Bar

In terms of assessing the quality of port services Mirotin (2003, p. 49) suggests the use of the following parameters:

- *internal port environment* (equipment, devices, dock transport systems for moving freight, storage, weighing, control systems, enclosures, training, hospitality, correctness and the complaisance of port personnel, the level of information support, etc.),
- *reliability* (execution on time, the absence of risk and user mistrust),
- *the liability* (the guarantee of fulfillment of port services, port staff wishes to assist the service user),
- *completion of services* (competence of port personnel, the existence of the necessary skills and habits),
- *availability* (ease of contacts) and
- *timing, speed and price.*

Marlow and Paixao (2003, p. 195) proposed as additional indicators: *frequency* (the time required for the provision of port services), *flexibility* (adaptability to customer requests for port services), *control* (appropriate information on the status and position of cargo in the port) and *security* (implementation services without any damage or loss of cargo). In addition, the Port practice testifies to the importance of mutual understanding between the port staff and users, the level of operating costs (cost of transport per unit of measure), the level of permeable options, mobility in providing of port transport under different conditions, continuity of port transport (their regularity), guarantee of keeping the cargo subject to port services safe, efficient use of transport vehicles, mechanization and automation of loading and reloading operations, etc..

Looking through the prism of these indicators, as well as the above theoretical approach (in 2), it seems safe to conclude that the current level of quality of port and logistics services in the port of Bar is unsatisfactory. The same can be said for its competitiveness in comparison with Adriatic ports of approximate capacity, particularly in relation to the world average. Comparison with the advanced world sea ports would be devastating according to all parameters. The reasons are numerous, but among economic causes, the lack of investment and high-quality logistics partners are predominant. The total realized turnover of cargo in 2010 amounted to 787 833 tones, of which 36.3% relates to the containers 20 'and 40'.

Montenegro is territorially and economically a significant economic area, which has unused resource and location capabilities. Their proper identification and valorization are the prerequisite for reflection on the above idea of partner logistic cooperation with the port of Koper. It may include expansion of the Free zone of the Port of Bar on the entire territory of Montenegro, which would be the best way to valorize Montenegrin resources, its comparative advantage and priority industries such as tourism, maritime and agriculture.

According to the statements of the management team of the port of Bar, it may receive only a small number of large ocean vessels, i.e. only 40 ships from the planetary fleet of containers of 4722 ships, due to technical limitations on the vertical mechanization of general cargo container terminal. However, there is contrary information in Serbian sources, according to which the port of Bar was made for ships from the Suez Canal, but because of the shallow draft, 70% of these ships can not sail into the port of Bar. In addition, the new investor would have to purchase a new crane for unloading containers from large ships. For all these reasons, it is emphasized that the port of Bar operates with only one half of the projected capacity of five million tons per year.

The process of negotiating with the largest global operators lasts for a long time. Due to the disturbed political relations, through the Port of Bar is transported only 7-8% of goods from Serbia. Until recently it was 20%, and so much more. Balancing of draft depth in the port of Bar to 14 meters would allow acceptance of ships such as “Panamax”. It is not possible to obtain detailed information on the depth measurement of all berths and waters. The fact is that so far not a single "Panamax" has ever entered the Port of Bar.

A brief PEST analysis is as follows:

- **P** - *Political / legal factors*: adopted Law on Ports of Montenegro, the Transport Development Strategy of Montenegro and the EU standards, laws on environmental protection and other;
- **E** - *Economic factors*: the excellent geographic and transport position of the port, global economic crisis, low level of economic development, bad GDP trends, slowed flows of goods in the gravitation field, the port privatization process aimed at giving long-term concessions, a large number of employees, low capacity utilization;
- **S** - *Socio-cultural factors*: still present paternalism among employees, oversized number of employees, a relatively new high level of professional skills of employees, there is a strong motivation of employees to learn and develop professionally;
- **T** - *Technological factors*: there are significant investments in research and development, focus on new technologies, poor technical-technological equipment, a soid representation of modern information technology, insufficiently developed transport infrastructure of the region, there is no integration in more complex systems, flexible organizational structure. The PEST analysis above shows that the Port of Bar has a need and real opportunities for partnership linking with the Port of Koper and integration with a big Chinese investment and global logistics service provider based on the benefits of long-term concessions.

A brief SWOT analysis is as follows:

- *Threats*: strained political relationships in the region, global economic crisis, the decline of direct foreign investments, lack of interest by investors;
- *Opportunities*: a clear development strategy, qualified and skilled workforce, a modern information system, great experience and tradition, the possibilities for

market expansion and the range of port and logistics services, desire for integration, absence of the possibility of new competition appearance;

- *Weaknesses*: lack of competence, unexploited competitive advantages, lack of investments, poor reputation among the users, the lack of brand and market leadership, average management, lack of protection from competition, outdated equip-ment and technology, low productivity;
- *Strengths*: favourable maritime-geographic location, proximity to the existing transport corridors in Central Europe, great capacity of loa-ding operations, a large storage area for goods and distribution centres, favourable transit fees, years-long solid business, openness for partnership cooperation and provision of long-term concessions. The above SWOT analysis shows that the port of Bar needs to focus on the improvement of overall business performance and creation of new concepts for new and successful strategy. Depending on the combination of internal and external factors, in the future, it is possible to identify several types of strategy, but it is certain that the Port of Bar (in the case of partnership cooperation with the Port of Koper and finding a strategic investors and global provider)will choose a maxi-maxi strategy.

The partners and banks of Italy are seriously interested in a strategic partnership with the Port of Bar, because this is the best link with Romania and Russia, as an important foreign trade partner. The lack of highway, modernized railroad and the lack of connection to the Pan-European network puts the Port of Bar in a second-rate position. The aged machinery and its low capacity, partial dilapidation and undeveloped infrastructure (banks, draught, internal roads) directly affect the poor business. All this speaks for the urgent need for a partnership linking and integration of the Port of Bar with some of the major Chinese investors.

The question is: are there realistic possibilities for this? Instead of a positive response, we will offer the following facts. Container mother ships from Asia more and more frequently stop in the Mediterranean hubs. Shippers have found that the freight, as well as the duration of the round trip from Asia to the Mediterranean ports, instead of the ports in the North Sea, may be reduced for 1/3. This is important in terms of cost per day trip of a modern container ship. The product of such decision is the opening of more container hubs in the Mediterranean, the most important of which are Piraeus, Malta and Gioia Tauro. The relocation of production requiring a great workforce from Western Europe and the Middle East to South East Europe is also a realistic opportunity. Great liner shipping companies are trying to ensure their market share by stronger control of the transport chain. They are not only ship owners anymore, but also providers at terminals that own the docks or control them, and are also involved in the inland handling of containers. Expensive loading/unloading equipment ensures quick loading operations and brief detention of a ship in the harbour. Until recently, the Mediterranean ports could not meet this requirement because their gravitational hinterlands were underdeveloped. Today's Mediterranean hub ports have developed due to the favourable position in relation to the main trans-Mediterranean route for container liners. This can be a great opportunity for investment in the Port of Bar.

4.6 Requirements for the Implementation of the Preliminary Concept

Strategic requirements of the discussed preliminary concept are based on the orientation of Montenegro toward the accession to EU and Euro-Atlantic integration. This anticipates a continuous effort to make the economic system compatible with EU standards, while maintaining the openness of the Montenegrin economy and strengthening its competitiveness on the basis of use of natural, economic and human resources. The above corresponds to the strategic development priorities (see more in the Government of Montenegro (2010).

The economic requirements for the implementation of the design concept can be found in the government's macroeconomic policy programme for 2009. Many elements directly indicate that there are realistic economic preconditions for the partner cooperation of the Port of Bar and the Port of Koper (the need for improving competitiveness, safeguarding the interests of foreign investors and logistics providers, implementation of prepared infrastructural projects, etc.). This is also the basis of the recommendations by the World Bank for boosting infra-structural investments.

Logistics requirements for the implementation of the discussed preliminary concept are based on the fact that the distribution centres in the world are the bearers of the logistics supply chains. They are the simplest way for achieving direct links to customers and total control of the market. Therefore the considered preliminary concept should be oriented toward their formation, in addition to the development of the Port of Bar. This requires big investments. Distribution centres contribute to the strengthening of the company's brands, market share, control of billing, improved customer service, winning the leading position in the market, providing sales services to customers, faster and safer delivery. Companies tend to reduce costs through more efficient supply chain management, which is now one of the basic principles of logistics, and therewith the existence of distribution centres.

Infrastructural requirements for the implementation of the preliminary concept is based on the fact that the infrastructural development of the Port of Bar would positively influence the implementation of the planned road and rail routes, thus connecting Montenegro to important European transport corridors, with better quality connections of the Montenegrin transport system to trans-European transport network (TEN-T). There is an ongoing resolving process regarding the bottlenecks and the construction of roundabouts for almost all the towns, the construction and reconstruction of the third lanes on many main roads and initialization of the highway construction. For the implementation of the necessary reconstruction programme and improvement in the efficiency of the railway system, EBRD has provided EUR 15 million. The construction of the railway Capljina-Niksic has been announced, having a regional importance since it connects Montenegro, Bosnia and Herzegovina, Albania and Macedonia, including an important connection to the Port of Bar. The overhaul and electrification of the railway Niksic – Podgorica is in the process of finalization.

Location requirements for the implementation of the preliminary concept are probably the most important ones. Montenegro is situated in Southeast Europe, on the Adriatic coast. It borders Serbia, Croatia, Bosnia and Herzegovina and Albania.

Montenegro is by its position a Mediterranean and Balkan country, thus main traffic routes connect the Port of Bar with the Montenegrin hinterland and the Balkan states. The total length of the railway network in Montenegro is 250 km (part of the Belgrade-Bar railroad, which is electrified, and the railway line Niksic-Podgorica-Bozaj (Albania). The total length of the roads in Montenegro is about 7,000 km, where the length of main and regional roads is 1847 km. It is expected to start with the construction of the highway Belgrade-Bar. Montenegro is a country with a long maritime tradition. It has also two airports (Podgorica and Tivat).

In maritime industry, there are requirements for the purchase of new ships that will perform container service between the Port of Bar and a transhipment centre. For entering into long term agreements with the parties interested in the transhipment of goods from a wider gravitation area of the Port of Bar, it is necessary to introduce the most updated logistics forms and create a single transport chain, which would include various forms of transport. Through organizational, management and functional transformation, and subsequent privatization of the Port of Bar, it is necessary to create infrastructural prerequisites for raising the attractiveness and optimal positioning of the Port of Bar on the market of transport. This will facilitate the attraction of foreign capital to be invested in operational activities and other development projects of the Port of Bar.

Figure 4.14. Location of the seaports Bar and Koper

These are all strategic movements toward the creation of conditions for providing the Port of Bar with regional significance. This primarily refers to the finding of strategic partners, such as the Port of Koper, the strong Chinese shipowner and global logistics provider. It is necessary to improve the port infrastructure, provide a deeper draft and updated technology for the transhipment of containers and general cargo. As unused opportunities, there are modalities for the activation of 7.8 ha of the port aquatorium, which is aimed at developing production and trading activities. This also anticipates the procurement of modern mechanization (mobile port cranes, loading bridges with deadweight of 12 tons, etc…). The Port of Bar will be given for years-long concession use (2010, p. 18).

The application of benchmarking in partner cooperation of the seaports Bar and Koper can ensure an improvement in the quality of port and logistics services, improvement in business processes, reduction in operating costs and total logistics costs, enhancement of the quality of the organization as a whole and increase in customer satisfaction, new business opportunities, achieving competitive advantage, increase in creativity, enhancement of the quality of the organization as a whole and increase in profit. In this case, it must be based on the best practices of advanced sea ports and logistics providers. Therefore, the expansion of possibilities regarding the discussed ports anticipates better stimuli for Chinese investors and providers and promotion of favourable investment environment.

The hinterland of the Port of Bar can be adjusted to the development of assembly industries and distribution centres for export to European countries, banking services and insurance, ecotourism and organic food production for the needs of tourism and export. The development of operational port and logistic functions, associated with the formation of large distribution centres, modern warehouses and port terminals (in the very Port of Bar and its hinterland) can be put in the function of the future free zone, which would be oriented toward the entire territory of Montenegro. In this part, the transport logistics is of special importance. It also anticipates the development of inspections, quarantines, industrial and economic administration, tax authorities and banks, insurance and telecommunications companies, liberalized legislation in the field of investment, low taxation and profit repatriation.

The Adriatic seaports of Rijeka, Koper and Trieste are competitive due to their geographical position. The Port of Koper is the youngest of the three. In terms of their areas, it is 10 times bigger than the Port of Rijeka. This provides it with a higher annual cargo turnover. However, its further development is limited by the 12-meter sea depth, lack of transhipment capacity, poor infrastructural connections to the hinterland, which is insufficient for the total daily turnover, small gravitational area.

According to European and international standards, the Port of Koper belongs to the group of small ports, and Port of Bar to the group of very small ones, because its bandwidth is below 500,000 TEU units. The global maritime market shows the great need for the centralization and concentration of seaports. This implies the need for their joint partner appearance and cooperation. In the future, the associated partner Ports of Koper and Bar could compete with medium-sized Mediterranean ports with the volume of container transhipment of approximately 0.7-1.7 mil. TEU units (*Containerisation International Yearbook*, 2009)

The world container shipping is dominated by the liner navigation between specialized container port terminals of various sizes. There are large sea ports with huge port terminals enabling high traffic. They are called hub-ports or hubs. Nevertheless, there are many medium and small container terminals in the world, in the so called spoke-ports. Big world routes operate between the limited number of hubs, and smaller feeder routes connect the hub ports with spoke ports. This kind of organization increases the intensity of traffic between hub ports, and therewith enables the growth of the spoke ports. This is where we should look for the conditions for future partner cooperation between the sea ports of Koper and Bar, which need to use their advantage of the most economical and shortest connections to Europe.

L. Qianwen (2010) analysed the technical efficiency of 32 Mediterranean container sea ports. He calculated the indexes of technical efficiency by the mathematical modelling of four internal variables as the inputs: the longitude of connections (m), total area of terminals, rate of capacity utilization with containers being kept (TEU units) and quality of capacity management (in tons). Many of the stated indicators contain the quality of logistics ports. The index of technical efficiency mainly depends on the investment in port infrastructure. In line with the increase in the discussed index, increases also the quality of port logistic services. The author came to the conclusion that the efficiency of sea ports primarily depend on shaping the strategy for investment in infrastructure that can be aggressive and/or non-aggressive.

The port of Koper is at the end of the list of medium efficient ports with the index of 0.26, while the port of Bar belongs to the group of inefficient ports with the index of 0.09 (Ibid., p. 32). We can conclude that the investment in port infrastructure and logistics, with better utilization of the capacities and application of integrated marketing logistics, is the prerequisite for increasing the technical efficiency. Investment in the port of Bar on the basis of awarded concessions would enable relatively fast familiarization of the discussed ports in terms of technical efficiency and facilitate their partner cooperation, which can be multifunctional.

Medium container capacities with stabile business environment and logistics providers in the inland area of hinterland are the development imperative for the port of Bar. The implementation of the discussed project idea for partner cooperation with the port of Koper can be fulfilled only based on some external capital, knowledge, management and acceptance of mutual risk. It would provide conditions for a fast, long-term and good quality solution for the following issues: preservation of old and creation of new jobs, increase in the scope of transport and production of port and logistics services, increase in export, increase in GDP, budget stabilization, neat servicing and reduction of foreign dept, increase in life standard, improvement of management etc.

The positioning of Montenegro in the processes of accession to EU is based on the principles of *Interconnectivity* – interconnections at all levels, *Intermodality* – inter-branching in entirety and *Interoperability* – internal-branching and inter-branching connection of services. Fast adjustment to the above stated principles is an additional reason for believing in the possibility of partner cooperation between the ports of Koper and Bar and attraction of a strong strategic investment partner and global logistics provider. This would enable an accelerated infrastructural and logistics development, as well as greater application of multimodal concept of transport. The seaports of Bar and Koper, acting together, would be an equal competition to the most of Mediterranean and Baltic ports in terms of good quality in port and logistics service providing, as well as the scope of transhipment.

5. THE ROLE OF LOGISTICS IN PERFORMANCE MANAGEMENT

Apart from theproven and significant role of logistics in integrating marketing and management systems of a company, the position on the connection between the logistics and institutional (top) level of a business strategy in contemporary literature and business practice is being acknowledged. The mentioned position implies the implementation of performance management. In this way, the earlier opinion and praxis of connecting logistics with operations and provisional functioning in the area concerning a degree of integrations of business functions are being surpassed.

The relationship between performance management and logistics can be considered from two aspects:

a) role of logistics in enhancement of performance management and

b) roles of measuring and analysis in enhancing the logistics performances themselves.

The text below explains the mentioned dual relationship through the prism of acquirement of key competences and competitive advantages of an organization through enhancement of certain performances.

The business philosophy pursuing success, in the last few decades, as never before, uses scientific, technological and organizational development more and more. In this way, the importance of knowledge, skills and creativity, as well as possibilities of influencing them, came to the forefront. In parallel, the significance of performance *management* as a modern approach to managing an organization and its adaptation to turbulent changes in overall environment had increased (Draskovic, 2008, p. 63) and it also implies realization of a vision and mission of a company and achieving success.

Most of authors are of the opinion that the key place in the process of strategic management belongs to directing of organization towards achieving *success,* which supposes the right choice, concretization and enhancement of a mission and strategic goals of the organization. In order to be successful, the organization has to constantly explore, identify and assess its limitations, chances and possibilities in its environment, to search for the best ways to adapt and make the best business results (performance). In that sense, the organization has to improve its strong and to revitalize its weak business characteristics and to insist on the use of its competitive advantages

All mentioned tasks of the strategic management and performance management can basically be reduced to one essential task: *creation of permanent competitive advantage*. Marketing logistics has a similar task as well. Roca (2004, p. 145) states that the strategic management of integrated logistics basically contains planning and strategy, and usually regards design of a network, human resources, managerial relations, organizational strategy, *measuring of performances,* goals and standards.

Logistics strategy comprehends that business option which in the most optimal way finds a balance between costs and results of trading (Ibid., p. 148). In principle, it has to be original (unique) as suggested by S. Harvey (as according to Sergejev, 2005, p. 810). The most widespread logistics strategies are:

- strategy of minimizing general logistics costs,
- strategy for improving quality of logistics services,
- strategy for optimization of configuration of logistics infrastructure and
- insisting on key logistics competencies.

They are all functionally connected with enhancement of performance management. When dealing with strategy of logistics, managers tend to achieve a compromise between decrease of costs and improvement of level of services, i.e. performances of an organization.

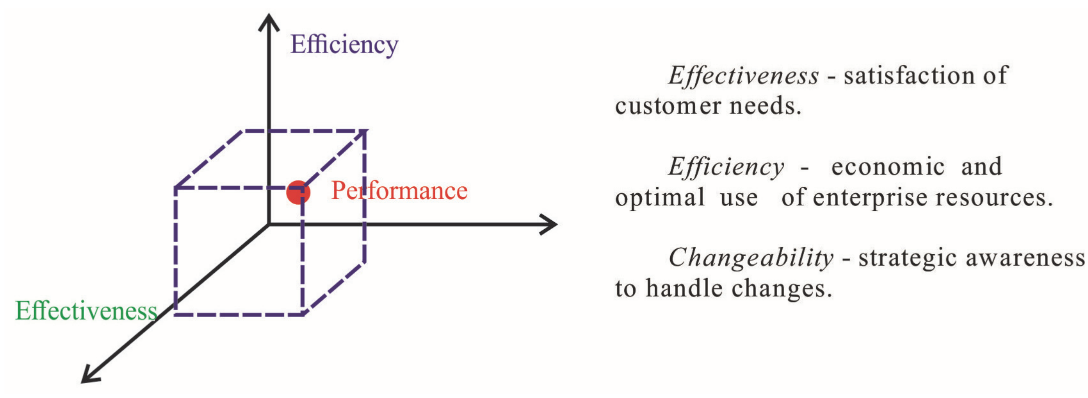
This paper analyses the concept of performance management and possibilities of increased role of logistics in formulation of its strategy on the top management level, related to acquiring of key competencies and competitive advantage.

5.1 Essence of Performance Management

In literature, and especially on Internet, one can find different interpretations of performance management, which is usually confused with problematic of human resources, even though it is much broader. The performance management combines methodology, metrics, processes, software systems and other systems which govern performances of an organization. Speaking generally, it seems that many authors prefer the definition according to which the performance management represents a process of managing and implementing strategies within an organization, by which plans turn into results. Performance management is also considered as a process for constituting common understanding about what is desired to be achieved and how it will be accomplished. Therefore, it is an approach about managing people which increases the probability for achieving success.

One example of a performance measurement system is the TOPP system, which was developed by SINTEF (Moseng, 1996) in Norway in partnership with the Norwegian Institute of Technology (NTH), the Norwegian Federation of Engineering Industries (TBL), and 56 participating enterprises. The TOPP system views performance along three dimensions (Moseng and Bredrup, 1993). These are in illustrated Figure 5.1.

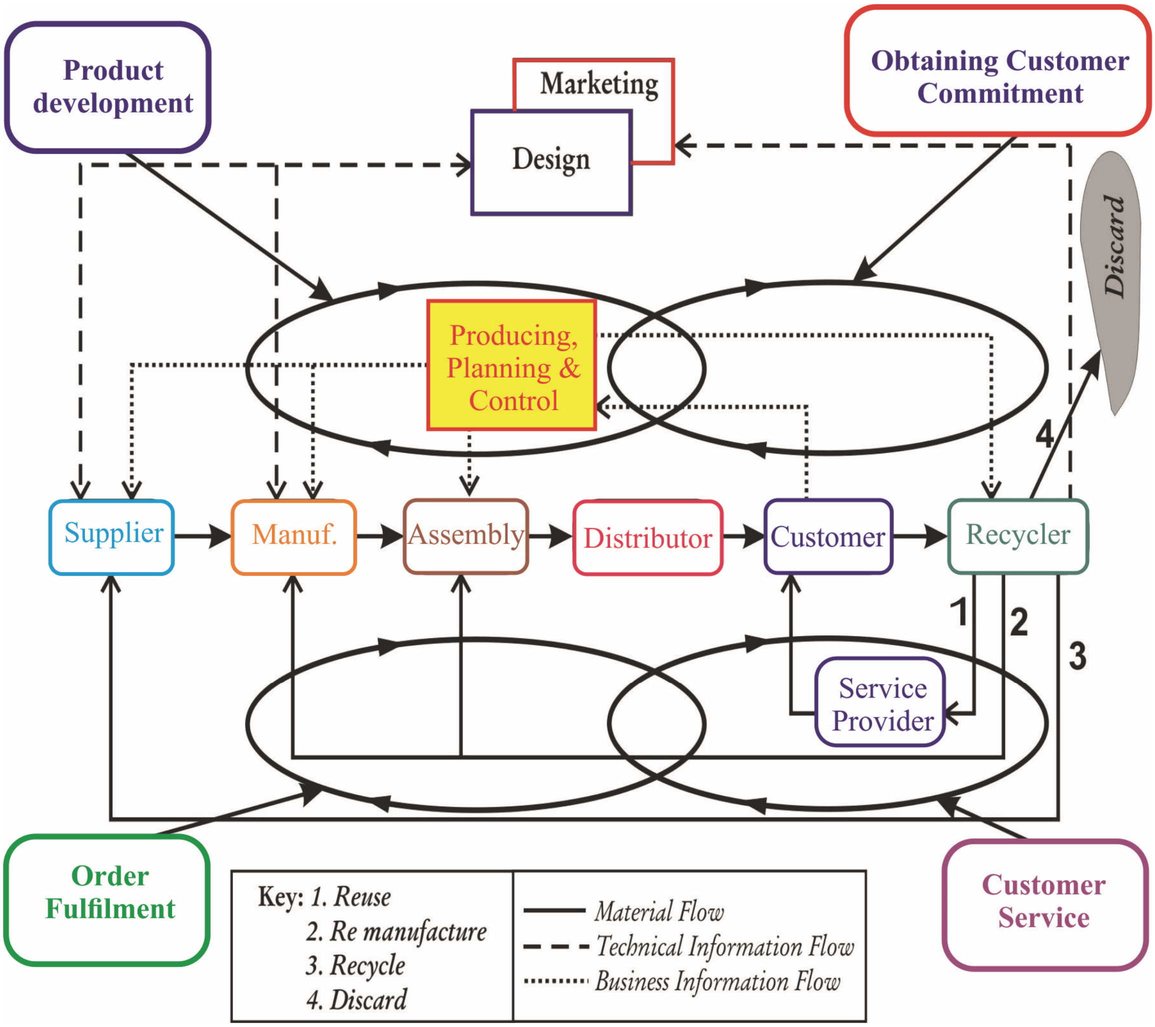
Figure 5.1. Performance measurement



Source: Moseng and Bredrup, 1993

In TOPP a number of performance measures were developed based on these dimensions. One example of a recent performance measurement system is the ENAPS (*European Network for Advanced Performance Studies*) performance measurement system, developed in the EU financed project ENAPS. This was based on a number of performance measurement systems and recent research.

Figure 5.2. The extended ENAPS business model



Source: Moseng and Bredrup, 1993.

The ENAPS business model is shown in Fig. 5.2. and reflects a future view of a manufacturing enterprise as it incorporates the end of life use of products (Andersen, Rolstadås, and Fagerhaug 1998). Based on this business model, ENAPS has suggested three levels of hierarchy for defining performance indicators. Each performance indicator is a function of two or more performance measures. The three levels of hierarchy for defining performance indicators are: "*Enterprise Level*", "*Process Level*" and "*Function Level*". The performance measures used in calculating these performance indicators are measured from all over the enterprise (Andersen et al. 1998).

Figure 5.3. Typical Performance Management Process

Source: Pulacos, E.. et al. 2004, p. 4

165 Experienced researchers identified few characteristics that represent preconditions for creation of an efficient system of performance management. However, it is also pointed out that there are many decisions which should be brought in order to design an original system which fully satisfies needs of a concrete organization. It is also stressed that the system of performance management does not have to strive for implementation of numerous number of goals, because in that case there is a danger of fiasco. The same author schematically explains the process of performance management (Figure 5.3).

Figure 5.4. Performance Management Cycle

Source: according to: www.datainitwales.gov.uk, p. 8

The process of performance management can be presented from the aspect of the mentioned definition as a circular interdependence between goals of an organization, performance measures (parameters), performance goals, actions, results, analysis and assessment of results (Figure 5.4). The performance management is a system process with which an organization activates all its employees in bringing and implementation of decisions and concrete measures for improvement of efficiency in achieving goals. Many authors believe that performance management represents a process used for introducing and maintaining corporate responsibility (and relevant behaviour) for results within an organization, as well as for planning, trainings, and assessment.

5.2 A New Improvement Oriented Model

There are a number of ways of classifying business. In the current paper it has been chosen to use the classification suggested by Fagerhaug (1999), which is based on a self-assessment approach. He suggested that the following five types of processes/structures could be used when classifying the processes of a business:

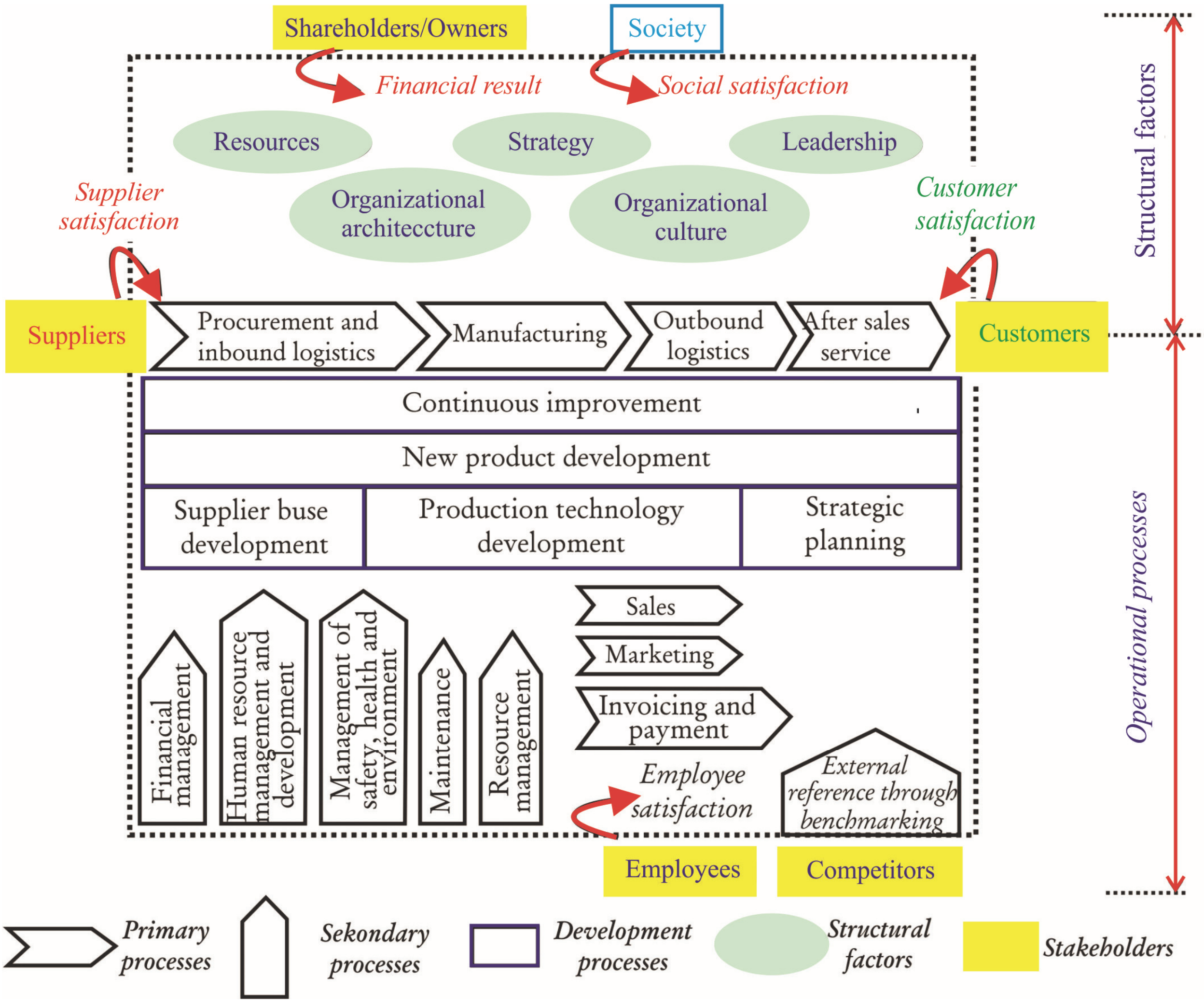
- *Primary processes* - The value-adding processes commonly found in any organization, often labeled main processes.
- *Secondary processes* - Processes supporting the execution of the primary processes. These are often labeled support processes.
- *Development processes* – Processes aimed at improving the organization's performance, for instance new product development.
- *Structural factors* - Innate characteristics of the organization, for instance resources.
- *Stakeholders* - The stakeholders are the parties that can affect or are affected by the degree of achievement of an organization's purpose.

When describing and measuring the performance level in a business process, a number of parameters might be used. It is pivotal to employ a balanced set of measures in order to understand the performance of the process and be able to identify improvement areas. Typical dimensions for describing and measuring performance are (Ibid.):

- qualitative and quantitative measures,
- "hard" versus "soft" measures,
- financial versus non-financial measures,
- result versus process measures,
- measures defined by their purpose (result, diagnostic, and competence),
- efficiency, effectiveness, and changeablity, and
- the *six* classic measures (cost, time, quality, flexibility, environment, and ethics).

All areas should be considered when developing performance measures. It should be emphasized that these dimensions overlap. In order to diagnose the “health status” of an organization one should ideally employ a balanced combination of measures.

Figure 5.5. A Business Model



Source: Fagerhaug 1999.

Figure 5.5 shows a business mode based on the five types of processes/ structures.

5.3 Concept of a Business Model as a Connection Betven Logistics and Performance Management

Exploring a business model is a respective route for searching methods for establishment and maintenance of a certain strategy. Business models as theoretical concept have their own history and are known as archetypes, structures, schools, gestalts, and in certain situations even as strategies and business ideas. The most common use of terminologies and concepts of business model in contemporary examinations can be found in combining management and Information Technology (IT). The concept of business model relates to the logic and functioning of a company (Tikkanen et al., 2005, p. 791) and in the long term it is an instrument which can be used in describing relations between activities and strategies. In this way, activities and logistics processes are being connected with a strategy.

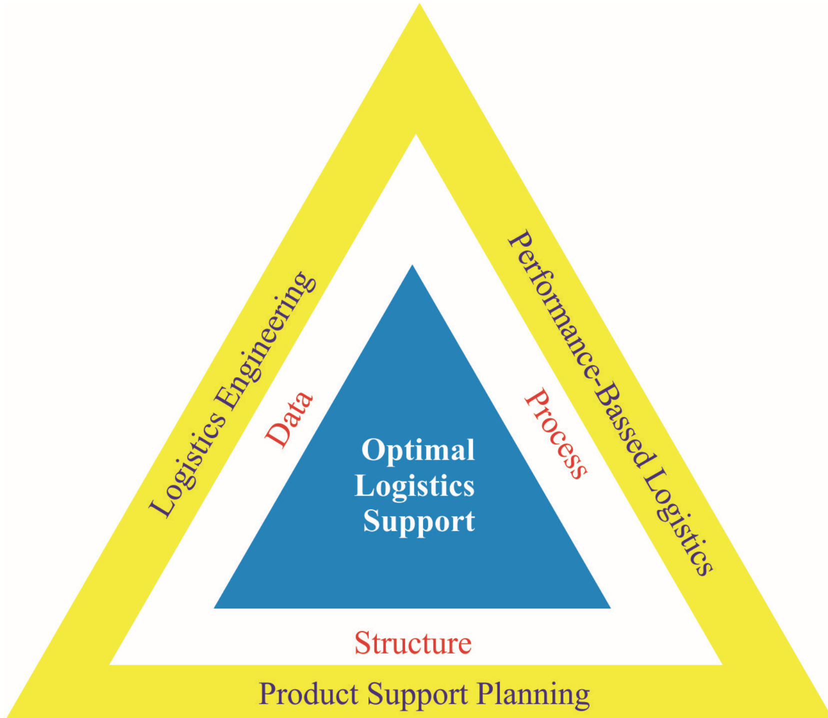
Afuah (2004, p. 9) emphasises that the business model represents "*a set of activities which a company is carrying out, a way in which the activities are implemented as well as time in which they are carried out using resources for implementing activities, taking into account the industry it deals with, and all towards creation of a superior selling price (low price of different products) and creation of a position for determining such price*". The mentioned possibility of a business model for helping the connection between activities and strategy of a company means that the business model can be used as a means in analysing roles of these activities and those processes in which these activities are carried out, within the company's strategy.

This business model is a successor of two completely incompatible teachings in a theory of strategy: schools of thought based on resources (*resource based view* – RBV) and industrial organization (IO). They are different theoretical explanations on why some companies' performances are successful and others are not. In the context of the current discussion on models of doing business it is important to take into account the real activities of a company, meaning that descriptions and analysis of the role of logistics in the strategy of a company are implied.

As a result of the mentioned interpretations, a need for new researches arose. These researches were aimed at explaining the role of logistics in the strategy of performance management. Earlier approaches on the role of logistics in the strategy from logistics point of view were abandoned, so its role from the point of view of strategic management is discussed more and more, that is from the point of view of a model of performance management. Certainly, motivation for the latest examinations derives from the fast growth of importance of logistics in company's competitiveness (Abrahamsson et al., 2003).

The model of performance management is used as a practical means for developing business of companies that are following their competition, orientated towards logistics. Much of attention is being dedicated to that what connects logistics activities and strategy of performance management, which implies knowing the answer to the questions: what is the role of logistics in performance management?

Figure 5.6. Optimal Logistics-Support Model



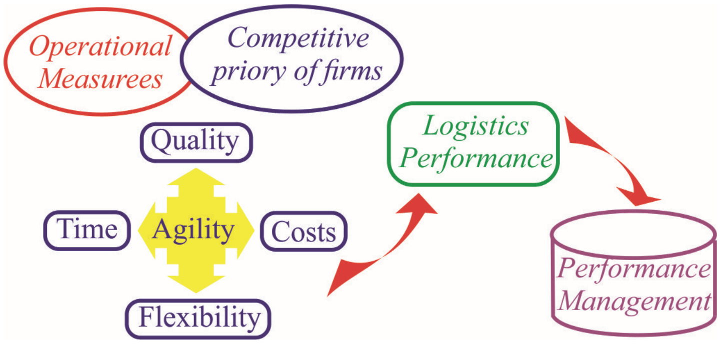
Source: Beggs, Kime and Jones 2007: p. 2.

Kihlén (2007, p. 7) believes that when exploring business models based on logistics of these two schools, they still have to be harmonised and adapted, in order to ensure their combining. He points out that in business models based on logistics, management of a company sees logistics as a very important factor which stands behind the strategy of performance management. It means that the logistics is very significant for development of business and performance management. Concept of a business model is often considered together with a strategy (Figure 5.6).

Logistics includes all functions of a company and it integrates all logistics activities, coordination and cooperation with all partners in logistics canal (suppliers, agents, external services and customers) with the aim to satisfy customers' requirements. Starting from this definition and earlier definition of performance management, a very significant role of logistics in strategy of performance management is very clear and it is illustrated in the Figure 5.7.

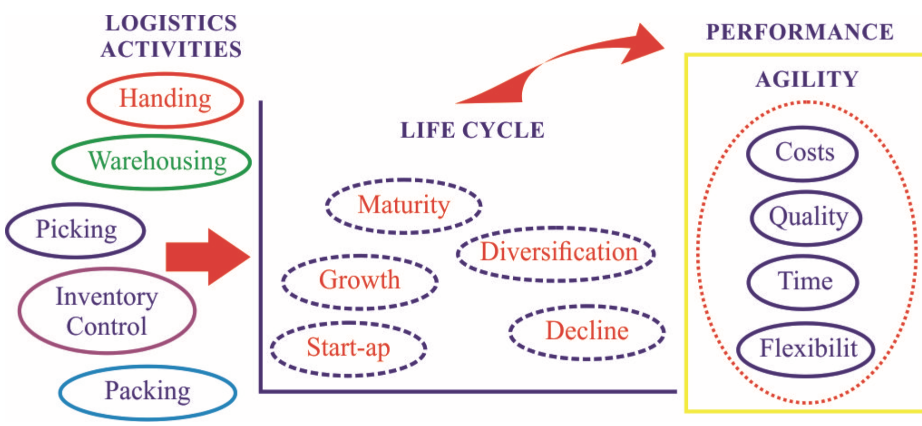
From the previously identified relationships, which embrace the several logistics activities and the correspondent measures of performance, the proposal of conceptual model corresponds to the one that is presented in the following Figure 5.8.

Figure 5.7. Relationship Between the Logistics and Performance Management



Source: Adapted to Ferreira, J. et al., Ibid., 7

Figure 5.8. The impact of logistics activities on the performance of the firms, according to the life cycle



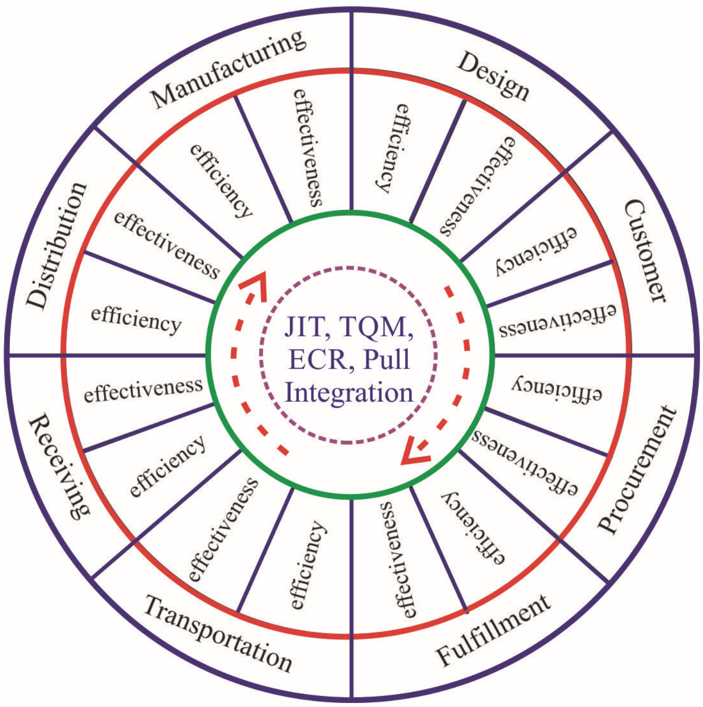
Source: Adapted to Ferreira, J. et al., Ibid., p. 11.

5.4 Performance Measures of Logistics Activities

Measuring, analysis and enhancement of logistics performances are the basis of continual improvement of quality of logistics services. There are four key areas for measuring performances in logistics and they are the following: measuring the level of customer satisfaction, measuring the level of satisfaction of all actors and other interested subjects, measuring characteristics of logistics services and measuring performances of logistics processes. Measuring and monitoring the level of customer satisfaction is the basic factor for conquering and keeping the market and it is realized through methodologies and models that match concrete specificities of a market and practices of a company.

The choice and use of relevant sources of information is of extreme importance here. Measuring and monitoring of logistics processes based on a defined methodology are aimed at assessing performance of the mentioned process such as: reliability, precision, time and cost structure, security, effectiveness, efficiency, use of capacities and so on. Measuring and control of executed logistics services enables us to determine harmonisation of planned and realized services. .

Figure 5.9. Integrated Supply Chain Metrics Model



Source: Adapted to Lawrence, p. 5.

Measuring satisfaction of actors and other interested subjects means determining their needs in certain phases of logistics course (from making an agreement to delivering goods to the final customer). Analysis of gathered and established facts and parameters enables the assessment of realized performance in relation to projected values and established plans and goals. Analysis and assessment of performance enables us to determine inconsistencies and to define potential areas of possible improvement of quality of logistics services. Different quantitative and qualitative methods and techniques are used for gathering and processing of data. One complex integrated supply chain of metrics model is shown in the Figure 5.9.

Besides evident role of logistics in integrating marketing and management functions of a company, contemporary literature and business praxis put more emphasis on the connection between the logistics strategy and institutional (top) level of a business strategy. This leads to overcoming former interpretation and praxis related to the connection of logistics and operative level as well as conditional functioning in the level of integration of business activities. The use of logistics enables companies to significantly decrease their stockpiles, to speed up floating capital flows, to decrease the price of product and logistics costs, to better satisfy needs of customers etc.

The end result is creation of added value of a product through enhancement of performances, which increases satisfaction of customers and competitive advantage of a company. It implicates a significant role of logistics in performance management. Functional complex of logistics also confirms this conclusion. The existence of close reciprocal interrelationship and conditionality of logistics and performance management is confirmed by their numerous common business areas, trends, functions, effects and activities.

6. SPECIFIC CHARACTERISTICS OF THE SHIP AND PORT SERVICES AS ASPECTS OF MARITIME MANAGEMENT

Apart from theproven and significant role of logistics in integrating marketing and management systems of a company, the position on the connection between the logistics and institutional (top) level of a business strategy in contemporary literature and business practice is being acknowledged. The mentioned position implies the implementation of performance management. In this way, the earlier opinion and praxis of connecting logistics with operations and provisional functioning in the area concerning a degree of integrations of business functions are being surpassed.

The relationship between performance management and logistics can be considered from two aspects:

a) role of logistics in enhancement of performance management and
b) roles of measuring and analysis in enhancing the logistics performances themselves.

The text below explains the mentioned dual relationship through the prism of acquirement of key competences and competitive advantages of an organization through enhancement of certain performances.

Service in the maritime transport (maritime industry and seaports) is a relationship between its providers and users in the process of preserving or changing the state, as well as movement of the cargo (packaging, piling, relocating, storage, transport). In that relationship, information and documentation regarding services play a vital role. The above mentioned relationship has been performed in several process activities (accomplishing several tasks) in a given time. A market offer involves, not only a physical product, but a whole service package composed of the service product, service environment and service delivery (Pettit and Beresford, 2009, p. 255).

Numerous participants in the maritime market encounter with many constraints. A primary goal of the maritime transport management is to solve those problems by implementing new knowledge, skills, technologies and information. That is the best way for ensuring quality maritime services, which are critical for success of the maritime companies. A competitive ability and its advantage are directly dependant on the quality (Bichou and Gray, 2004, p. 49).

The service in the maritime transport in many cases depends on a physical product (cargo) and it represents information and transport interaction between the supplier (producer) of the maritime services (shipowner, port, maritime customs, carrier, etc.) and the user (ordering party) of the maritime services (Illeris, 1996). Success and profitability of maritime transport companies directly depend on the competency of their managers and service operators. Success is not a matter of chance or a magic wand, but a product of the rational and quality management which includes the following:

- permanent and quality fulfilment of all requirements of the ship and port customers;
- increasing productivity (relationship: output-input in the given time, along with a high quality achievement);
- innovations in the organisations, implementation of the maritime transport, communication and information technologies, etc.;
- improving the quality of transport services (maritime, ports, etc.);
- a competent management team and an organisation structure of the maritime transport company (ship-owners, ports, etc.);
- stable finance and well-planned long-term investment;
- responsibility to the environment (inside, outside), as well as society;
- rationality in management etc.

A shipowner (maritime company) is a subject of the maritime industry, which is a subsystem of the maritime transport as a polyvalent service industry - i.e. a sum of all activities, knowledge, skills in the relationship on the sea and in connection with the sea.

A ship company is an economic organization which deals with delivering services in the maritime industry. Those services involve performing commercial-transport activities, using transport ships and special transport contracts. Like any complex, open and hierarchical system, a maritime company has to be based on the systematic principles in solving business and management problems. A systematic principle emphasizes a rapid development of the transport, information and com-munication technologies. They directly determine the progress of the sea-shipping, which together with the seaports make the main part of the maritime industry. The maritime industry, like any other, is characterized by several management levels, such as:

- the highest level, a so-called "top", strategic or institutional management;
- the middle level, a so-called "tactical", business or administrative management;
- the lowest level, a so-called "operational", executive, functional or technical management.

The “top”" management of the maritime company is concentrated on one, or a very small number of managers in the company. It is responsible for defining the following: a strategic mission, visions and goals, creating developments, changes of the business strategy and a long-term planning, as well as creating a business environment and the organization culture, selection of the management staff and the captain of the ship crew, their training etc. These are the most complex and responsible business activities and decisions.

The middle-level management of the maritime company has several organizational and management levels. It's about several managers who deal with some parts of the business units, for example: maritime transport services, negotiating cargo and passengers transport, ship space and tolls, purchase and lease of the ships, servicing and repairing the ships, researching the maritime market, finance and accounting, the department for development and innovations, electronic data processing (electronic computer center), quality control etc.

The operational (functional) management level of the maritime company is a representative of the whole management team towards the operational executive team.

For the maritime company, of vital importance is the relationship between the management (especially the strategic one) and actions (activities oriented towards the maritime service). That relationship is directly dependent and complementary, usually simplified as a relationship between “*what needs to be done*” and “*how it has to be done*” to accomplish success of the maritime company and to form a positive business image, i.e. to realize the planning goals. Success always comes later and it assumes initiative planning of certain goals, analyzing the internal and external company environment, a correct choice of the strategy and resources between the alternative solutions, as well as undertaking adequate actions, which lead and control business, based on the feedback (Milisavljevic, 2000)

Action is based on the shipowner decisions (strategic, operative etc.), which represent an executive choice between alternative actions. It means that decision of the shipowner determines action which needs to improve a strategic position.

According to Pirson's treatment of the six different actions, a maritime company (ship company, seaport etc.) has to take the following actions:

- identify the most important aspect for the business, especially from the competition point of view;
- define and conduct the highest concurrence behaviour standard, with a tendency of constant improvements;
- stimulate innovations;

- involve the top managers;
- make constant updating and development of the staff structure;
- create and develop a motivation system (rewarding process) which is oriented towards the results.

Maritime managers at all the levels (strategists, operators, ship commanders, etc.), have to realize all the managers' functions related to the maritime, ports and other operations which belong to the working environment of the maritime organization.

The realization of the manager's functions is performed by making adequate decisions, their implementations into practice, as well as controlling the level of their execution. It is believed, that the most significant shipowners' decisions are related to security, employment and releasing ship capacities (Tauzovic, 2002).

A similar statement can be made for the port systems. The decisions related to securing ship capacities are: ships returning from the dismantling, purchasing ships (new and second-hand), leasing ships, recurrence of the lease of ships etc. The decisions related to ship exploitation are: cargo, goods and people transporttion, the form of the ship exploitation (a voyage or a period of time) etc.

The decisions related to the clearance of the ship capacities are: dismantling the ships, selling or write-off of the ships, leasing the ships, recurrence of the leased ships, etc. There are many specific characteristics of the maritime industry in its relationship with other service industries. Because of those specific characteristics, maritime services are subject to a very strict legislative regime, different conventions, clauses and different kinds of contracts.

Those specific characteristics are technical, legislative (contracts), economic and other. From the author's point of view, the most important specific characteristics are the economic ones, which are derived from the character of the maritime services. In that sense, it can be stated that maritime services can be divided according to (Draskovic, 2003):

- the non-material product;
- productivity and consumption at the same time;
- impossibility to store;
- impossibility for the users to try and test it;
- huge differences in the maritime services in relation to different types of ships, ship storage, market, cargo etc.;
- forming freight payment systems for the maritime services;
- high degree of competitiveness on the maritime service market;
- great conjuncture influences on the maritime service
- market;
- high degree of capital investments in maritime service production;
- high degree of the organizational complexity in providing maritime services;
- high degree of business complementarities of all parties (subjects);

- active participation of the science and technology progress in the maritime services environment etc.

In addition to the above mentioned, it is very important to emphasize that the modern transport of goods and people, is characterized by high speed, quality, rationality, security, as well as with the existence of different technical facilities: freezers, cranes for fast reloading, tanks for liquid materials etc.

An economic goodness is everything that has capability to satisfy some kind of the human needs. To get it, people are willing to sacrifice a certain amount of money or another goodness.

Economic goodness consists of different products, services, resources (production factors) and so on. Port services, as an economic goodness are all activities related to relocations of the cargo in the area of the seaport at a certain time, as well as accompanying ports service activities.

Port activities can be divided into (Kolanovic, 2007, p. 209):

- basic or primary, to which the following belong: loading, unloading, re-loading, storage, grouping of the cargo, distribution, container loading and unloading, preparation of the cargo, binding, ship supplying, information about the cargo, ship arrival and departure etc.;
- auxiliary or additional, to which the following belong: packaging and/or storage and preserving in accordance to physical cargo characteristics, repackaging, quality and quantity control, repairing, finishing, processing, piling, etc., marking, coding and special labelling, using a unified transport code, forming the cargo units, use of the palettes and containers, selection of an optimal form of port transport and transport facilities, optimal usage of port transport facilities with correct loading, using modern port technologies, as well as a modern organizational approach to the relocation and processing of the cargo and stock in the port warehouses and terminals and applying modern informational technologies and computer support.

For quality evaluation of the performed port services the following standard set of parameters is suggested:

- the internal port environment (equipment, appliances, systems of the port transport for cargo allocation, scale, control systems, restricted spaces, training, politeness, correctness and good communication skills of the port personnel, the level of the information support and so on);
- reliability (timely performance, absence of the risks for users);
- responsibility (warranty of port services accomplishment, staff willingness to help users of the port services);
- fulfilment of services (competiveness, existence of routine and suficient knowledge of the port personnel;
- availability (easy contact);
- timely service;

- promptness and price.

Some authors (Marlow, 2003, p. 193) suggest the following additional indicators:

- frequency (time needed to extend delivery of ports services);
- flexibility (adaptation to demands of port service
- users);
- control (having information about the status and position of cargo in the port);
- certainty (realisation of services without damage or loss of cargo).

In addition, port practice testifies great importance of mutual understanding of port personnel and users of the services, the level of exploitation cost (price of transport per measuring unit), the level of permit possibilities, mobility in safeguarding transport in different circumstances, continuity of the port transport (and regularity), warranty of the cargo protection which is subject of port services, effective use of transport resources, mechanization and automation of loading and unloading services, etc.

Port service, as an economic goodness, demonstrates a relationship between its producers (subject of a seaport) and users, which is generated in the process of preserving or changing the state, as well as the movement of the cargo in the seaport (packaging, piling, relocating, storage, transport). In that relationship, information and certain documentation regarding the services play a vital role.

A specific feature of the port services is the fact, that ports are an inter-section of the rail, road and sea transport. That makes its basic logistic functions very complex, because of the necessity for a continuous adjustment of their characteristics. Terminals play a special role in port services, as locations where sorting and consolidation of cargo (the central terminal) and pick-up and delivery of cargo (in accompanying terminals) take place. Port terminals have numerous specifics which are characteristic of the sea transport and port services. In the last decade container terminals become widespread.

The next characteristic of port services is huge, complex, specific and legally well-defined documentation, which follows cargo (because of change in the ownership). In the case of integrity of port services in logistics, marketing logistics has numerous specific requirements, like:

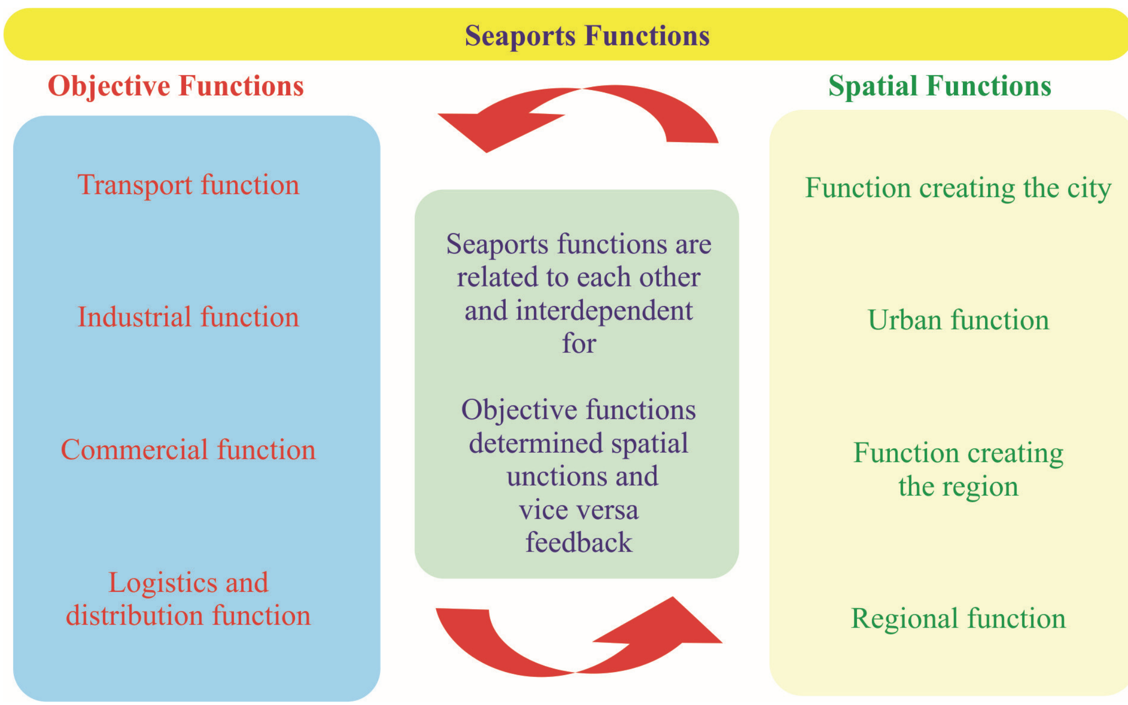
- standards of parameters in the technical assets of the port;
- permits and transport systems which depend on each another;
- homogeneity of the port-transport technologies;
- a complementary set of information about the subject, aspect of delivery, fast and timely transport from one subject to another (in order to make decisions), and
- homogeneity of legislative and economic regimes of port system, etc.

Table 6.1. Identifier of quality realization of ports services

Price	*Different factors*
Capability of execution of the contract obligation	Good timing, security of cargo, cargo insurance, compatibility of involved parties, image of the transport company
Flexibility	Terms of delivery (due dates, warranty), level of transport services, payments conditions
Complexity of the proposed port services	Different factors
Access to the information	About prices, delivery conditions, movement of cargo, etc.
Speed in accepting port orders and forming documentation	
Timing (decreasing unnecessary hold-ups)	

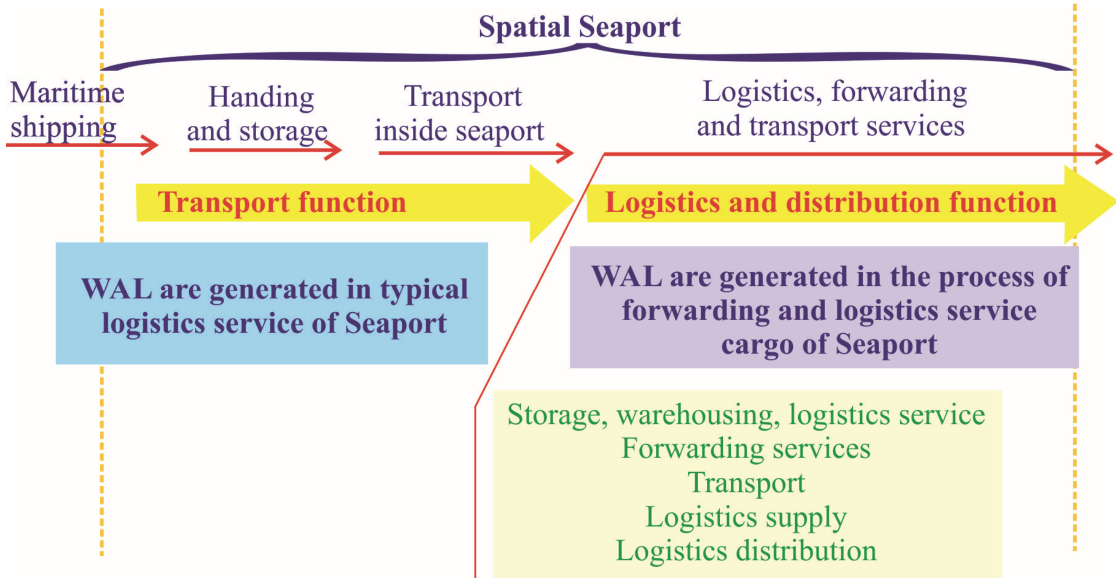
Source: Marlow, 2003, p. 193

Figure 6.1. Seaport functions



Source: Montwiłł, 2014, p. 260.

Figure 6.2. Cargo handling in the ports of the third and fourth generation, along with the areas of VAL generation



Source: Montwiłł, 2014, p. 261.

The logistic cycle and logistic flow in seaports are very complex, because they involve numerous undercycles: the cycle of delivery of port service orders, processing the order, the cycle of organization and allocation of the order, delivery of cargo, preparation of port services and the appropriate documentation, the cycle of analysis and invoice preparation, the operational cycle in finalizing port services, the cycle of packing and consolidation of the cargo, the cycle of delivery of cargo, port transport, manipulation of the cargo, storage, etc.

Seaports develop a logistic net to get a better information quality, port infrastructure, port organization, market of port services and technology, as well as increase in the economic value. They represent the top of the interlogistic management and organization, because control of logistics gives a quick answer to changes in demands for port services. To meet those requirements, quality and timely decisions must be made by all the parties in the logistic net of the seaports and their flawless cooperation.

The main tasks of ports services in logistic nets are: increasing the speed of the flow of cargo in the port, quality and quicker loading of the ships in the port, decreasing the holdon of ships in the port, rationality of all port operations (in space, in time, in communication), rationality in the cooperation with the road transport, quality cooperation with the port surroundings, optimization of the information support, quality communication between all the parties in the port system, minimizing the idle run of the ships, delays, etc., as well as increasing the quality of the port logistic system (transport assets, information and control systems, personnel, the process of coordination, etc.).

The modern use of the integral marketing logistics, as a complex system of planning, organization and control of the flow of cargo in ports services, means bigger and bigger use of the port logistics net. In addition, there is a necessity for modern electronic, communication, transport and information technologies, which follow all the transport logistics activities, from the entry of cargo into the port to the exit from the port, as well as all the technical assets in the transport logistic system and manipulation of cargo in the port, all the technological phases, all the subjects of the logistic system in seaports, all the logistics information and all the communication channels and connections.

For port services it is important that they are unique and acceptable for users, and that, as a final result of the executed services, nothing is left behind, except information, documentation and payment, and that port service cannot be recycled, stored, repaired or done again.

The market-formed integral system of port transport services is made up of offer, demand, legislation as an institutional base for negotiation of freight services and the accompanying subjects, like banks, insurance companies, customs and so on. Offer is made by freight forwarding companies, terminals and subjects that provide additional transport services, and demand makes numerous users of transport services.

Table 6.2. The order of performing port services

Step	*Service description*
9	Client consulting and service establishing
8	Supervising the process of service delivery
7	Informing client of the service delivery according to the time schedule
6	Making a service time schedule for the clients
5	Predicting clients' answers
4	Accepting an obligation for rendering a service
3	Considering possibilities for performing the service
2	Considering clients' needs
1	Making contact with the client

Source: Roca, 2004, p. 73.

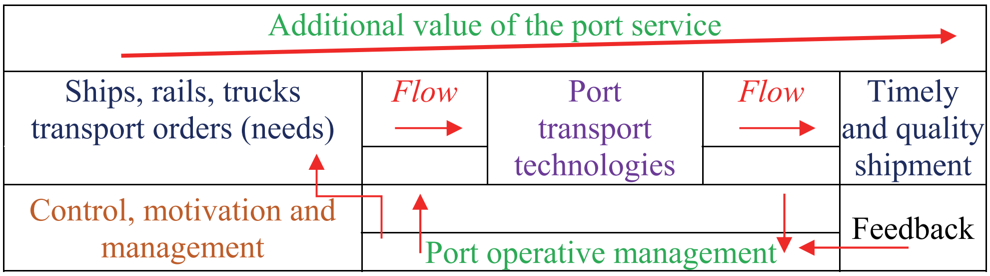
In terms of the port transport integrity, there are several requirements (Table 6.2):

- standardisation of the port technical assets parameters;
- permits and service capabilities of the intertwined activities of the transport services in the port systems;
- homogeneity of the port-transport technologies;

- a complementary set of information, form of delivery, communication speed and timely delivery from one kind of transport to another (for the purpose of making decisions);
- homogeneity of the legislative and economic regimes of the port systems, etc.

The process of providing port services and logistics activities has several stages, which are shown in Figure 6.3.

Figure 6.3. The stages of the seaport service process



Source: Draskovic, V. and Draskovic, M., 2007.

A feedback connection takes place between the several stages of the port service activities, while the control processes, motivation and management are in the role of the synchronizers at all the stages of performing logistic activities. It can be seen that several kinds of transport facilities take part in the basic stage of the port service process (ships, rails and road vehicles), applying adequate port transport technologies which have a primary goal to realize timely and quality cargo shipment to the planned destinations in the seaport, as well as an adequate manipulation of those cargoes. In a port operative management, a number of subjects take part as the executors of several port and logistics services.

So, a modern port business demands an economical cargo movement, transport and other resources (V. Draskovic, 2003; M. Draskovic, 2004).

That comes up with minimizing transport and manipulative expenses, along with reducing space distances, time limits and a number of middle-man agents. In order to have economical port-transport services, it is necessary to develop a modern logistic strategy of the seaport systems. It is based on the improvement of the port system characteristics in terms of cargo movement, ships and road transport systems, as well as of infrastructure and other characteristics.

Maritime transport (ships and ports) represents one of the most important logistic subsystems and a physical distribution, because it performs a materialisation of the goods flows between separated production and consumer destinations, and it represents almost 60 % of the total logistic costs.

In the context of rapid and continuous development of the service sector and its growing contribution to the gross domestic product, a consideration of those ships and maritime transport services is very important, especially for the maritime countries, because they generate extra-ordinary possibilities for increasing employment, competitiveness and economic development. In addition, quality maritime and port services represent bases for the modern logistic network. Chinese experience is the best example for the above mentioned statement.

Part two

LOGISTICS OPTIMISATION

7. CONCERNING THE INCREASING SCM INTEGRATION WITH A REFERENCE TO SOME RFID CHALLENGES*

The first couple of years of the century brought great and paradigmatic changes to the field of integrated logistic. These changes are accompanied by numerous technological innovations. One of them is the radio frequency identification (RFID). Significant contemporary logistical challenge for information and communication technology (ICT) experts is how to integrate seamlessly RFID into existing supply chain management (SCM), customer relationship management (CRM) and enterprise resource planning (ERP) applications within the entire system. Literature in this domain has not yet comprehensively analyzed associate challenges and impediments to such integration.

In attempt to fill at least partly this gap we realized two surveys with aims to:

a) rank four challenging issues estimated as key ones in implementation of RFID in SCM, and,
b) establish correlation between two pairs of critical criteria sets of impediments in this domain, along with ranking belonging sub-criteria.

Through the appropriate quantitative-qualitative analysis of the obtained responds we examined to a certain extent the relations between stumbling factors for increasing the integration of SCM by adapting contemporary RFID technology solutions.

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* Co-authorship with S. Bauk

The logistics administration has two related and complementary dimensions: SCM and logistics processes. SCM is focused on six key areas: production, delivery, place of location, supply, transportation and information. As a system and strategy of the company, SCM is composed of two subsystems, i.e., supply chain planning and supply chain execution. The logistics processes include optimization of resources in managing the material, services, information and financial flows. They refer to the four basic functional areas: supply (procurement, transport and storage), support for the production with the finished goods, warehousing and distribution (transportation, storage and physical distribution).

The increased interest in logistics was caused by the globalization of business, the growth of competition, need for lowering distribution costs, quality of the products and services, expansion of production, shortening product life cycles and technology and increasing the shareholders expectations for obtaining profit (Wiktorowska-Jasik, 2014). Parallel evolution of logistics and SCM is characterized by the increased level of integration.

In the modern business environment, the developed organizations are trying to integrate all the logistics functions (basic and supporting ones) as much as possible. They are attempting to reduce the time needed for the fulfilment of orders, to speed up the logistics flows and reduce the time necessary for logistics operations. This results in the reduced overall logistics expenses and fuller satisfaction of the clients. Integration is necessary in order to adapt organizational structures to the speedy and risky changes in the global business environment, particularly with regard to the competition and finance as well as due to the reduction in the number of mediators and improvement of partner relations. The practice of the modern companies shows that integration of logistics functions is a prerequisite for continuous creation of value added, as it ensures the performance of these functions in a quality, timely and reliable manner. This is the way for the companies to ensure sustainable competitive advantages and key competencies within the SCM.

Through the perception of interviewees, this paper analyses the expected impact of the use of RFID technology on the increase of SCM integration. The paper is organized in the following manner: the second section gives an overview of SCM and RFID, the third one concerns the advantages and disadvantages of implementing RFID in SCM, the fourth one contains the methodology and outcomes of two surveys realized with the intention to assess the rank of severity among challenges in implementing RFID into SCM, and the last one contains conclusion remarks and directions for further research work in this domain.

7.1 Theoretical Overview

The integrated logistics supply chain is the term used to characterize the developed business systems. This refers to the set of all types of providing logistics services (reception and processing of orders, design and production of services, sales, service, distribution, resource management and supporting logistic functions). These are required to meet the demand of users -

from the initial moment of order, through information on logistics flows to delivery to the end user. Mentzer et al. (2001) suggested that SCM should be observed as a *management philosophy*. With that, they primarily think of the integration of all processes, activities and institutions in the SCM framework. In this context, SCM adopts a systems approach to viewing the supply chain as a whole, from the supplier to the ultimate customer. Seven activities are proposed, based on the earlier research, which appear necessary in the successful implementation of the philosophy:

- integrated behavior in customer and supplier firms,
- mutually sharing information,
- mutually sharing risks and rewards,
- cooperation among supply chain members,
- the same goal and the same focus on serving customers,
- integration of processes, and
- partnerships to build and maintain long-term relationships.

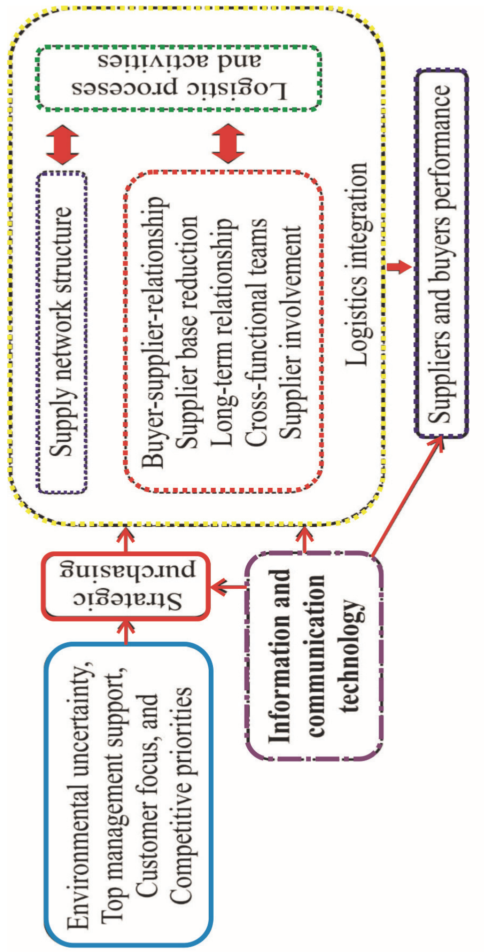
These activities are aiming to create added value of logistics and other services, durable competitive advantage and key competences for performing certain activities.

Bowersox et al. (2000) describe a framework of six competencies that lead to world class performance in logistics and SCM. These competencies are grouped into three areas (operational, planning and relational) which are directly related with integration. Fawcett and Magnan (2002) identified four levels of integration in practice:

- internal cross-functional integration,
- backward integration with valued firsttier suppliers,
- forward integration with valued firsttier customers, and
- complete backward and forward integration ("from the supplier's supplier to the customer's customer").

In the opinion of Sweeney (2011), supply chain integration comprises of internal (micro) and external (macro) integration. This opinion is also represented by Stock and Boyer (2009, p.706). Contemporary chain management of logistics and other services involves the integration of key logistic flows, operations, activities, and processes between entities (suppliers, operators, retailers and users). The essence of logistics integration has its own logic, according to which each functional area should maximally contribute to the overall result, which increases the logistical competence. Interdependence of relationships within the supply chain is presented by Chen and Paulraj (2004). They originally modeled the research framework of SCM. With some modifications and adjustments, we emphasized integrative role of ICT (Figure 7.1).

Figure 7.1. A research framework of supply chain management

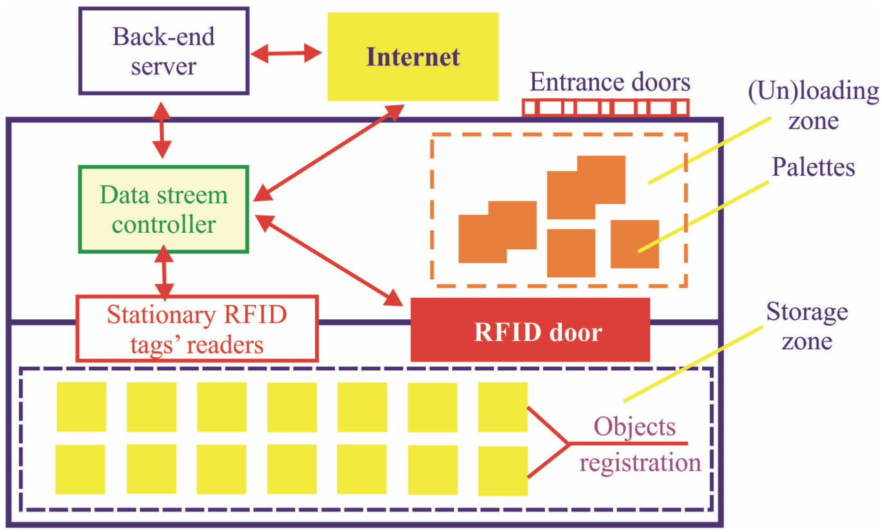


Source: Adapted from: Chen and Paulraj, p. 121.

The exponential geopolitical and economic changes caused by globalization are accompanied by improvement of business and organizational strategies (outsourcing, automation of inventory management, business networking, controlling, performance management, etc.) and infocommunications, transport and other technologies.

Among these technologies a special place is occupied by identification of products. It is extremely important not only for the logistics sector, but also for business decisions and synergistic effects of many participants in the supply chain. In this regard, the importance of RFID is particularly emphasized in recent times a wireless technology that uses transmitted radio signals, and promises many supply chain benefits. Among these advantages Tajuma (2001) emphasizes reductions in shrinkage, efficient handling of materials, increased product availability, and improved asset management (Figure 7.2).

Figure 7.2. RFID in a warehouse asset management



Source: Adapted from Kamozin 2013, p. 73.

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In Figure 7.2 is given a scheme of tracking palettes at a warehouse. Each palette entering and leaving the storage zone is reading by means of RFID door reader, while changing the data of the tags is provided by stationary RFID tags placed at strategical points over the storage zone. The data flow most commonly through the mesh wireless network, where the controller route the data streams to the backend server and/or Internet.

Effective tracking enables better SCM by providing possibilities to improve responsiveness and increase the operational performance of the whole supply chain. RFID is the latest technology, which is, similarly to its predecisor - bar code technology, used for tracking and tracing cargo in SCM. Thus, the RFID directly affects on the increase of:

- the efficiency and integration of complex and geographically sparsed supply chains,
- material flow transparency and control,
- security, and
- possibilities for reaction between different user requirements.

The integration of key business processes in logistics SCM is imperative. It has been shown that the integration of SCM has direct proportional impact on the quality performance of SCM (Pagell, 2004).

Most of the current RFID tracking systems are designed for single companies. Many authors (Power, 2005; Prajogo and Olhager 2012) point out that the greatest level of SCM integration is achieved in the cases of maximum communication compliance of the companies information systems with information and communication technology (ICT) solutions. In this sense, it is considered that the optimal solution involves the construction of an integrated tracking system to cover the whole supply chain (Wyld, 2006; Zhou, 2009).

However, some authors (Fabbe-Costes, 2007; Das, 2006; Germain, Claycomb and Droge 2008; Gimenez, van der Vaart and van Donk 2012) deny the positive relationship between supply chain integration and supply chain performance. They feel that high supply chain integ-ration will be positively related to performance only if supply complexity is high. It is therefore very important to create complementary infocommunication requirements, in the context of the SCM. We believe that they can allow greater use of RFID, and quality SCM integration. Because supply chain in the progress of tracking items requires not only collaboration between actors, but also advanced and integrated information systems between organizations.

Supply chains consist of two sub-structures:

- physical, which deals with the flow and storage of goods, and
- information on their movement.

The rapid development of ICT systems has enabled companies to increase the level of supply chain integration by linking inter-organizational information systems (IOIS) with applications such as e-business technologies (Sanders, 2007; Rajaguru and Matanda 2009), inte-rnet of things, or "*internet of everything*", and outsourcing services. Therefore, IOIS have beco-me an essential tool to achieve supply chain integration. Zhang, van Donk and van der Vaart (2011) consider that ICT is expected (among other factors) to influence the following supply chain performance measures: cost, delivery, quality, flexibility, inventory, process improve-ment, innovation, and sales and financial. The SCM literature highlights the existence of certain problems in the adoption of IOIS. It is connected with the need of integration of the entire supply chain, as well as the integration of information flows. It is very difficult to provide the first, although specified degrees of integration are mutually dependent and directly affect the level of competitiveness of the supply chain and all the firms within it.

7.2 RFID Implementation Strategy

The use of radio frequency identification (RFID) technology in the supply chain (Sri-vastava, 2010) is one of the latest logistic strategies. It is expected that adopting the RFID sys-tem will be disruptive for many competitive (alternative) technologies. But, since RFID technology brings real-time data, speed and connectivity to supply chains, it is clear that companies that share and process information in real-time across the supply chain will be in a much better position to respond to changes in the marketplace, as Barratt (2004) emphasizes. All this has a significant impact on overall profitability. There are several benefits and impediments of RFID implementations to supply chains.

RFID tags attached to products are capable of providing real-time tracking and tracing information across the supply chain. Angeles (2005) and Srivastava (2004) considered this important because of the possibility of supply chain efficiencies and revenue generation. In this regard, a number of studies forecast the market for RFID tags, products and services to increase sharply in the coming years. However, several years ago, many authors indicated: a) that the technology for supply chain management is still emerging, and b) that there are many obstacles related to cost, global standards, system integration, information technology (IT) infrastructure, privacy and security are seriously hindering the widespread deployment of RFID in supply chains.

There are also some major technological problems, which are associated with signal distortion, reader accuracy and scalability all of which can lead to imprecise tracking of products in the supply chain.

Nevertheless, for several years, many companies have embraced RFID in their supply chains and are beginning to enjoy real business benefits from this technology (Attaran, 2012). Today, supply chains have to rely on technology to deliver a higher level of performance and satisfying consumer needs. The basic advantages of RFID technology could much improve supply chain performance by reducing inventory levels, lead times, stock outs and shrinkage rates. It can also increase throughput, inventory visibility, inventory record accuracy, order accuracy, customer service, quality and collaboration among supply chain members.

Numerous changes and benefits of the deployment of RFID technology in SCM are in detail specified by Attaran (2012, pp. 148-149). The main thing is that through the improvement of communication in the SCM, RFID has the real potential to increase accuracy and reliability, enhance service and reduce costs. In Table 7.1 are listed some comparative advantages of RFID due to bar code applications, e.g.

Table 7.1. RFID vs. bar code

Features	*Bar code*	*RFID*
The rate of multiple reader information	slowly	fast
Identification of moving objects	very difficult	simply
Simultaneous identification of multiple objects	impossible	possible
The need for line of sight tag	yes	no
Location tags	reader in a parallel plane	3D reading
Security feature	absent	great safety
Rewritable information / reusable labels	impossible	possible
The ability to store hidden data	absent	present
The volume of storage	little	big
The presence of the unique tag identifier	no	yes
Opportunities for distance reading label	low	high
The life of the label and operating conditions	not rated	10 years or more

Source: Adapted from: Kamozin, 2013, p. 73

From the point of SCM efficiency, tracking enables visibility between supply chain actors and operations. The literature points out that RFID has the following two crucial advantages over barcodes:

- it does not require a line of sight to be read, and
- it is possible to read multiple RFID tags simultaneously.

In addition, an RFID tag can hold a greater amount of information and these information can be changed, oposed to bar code, e.g.

To classify different usage levels of RFID tracking, Wamba and Chatfield (2009) created a four-level contingency model for effective RFID tracking integration across a supply chain:

- slap & ship (where the supplier attaches RFID tags to shipments to a focal company, which uses these tags in its own operations),
- intra-organisational,
- inter-organisational, and
- network- organisational level.

The spread of RFID technology in the context of the SCM restricts a range of economic, technical and organizational factors. Each optimization and automation require a clear formalized process of organization. This implies serious organizational changes. Another limiting factor are the high investments for its introduction and exploitation, compared, e.g., with the systems that are based on bar code. The problem is that the identification area of the tags (which are information holders for the object) has no clear boundaries in the case of using signal frequencies. Serious limitation is the absence of a unified international system of electronic coding, within which any merchandise would have a singular number, a unique global standard for frequency and a protocol for identification tags and equipment exchange.

7.3 Problem Formulation

As it is previously mentioned, the RFID technology has several significant beneficial aspects (Kapoor, Zhou and Piramithu, 2009) in comparison to bar code technology, e.g., batch readability, resistance to harsh environment conditions, information storage and processing capability, etc. On the other side it has also several substantial disadvantages, as: read error, privacy / security concerns, computing bottleneck, cost-benefit issues (vagueness of return of investments and difficulties in estimating opportunity costs), ownership transfer problems, economic disincentives of information sharing, risk of obsolescence, inter-operability (global) standards issues, etc. In an effort to estimate preferences among some of the RFID shortcomings while implementing in SCM, we conducted two surveys among the post-graduate students at the University of Montenegro. It is about the students who have previously acquired a solid theoretical knowledge in the fields of SCM and RFID. Also, we have previously estimated throughout our work with these students that they have a high level of logical reasoning and that they are highly motivated to give a contribution to our research work.

7.4 Some Quantitative-Qualitative Analysis

Namely, in order to determine the preferences of some critical issues in adaptation of RFID technology in the supply chains, two surveys are conducted among the selected post-graduate students with high level of logical thinking at the University of Montenegro, as it is noted above. In the first survey, on the basis of Saaty AHP method (Saaty, 1980; 1994; 1997, 2003), 15 consistent responses are selected and the rank of four key challenging issues in implementation of RFID in SCM is estimated.

In the second survey, 20 responds, given by another group of selected post-graduate students at the same University, is used for examining correlation between two pairs of criteria considered as relevant ones for adapting RFID. For this purpose Spearman's rank correlation coefficient is used (Bertskas and Tsitsiklis, 2008). Additionally, each sub-criterion identified within the main four sets of the analyzed critical factors for implementing RFID in SCM is determined.

A rather simple additive method has been used over respondents' numerical assessments of the sub-criteria relevancies for the considered topic. Some more detail about the surveys, including the methodology and the obtain results discussions, are given in the following two sub-sections.

7.5 Survey 1: Methodology and Results

The idea of ranking criteria indentified as challenging ones for adapting RFID in supply chains is associated in the paper with AHP (Analytical Hierarchy Process) approach (Saaty, 1980; 1994; 1997, 2003; Bauk, Sekularac-Ivosevic and Jolić, 2013). Ranking is a procedure, when the most significant criteria is given the highest rank, the last significant one is given the lowest rank, while the other criteria are somewhere between these two upper and down rank boundary values.

The respondents, i.e., 35 selected postgraduate students at University of Montenegro (i.e., Faculties of Management Studies in Kotor and Cetinje) with the high level of logical thinking and comprehensive theoretical knowledge in SCM and RFID management are asked to compare each pair of four selected criteria:

- C1 - read errors and privacy (security) issues;
- C2 - back-end IT system bottleneck;
- C3 - cost issues (future payoff); and
- C4 – evolving standards.

Table 7.2. The individual ranks of the criteria (C1-C4) estimated by each respondent

R	w/r	C1	C2	C3	C4	CR
R_1	w	0.192393	0.128661	0.40681	0.272085	0.069739
	r	3	4	1	2	
R_2	w	0.113462	0.142671	0.182317	0.56155	0.015026
	r	4	3	2	1	
R_3	w	0.295185	0.417454	0.133365	0.153996	0.0795689
	r	2	1	3	4	
R_4	w	0.404851	0.316813	0.182912	0.0954243	0.0795689
	r	1	2	3	4	
R_5	w	0.291078	0.244764	0.173076	0.291078	0.0679926
	r	1.5	3	4	1.5	
R_6	w	0.090822	0.444936	0.348181	0.11606	0.0990883
	r	4	1	2	3	
R_7	w	0.103939	0.115028	0.578559	0.204740	0.0648318
	r	4	3	1	2	
R_8	w	0.0640487	0.101472	0.312540	0.521939	0.0785161
	r	4	3	2	1	
R_9	w	0.0887143	0.116755	0.277691	0.516841	0.0779181
	r	4	3	2	1	
R_{10}	w	0.294223	0.480464	0.142843	0.0824703	0.064535
	r	2	1	3	4	
R_{11}	w	0.102988	0.483557	0.252269	0.161186	0.052792
	r	4	1	2	3	
R_{12}	w	0.0745206	0.129073	0.466524	0.329882	0.0795689
	r	4	3	1	2	
R_{13}	w	0.090822	0.444936	0.348181	0.11606	0.0990883
	r	4	1	2	3	
R_{14}	w	0.10611	0.450187	0.259915	0.183788	0.0606714
	r	4	1	2	3	
R_{15}	w	0.105058	0.445724	0.284792	0.164425	0.0956619
	r	4	1	2	3	

Due to the Saaty scale, the respondents used the following grades: 1-same importance of the criteria in the considered pair of criteria, 3-weakly more importance, 5-moderately more importance, 7-strongly more importance, and 9-absolutely more importance of the first than the second considered criterion; or, the corresponding reciprocity values.

Although 35 respondents were asked to create Saaty matrixes, only 15 consistent Saaty matrixes have been taken into further consideration.

By means of the normalized eigenvector values calculus (Sivilevičius and Maskeliunaite, 2010), the weight vectors (w) and ranks (r) of the examined criteria are calculated for each respondent (Table 7.2), along with the consistency index CI, while the random index RI is equal to 0.9 in all cases, since the number of criteria is constant and equal to four. The ratio of CI and RI is calculated and it is in all selected cases smaller or equal to 0.1 ($CR \leq 0.1$) what is the condition of Saaty's matrix consistency (Bauk, Sekularac-Ivosevic and Jolić, 2013).

The source code being realized in Wolfram Mathematica (ver. 8) program is used for the calculus.

The aggregate or final rank of the four selected criteria (C1-C4) is determi-ned by means of normalized average weight coefficients per criteria. The idea of evaluating these weight coefficients is associated with the sum of ranks of each criterion, with respect to the estimates of respondents:

$$c_q = \sum_{p=1}^{15} c_{qp} \,,\ q = \overline{1,4} \qquad (1)$$

Where, c_q - is the sum of ranks of each criteria, while q is the number of criteria (4), and p is number of respondents (15); and, c_{qp} - is rank of the q-th criteria estimated by the p-th respondent. The average weight coefficient for each criterion is calculated by the following formulae:

$$\overline{w_q} = \left[c_q / \sum_{q=1}^{4} c_q \right]^{-1} \qquad (2)$$

The normalized average weight coefficients are then calculated by formulae:

$$\overline{w_{qn}} = \overline{w_q} / \sum_{q=1}^{4} \overline{w_q} \qquad (3)$$

The aggregate or final ranking of analyzed criteria (C1-C4) according to their significance, carried out by 15 respondents is demonstrated in Table 7.3 and presented graphically in Figure 7.3.

Since the consistency of the respondents ranking is important in making conclusions due to the final criteria rank, the concordance coefficient value is calculated as a measure of reconciliation of the respondents' attitudes towards the considered critical issues in adapting RFID technology in SCM.

Figure 7.3. Final rank of critical factors for adapting RFID in supply chains

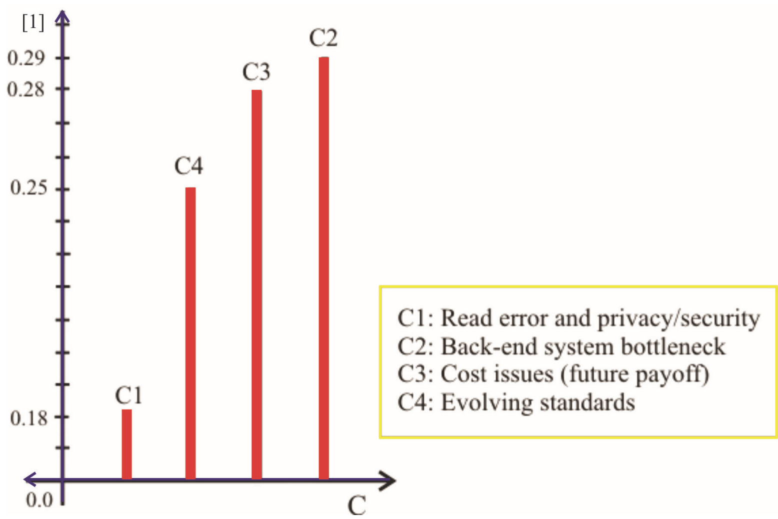


Table 7.3. The aggregate (final) rank of the examined criteria (C1-C4)

C/R	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9
C1	3	4	2	1	1.5	4	4	4	4
C2	4	3	1	2	3	1	3	3	3
C3	1	2	4	3	4	2	1	2	2
C4	2	1	3	4	1.5	3	2	1	1

R_{10}	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	$\overline{w}_{qn}$	r
2	4	4	4	4	4	0.18339	4
1	1	3	1	1	1	0.29283	1
3	2	1	2	2	2	0.27508	2
4	3	2	3	3	3	0.24870	3

The concordance coefficient W is calculated as [35]:

$$W = 12S / p^2 q\left(q^2 - 1\right) \qquad (4)$$

Where,

$$S = \sum_{q=1}^{4}\left(c_q - \left(\sum_{q=1}^{4}\sum_{p=1}^{15} c_{qp} / 4\right)\right)^2$$ - is analogue to the variance of the ranks;

p – is the number of the respondents (15); and,
q – is the number of the criteria (4).

The smallest value of W, i.e., W_{min} is calculated by the formulae:

$$W_{min} = \chi^2_{\alpha,\upsilon} / p(q-1) \qquad (5)$$

Where,

$\chi^2_{\alpha,v}$ - is critical chisquare statistics, found in the table [36, p. 655] by assuming the degree of freedom $\upsilon = 4-1$, and the significant level $\alpha = 0.050$. Here, it is: $\chi^2_{\alpha,\upsilon} = 7.81$. By taking into account the obtained value for $\chi^2_{\alpha,v}$ and by replacing it in (5), we get value: $W_{min} = 0.128482$, while $W = 0.184444$.

We can conclude that the condition $W_{min} \le W$ is satisfied, and that the estimates of the respondents are consistent in the satisfying level. The appropriate source code realized in Wolfram Mathematica (ver. 8) program is used for calculating concordance coefficient W and checking the measure of reconciliation of the respondents.

In the following paragraph a short discussion of the obtained final rank of the analyzed criteria is given. Namely, the respondents gave the highest priority to the critical issue C2 - back-end IT system bottleneck, on the second place is the criterion C3 – cost issues (future payoff), on the third one is C4 – evolving standards, and on the last position is C1 – read error and privacy (security) issues.

The respondents are very well aware that RFID tags generate more information per scan than bar code and they are scanned more frequently. More precisely, RFID-tagged systems generate 10-100 times the volume of data generated in bar code systems while the mobility in SCM increased frequency in tag reads (Kapoor, Zhou and Piramithu, 2009). This problem can be overcome by evolutionary computational breakthrough, like quantum computing, which is still in its infancy. Bearing this in mind the respondents gave the highest priority to this criterion (C2).

Furthermore, it is quite clear that RFID implementations are more expensive than comparable bar code applications. RFID applications include the cost of implementation, tags, readers, backend IT systems to gather, maintain and process the data, including the adaption of the existing customer relationship management (CRM) and enterprise resource planning (ERP) systems. Each of these costs exceeds the bar code ones. The cost structure when it comes to implementation of RFID technology is clear while the opportunity costs and future payoff are unclear. These considerable costs of implementation and vague opportunity costs and future payoff are the reasons why the responders here highly ranked this criterion (C3).

When it comes to the regulatory standards, they are necessary to ensure minimum level of quality, inter-operability, reliability and safety. However, the respondents are aware that the standardization should be treated as a follow-up process of this emerging technology adaption in SCM, and this might be the reason why they placed it at the third position (C4). And finally, even it is difficult to guaranty 100% RFID tags read rate due to the dynamic nature of reading process and various ambient conditions, this technology is progressing one and read rate error is today quite low (Piramuthu, 2008).

Besides, the researchers have developed a large number of security protocols that can be used for secure communication between tags and readers (Roberti, 2015). These are the reasons why the respondents considered the first examined criterion (C1) as the lowest challenging one in wider RFID implementation.

7.6 Survey 2: Methodology and Results

In the second cycle of exploring challenges of adapting RFID technology in SCM, 20 respondents selected among the postgraduate students at the University of Montenegro (Faculties of Management Studies in Kotor and Cetinje) are asked to evaluate the importance of the several sub-criteria grouped in four categories: standardization, privacy/security, technology evolving, and costs (Table 7.4).

Table 7.4. Examining correlation between challenging criteria sub-sets for adapting RFID in SCM

Standardization (S) ←→ Privacy/security (P)			
S1	Developing standards for ensuring interoperability at the global level	P1	Ownership transfer issues between seller and buyer
S2	Developing new standards while ensuring that these interoperate with existing standards	P2	Securing data safety and customer privacy
S3	Alleviating regulatory aspects differences among countries	P3	Conflict of interests caused by sharing tagged items information between seller and buyer
Technology evolving (T) ←→ Costs (C)			
T1	Reducing bottleneck in RFID back-end data processing	C1	High investments while introducing this technology
T2	Reducing read rate error to a minimum	C2	Returns on investment vagueness
T3	Developing advanced tag and reader solutions	C3	Difficulties in estimating opportunity costs and risk of obsolescence

The respondents had to estimate each of below listed sub-criteria by mark 1, 2, 3, 4, or 5, due to their own opinion, while 1 represent the lowest importance (priority), and 5 the greatest one. The rest (2,3, and 4) are in between boundary values. Then, the correlation between standardization (S) and privacy/security (P) sets of criteria, and between technology evolving (T) and costs (C) sets is calculated on the basis of Spearman's rank coefficient of correlation (Bertskas and Tsitsiklis, 2008), since the number of compared pairs is relatively small (here it is 20).

Table 7.5. Calculus tor determining Spearman's rank correlation coefficients

S	P	Rank (S)	Rank (P)	d	d^2	T	C	Rank (T)	Rank (C)	d	d^2
4.33	3.67	4	15	0.67	0.44	4.33	3.67	4	15	0.67	0.44
3.00	4.67	16	6	-1.67	2.78	3.00	4.67	16	6	-1.67	2.78
4.33	4.67	4	6	-0.33	0.11	4.33	4.67	4	6	-0.33	0.11
5.00	5.00	1	1	0.00	0.00	5.00	5.00	1	1	0.00	0.00
4.00	5.00	8	1	-1.00	1.00	4.00	5.00	8	1	-1.00	1.00
4.00	5.00	8	1	-1.00	1.00	4.00	5.00	8	1	-1.00	1.00
4.33	3.00	4	18	1.33	1.78	4.33	3.00	4	18	1.33	1.78
2.67	4.00	18	13	-1.33	1.78	2.67	4.00	18	13	-1.33	1.78
4.67	3.00	2	18	1.67	2.78	4.67	3.00	2	18	1.67	2.78
4.33	5.00	4	1	-0.67	0.44	4.33	5.00	4	1	-0.67	0.44
2.67	3.33	18	17	-0.67	0.44	2.67	3.33	18	17	-0.67	0.44
3.67	4.00	14	13	-0.33	0.11	3.67	4.00	14	13	-0.33	0.11
4.00	4.67	8	6	-0.67	0.44	4.00	4.67	8	6	-0.67	0.44
2.33	4.67	20	6	-2.33	5.44	2.33	4.67	20	6	-2.33	5.44
3.67	4.67	14	6	-1.00	1.00	3.67	4.67	14	6	-1.00	1.00
4.00	3.00	8	18	1.00	1.00	4.00	3.00	8	18	1.00	1.00
4.00	5.00	8	1	-1.00	1.00	4.00	5.00	8	1	-1.00	1.00
4.00	4.67	8	6	-0.67	0.44	4.00	4.67	8	6	-0.67	0.44
3.00	4.67	16	6	-1.67	2.78	3.00	4.67	16	6	-1.67	2.78
4.67	3.67	2	15	1.00	1.00	4.67	3.67	2	15	1.00	1.00

Based on the conducted survey, it appears that there is a high degree of positive correlation between challenging criteria sets: standardization – privacy / security, and technology evolving – costs. The obtained results are presented in Table 7.5.

Spearman's rank correlation coefficient (r_s) is a reliable and fairly simple method of testing both the strength and direction (positive or negative) of any correlation between two variables. It can be calculated by using the following formulae:

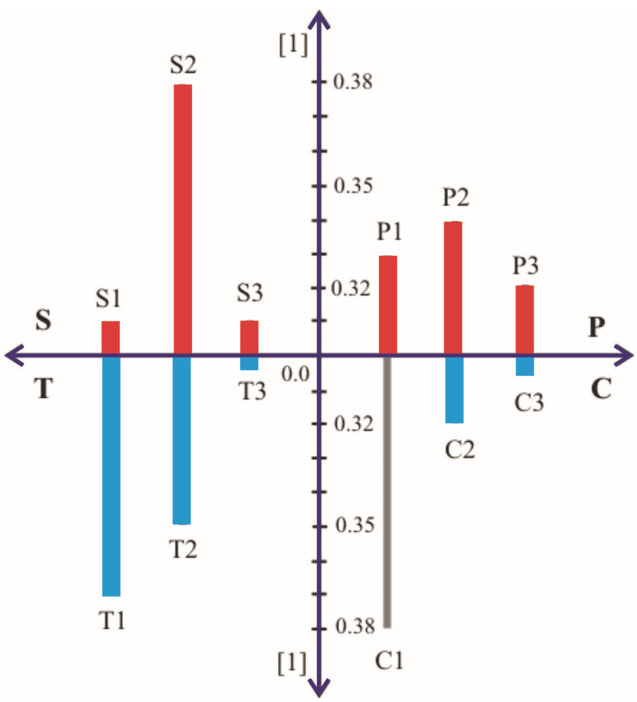
$$r_s = 1 - \left(\frac{6\sum_{i=1}^{n} d_i^2}{n^3 - n} \right) \qquad (6)$$

Where,

r_s – is Spearman's rank correlation coefficient;
d – is the difference between two considered variables ranks; and,
n – is the number of pairs of criteria compared by the respondents (here 20).

In the first here considered case, $r_s = 0.983$, and in the second one, $r_s = 0.993$. Of course, it is necessary to see how likely it is that r_s is not just the result of chance. As a result of significance testing, by checking Spearman's rank correlation coefficient critical values table, arises that the probability that r_s is result of poor chance is lower than 0.005. It means that in less than 5 cases of 1000 ones, r_s is obtained by chance. Or, in other words, in more than 955 cases of 1000 ones, there is a strong positive correlation between the sets of compared critical issues for employing RFID in SCM. These results have statistical significance, and they have also logical meaning: higher level of standardization causes greater level of privacy/security; and, greater technological deve-lopment produces greater necessity for extensive cost-benefit analysis.

Figure 7.4. Normalized rank of examined criteria relevant for adapting RFID in SCM



Legend: S – standardization; P – privacy/security; T – technology evolving; C – costs issues

Besides the analysis of Spearman's rank correlation coefficients for standardization – privacy / security sub-sets of characteristic criteria, and technology – costs ones, their normalized ranks are determined and presented in Figure 7.4. On the basis of the second conducted survey (Figure 7.4), it is clear that the respondents estimated as highly important developing new standards while ensuring that these interoperate with existing ones (S2) while developing standards for ensuring interoperability at the global level (S1), and alleviating regulatory aspects differences among countries (S3), share the second and the third position.

The ranks of privacy/security sub-criteria are rather uniform, while securing data safety and customer privacy (P2) has a slight preference in comparison to ownership transfer issues between seller and buyer (P1) and conflict of interests caused by sharing tagged items information between seller and buyer (P3) sub-criteria. When it comes to technology evolving set of sub-criteria relevant for wider implementation of RFID in SCM, than reducing bottleneck in RFID back-end data processing (T1) has considerable preference in comparison to reducing read rate error to a minimum (T2) and developing advanced tag and reader solutions (T3).

The greatest rank of analyzed costs is assigned to the high investments while introducing this technology (C1) sub-criterion. Costs' sub-criteria related to returns on investment vagueness (C2) and difficulties in estimating opportunity costs and risk of obsolescence (C3) have considerably lower rank, respectively. It should be noted that these results are obtained by interviewing the students who have a solid knowledge in the fields of SCM and RFID. However, the results might be different in the case of interviewing other (larger) group(s) of students or experts in this area. In the absence of opportunities to interview the experts for the implementation of RFID in SCM or users of this technology, the analyses are done over the available set of respondents in the case of our research. Hence, the possibility of cloning the above performed and discussed experiments on a larger sample and different structure of respondents remains open.

In this paper by using the information from published secondary data, we have identified a comprehensive list of both advantages and disadvantages of RFID implementation into SCM with an aim to support its complete integration. While RFID has many benefits to offer, significant stumbling blocks still exist (Attaran, 2012). Due to the lack of literature sources dealing with a deeper analysis of the shortcomings of RFID technology implementation into SCM, we have just put in our work an emphasis on this aspect. Throughout two surveys conducted among selected groups of post-graduate students at the Faculties of Management Studies in Montenegro, the rank of four critical issues for adapting RFID in SCM is identified: back-end IT system bottleneck, cost issues (with particular attention to payoff interval), evolving standards, and read error and privacy/security issues. Some logical explanations of such rank, supported by available data from secondary re-sources, are given. The explanations include a dose of arbitrariness related with relatively small sample of respondents. Our future research work in this domain should include a larger number of heterogeneous respondents (including experts, researchers, producers, and customers) and it might include indepth interviews besides the standard questionnaires, as well.

Besides the aggregate rank of above listed four key critical factors for implementing RFID, a Spearman's rank correlation coefficient for two pairs of impediment criteria in this domain is determined. The high degree of positive correlation between standardization – privacy / security (and technology – costs criteria sets is ascertained. Also, the ranks of sub-criteria forming standardization, privacy/security, technology, and costs concerned sets is set by a rather simple additive method over assessments of the sub-criteria given by the respondents. The following final rank of these sub-criteria is observed:

- *Standardization*:
  - ✓ developing new standards while ensuring that these interoperate with existing ones,
  - ✓ developing standards for ensuring interoperability at the global, and
  - ✓ alleviating regulatory aspects differences among countries;
- *Privacy/security*:
  - ✓ securing data safety and customer privacy,
  - ✓ ownership transfer issues between seller and buyer, and
  - ✓ conflict of interests caused by sharing tagged items information between seller and buyer;
- *Technology*:
  - ✓ reducing bottleneck in RFID back-end data processing,
  - ✓ reducing read rate error to a minimum, and
  - ✓ developing advanced tag and reader solutions;
- *Costs*:
  - ✓ the high investments while introducing this technology,
  - ✓ returns on investment vagueness, and
  - ✓ difficulties in estimating opportunity costs and risk of obsolescence.

Similarly to the comments associated with the previously presented ranks, it should be pointed here as well, that further examinations in this domain should involve larger sample of respondents of different profiles, and eventually involve another and/or additional quantitative methods. However, the observed results might be useful for the managers, particularly in transitional economies, to give them an overview of critical factors and the scale of their impacts while tailoring RFID adaptation and applications to the individual company needs.

There is also one new dimension which should not be neglected within this context: shifting emphasize from manufacturers and retailers in supply chains to the customers. RFID's insight into consumer buying habits can provide delivering higher level of performances, but it can also increase vulnerability of customers' privacy/security. Therefore the future investigations in this domain should take into consideration both positive and negative impacts of scanning customers' habits via RFID with an intention to empower providing novel, customized services within fully integrated supply chains while guaranteeing satisfying level of privacy /security.

8. SPREADSHEETS IN FUNCTION OF OPTIMISATION OF LOGISTICS NETWORK*

Study below discusses how estimated spreadsheets functions in logistics networks optimization. The basic point for efficacy of estimated spreadsheets in designing logistics networks is n and a practical example. In this way the given model can be applied to all logistics networks of similar problem capacity. Logistics network model confronting estimated spreadsheets present a real world at a level needed for understanding the problem of optimization of logistic networks. Applied scientific research is based on analysis and synthesis method, mathematical method and information modelling method.

* Co-authorship with D. Pupavac

The development of network of national, regional and global economies provides possibilities for taking advantages of volume economies, i.e. development of greater number of logistic operators which will, besides the services provided within national networks, offer them on regional level and ultimately, on global level. Spreading of logistics network leads to rationalisation in transport network, distribution network and decrease of stock within unique global logistics network. Technological break-throughs, that form part new technology paradigm, offer the possibility of creating different structure of global logistics networks, which can be entirely optimised by use of information technologies.

Therefore, the following hypothesis has been set: Calculation tables form representative model in logistics networks' optimisation, i.e. model once created for a certain problem can be used for solving problems in all logistics networks of similar problem area. Scientific research applied for proving the hypothesis is based on methods of mathematical and information modelling.

8.1 Theoretical Characteristics of Logistics Network

Multiple networks between companies are becoming more of a rule than an exception nowadays. The world where single companies are competing among themselves for profit, in a kind of interpersonal market, does not actually exist. The world of modern business is characterised by networks of social and exchange relations between companies and surrounding factors. Companies choose cooperation as one of the ways of achieving competitiveness; enter different kinds of supply chains or logistics networks. In this way, multiple networking is being created which has marked modern global economy, and has made difficult drawing a line between cooperation and competition.

Complex inter-connected processes (networks) can be found in almost every kind of human activity, especially transport, logistics and economy. A network is made up of nodes and directed arcs connecting pairs of nodes. Networks can take all sorts of forms (Table 8.1).

Companies develop logistics networks in order to obtain information, resources, markets and technologies, or in order to achieve economy effects of size and range. Logistics networks represent ultimate achievement of inter-logistic management or logistic chains management. In logistics terms network is the collection of locations and routes along which a product can be shipped.

For example, a company needs to decide whether to ship products directly to customers or to use a series of distribution layers. Quick response to changes in demand requires effective solutions by all participants along the logistics network (Figure 8.1.1).

Table 8.1. Type of network

Type of network	*Nodes*	*Arcs*	*Flow*
Communicaton networks	O-D pairs for massages	Transmission lines	Message routing
Computer networks	Storage device or computers	Transmission lines	Data, messages
Railway networks	Yard and junction pts.	Tracks	Trains
Logistics networks	Plants, warehouses, ...	Highways, railway tracks etc.	Trucks, trains, etc

Logistics network in figure 8.1. is made of four objective layers. Process of produc-tion is taking place downstream from the production supplier, from production plant to distri-bution centres and from distribution centres to market. Logistics network can have any given number of objective layers. Furthermore, production layers sometimes take place downstream even when semi-products or parts of products are being returned to production plants for fi-nishing or when the products not intended for further sale are being returned from retail locations to distribution centres for recycling. In this way the there is no competition between single companies but between entire networks, and the prize goes to the company that has created a better network.

Principle of operation is very simple: create a solid network of relations with key elements, aided by logistics operator as optimisation factor for logistic activity along the network, and the profit will follow.

The network being created by global logistics operator between global producer and buyer can be viewed as follows (Figure 8.3).

Figure 8.1. Logistics network

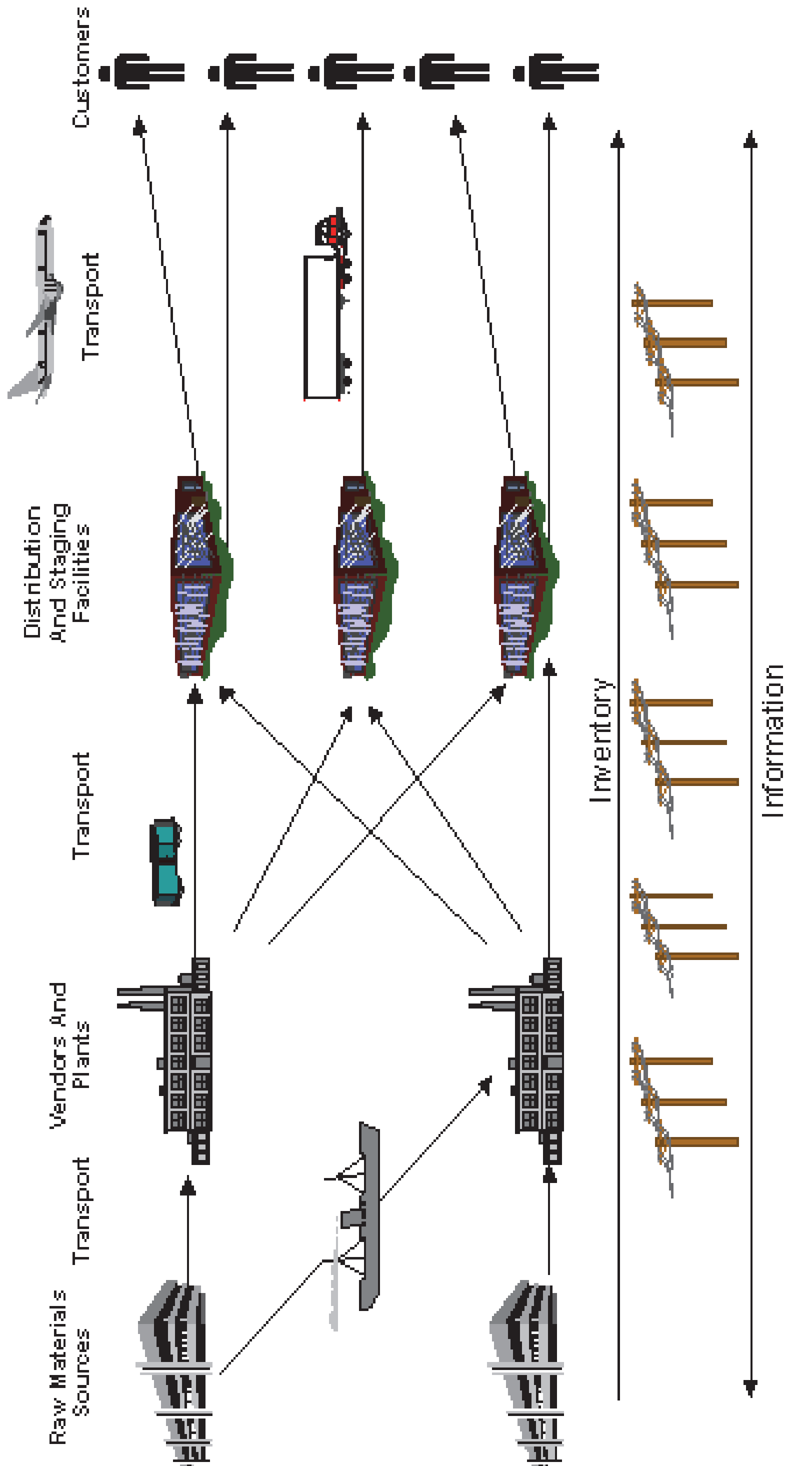


Figure 8.2. Logistics network in industrial firm

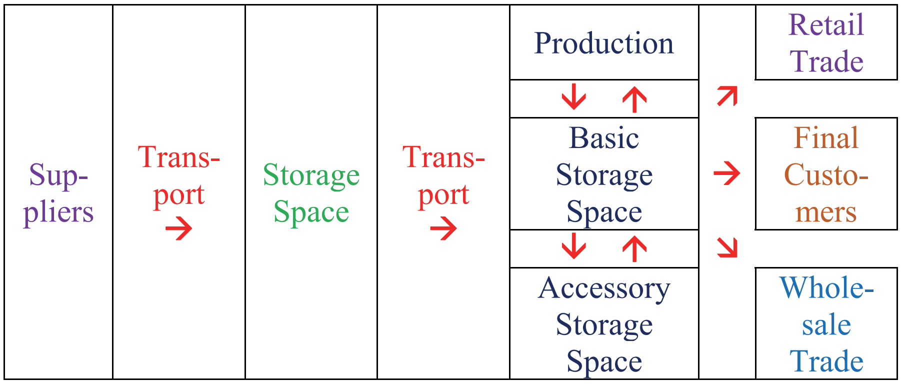
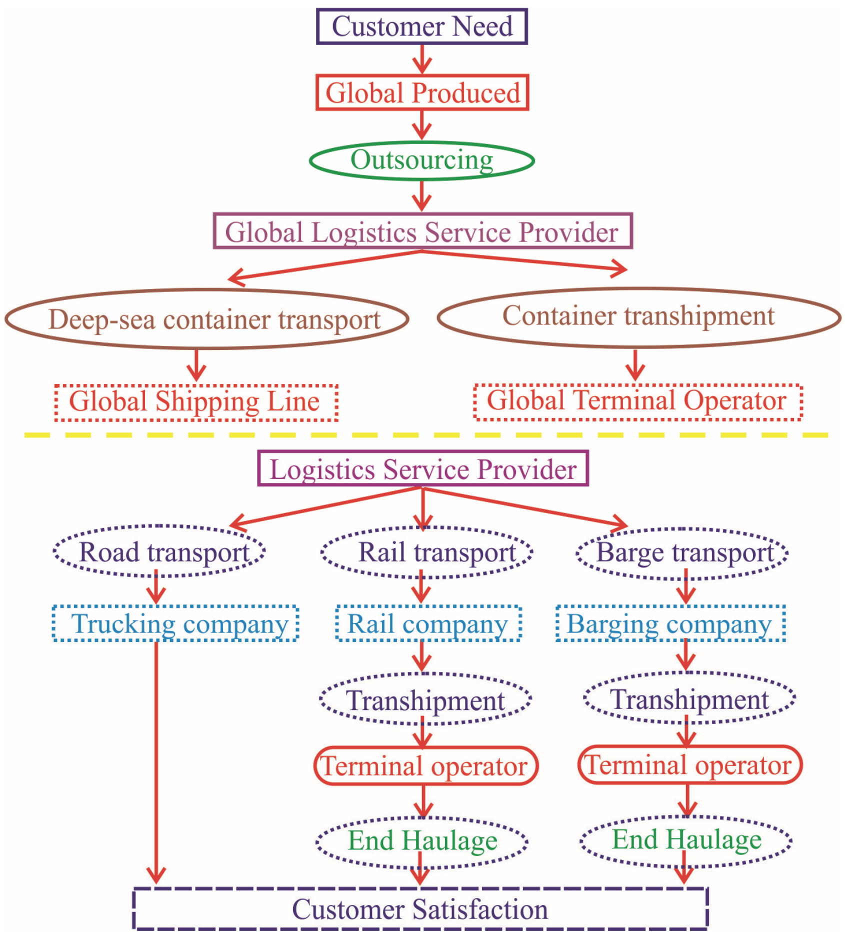


Figure 8.3. Global logistics network



Source: Prepared author according: Wiegmans et. al., 1999.

By connecting supply and demand, i.e. production and consumption, logistics operators are creating national, regional and global logistics network which can provide following advantages to participants in global logistics chains:

- decrease of costs (labour, taxes, customs and other duties),
- improvement of effects for all the participants in supply chain that has been formed,
- higher quality production inputs, and especially higher quality logistics services,
- opening of new and more distant markets, and
- improvement of own performance through development of partner relations with other participants of the chain.

8.2 Spreadsheet and Problem of Optimisation on Logistics Network

In the realm of accounitng jargon a «spread sheet» or spreadsheet was and is a large sheet of paper with columns and rows that organizes data about transactions for a business person to examine. An electronic spreadsheet organizes information into software defined columns and rows. The data can then be “added up” by a formula to give a total or sum. The market for electronic spreadsheet software was growing rapidly in the early 1980s and VisiCalc stakeholders were slow to respond to the introduction of the IBM PC that used an Intel computer chip. During this period, Mitch Kapor developed Lotus and his spreadheets program quickly became the new industry spreadsheet standard. In 1983, Lotus' first year of operations, the company reported revenues of $53 Million and had a successful public offering. In 1984, Lotus tripled in revenue to $156 Million (Power, 2004).

The next milestone was the Microsoft Excel spreadsheet. Excel was originally written for the 512K Apple Macintosh in 1984-1985. Excel was one of the first spreadsheets to use a graphical interface with pull down menus and a point and click capability using a mouse pointing device. When Microsoft launched the Windows operating system in 1987, Excel was one of the first application products released for it. When Windows finally gained wide acceptance with Version 3.0 in late 1989 Excel was Microsoft's flagship product. For nearly 3 years, Excel remained the only Windows spreadsheet program and it has only received competition from other spreadsheet products since the summer of 1992.

Definition of a calculation table within new condition of technological paradigm is being transferred to functional nature of calculation tables from the system transition application state viewpoint (Vukmirović, Zelenika, and Pupavac 2004). In such paradigm a calculation table is being observed as an entirety made of four main components saved in address lines of lines, columns and matrixes. Such observation is pointed to calculation table as function of computer supported complex mathematical operation combined with matrix-network modelling. Such approach leads to new definition of calculation table: calculation table is collection of functions and formulas which, when inter-connected, can support the logic of data flows and establish development of complex computer supported mathematical algorithms to support quantity modelling of entire and complex problems.

Following expenses can be the object of optimisation on a logistics network (Pupavac, and Zelenika, 2004):

- material cost,
- acquisition costs,

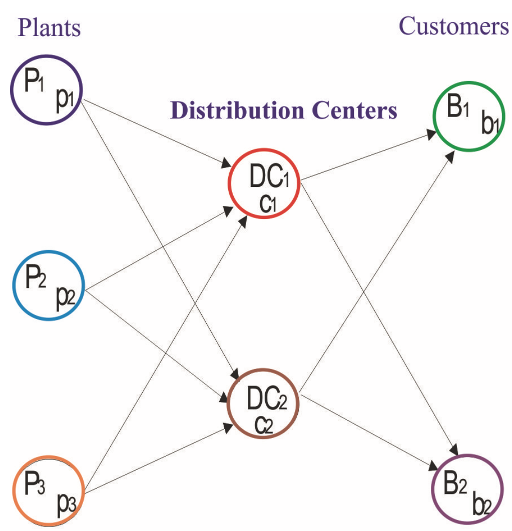
— investment costs,
— production costs,
— costs of distribution centres,
— costs of keeping stock,
— costs of internal and outbound transport.

Execution of optimisation methods by use of calculation tables has the advantage in possibility of physical integration of programmed routines into self-generated applications. Computer supported optimisation methods are created in a manner that allows them to be parallel used in other relevant applications, to the point that they can be physically incorporated into them. Such methods fall under category of computer-integrated tools of applied mathematics. After programme execution the data remains permanently saved in template form, which is the basis for development of model base in logistics networks optimisation.

8.3 Computer-Supported Model of Logistics Network Optimisation

In order to illustrate the part of calculation tables in logistics network optimisation we will further on deliberate on logistics network which has "i" production plants, "j" distribution centres and "k" consumer points (Figure 8.4).

Figure 8.4. Crossdocking



Production plants P_1, P_2 and P_3 produce same goods during the period in question in quantities p_1, p_2 and p_3. B_1 and B_2 are consumer points of the same goods with quantities b_1 and b_2. Every unit of goods is being transported from producer to consumer via one of distribution centres D_1 and D_2 which have capacities of c_1 and c_2. We will mark c_{ij} the cost of transport per unit from producer P_1 to distribution centre DC_j, and c_{jk} as cost of transport from distribution centre DC_j to buyer B_k. This is a classic two-layer transport problem (Pasagic, 2003, pp. 161-162) because the transport is done from the place of production to the place of consumption through distribution centres.

One can ask which are the reasons that speak in favour of distribution centres in a logistics network. The reasons are many (Barković, Meler, and Novak, 1986), and we will state only three:

- decrease distribution costs (degression effect of cost from producer to distribution centres due to quantities being transported),
- decrease of delivery time (from distribution centre to buyer due to stock),
- possibility of combining shipments for one buyer with the possibility of reduction of transport costs.

As the costs of shipments' processing in distribution centres are not an issue of this scientific debate, the total function of transport costs to be minimised on the suggested logistics network is (Pasagić, H., Pasagić, J., and Markic, 2004, p. 431):

$$C = \sum_{i=1}^{m} \sum_{j=1}^{r} c_{ij} x_{ij} + \sum_{j=1}^{r} \sum_{k=1}^{n} c_{jk} x_{jk} \rightarrow \min \qquad (1)$$

Production centres produce one type of goods in quantities p_1 = 200000 t, p_2 = 300000 t and p_3 = 100000 t. Demand for such goods is b_1 = 400000 t and b_2 = 180000 t. Only 200000 t can be distributed from each production centre to each distribution centre, and the same can be done from each distribution centre to each consumer. Transport costs differ and are shown in table 8.2 and table 8.3.

Table 8.2. Transportation costs - Plant to DC (€ 000 t)

Plant to DC	DC 1	DC 2
Plant 1	5	5
Plant 2	1	1
Plant 3	1	0,5

Table 8.3. Transportation costs - DC to Customer (€ 000 t)

DC to Customer	DC 1	DC 2
Customer 1	2	2
Customer 2	12	12

In table 8.4 we have set solution for minimum cost network flow problem by us of Excel calculation table, or its add-in Solver.

Firstly, single transport costs from production centres to distribution centres and from distribution centres to consumer centres (upper left part of the table) are entered into table 8.4, followed by information on transport capacities and distribution centres capacities (upper right part of the table).

The decision variables represent quantities being transported from production centres to distribution centres and from distribution centres to consumer centres (lower left part of the table). Transport costs from production centres to distribution centres, from distribution centres to consumer centres, as well as total transport costs are shown in lower right part of the table.

Variables: $C$17:$D$19;$C$23:$D$24
Constraints:
Do not exceed supply at the plants
$E$17:$E$19 ≤ $F$17:$F$19
Meet customer demand
$E$23:$E$24 ≥ $F$23:$F$24
Do not exceed shipping capacity
$C$17:$D$19 ≤ $K$6:$L$8
$C$23:$D$24 ≤ $K$11:$L$12
Flow conservation at the DCs
$C$28:$D$28 = 0

After formulating the model in this manner in Solver Parameters, click on Solve which activates the Solver programme calculating the value of variables in address sequence $C$17:$D$19 and $C$23:$D$24.

Decision variables calculated in address sequence $C$17:$D$19 and $C$23:$D$24 define the optimum solution. Table 5 show the optimal solution to the problem by use of calculation table MS Excel.

Based on the information from the table 5 it is clear that 180 t of goods should be shipped from the first production centre to first distribution centre, 200 tons of goods from second production to first distribution centre and 100 tons of goods to second distribution centre. 100 tons of goods should be shipped from third production centre to second distribution centre.

Therefore, 380 tons of goods will be shipped through first distribution centre as follows: to first consumer centre 200 tons of goods and 180 tons to second consumer centre. Second distribution centre will have shipped 200 tons of goods to first consumer centre. Minimum cost of such shippment amount to 4 210 000€ and are 390 000€ or 9,26% more favourable from the least acceptable solution obtained when the function is resolved by maximum.

Modern supply chains represent dynamic, flexible and responsive networks operating on "*predict and process*" principle, which is opposed to traditional approach "*produce then sell*". Quick response to changes in demand requires effective solution in all stages of supply chain: production, acquisition, stocking, transport and distribution. Lower number of participants, but also the domination of logistics operator characterize modern logistics network. Logistics operator is a factor, which successfully designs and optimises the logistics network, which is more and more integrated into national, regional and/or global economic system. This is the main reason for transformation of traditional forwarders into logistic operators offering not only transport, but also warehousing, information technology, and even production and global approach.

Table 8.4. Minimum Cost Network Flow Problem

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Minimum Cost Network Flow Problem												
2													
3	Unit Shipping Costs								Arc Capacities				
4	**Transportation Costs ($ 000/Ton)**								**Transportation Capacities**				
5		Plant to DC	DC 1	DC 2		Costs				Plant to DC	DC 1	DC 2	
6		Plant 1	5	5		Capacities			Costs	Plant 1	200	200	
7		Plant 2	1	1		Flows			Flows	Plant 2	200	200	
8		Plant 3	1	0,5		Payments			Payments	Plant 3	200	200	
9													
10		DC to Custome	DC 1	DC 2						DC to Customer	DC 1	DC 2	
11		Customer 1	2	2						Customer 1	200	200	
12		Customer 2	12	12						Customer 2	200	200	
13													
14	**Shipments**								**Payments**				
15													
16		Plant to DC	DC 1	DC 2	Total Out	Supply				Plant to DC	DC 1	DC 2	Total Out
17		Plant 1	0	0	0	200				Plant 1	0	0	0
18		Plant 2	0	0	0	300			Costs	Plant 2	0	0	0
19		Plant 3	0	0	0	100			Capacitie	Plant 3	0	0	0
20		Total In	0	0	0				Flows	Total In	0	0	0
21	Costs												
22	Capacitie	DC to Custome	DC 1	DC 2	Total In	Demand				DC to Customer	DC 1	DC 2	Total Out
23	Payments	Customer 1	0	0	0	400				Customer 1	0	0	0
24		Customer 2	0	0	0	180				Customer 2	0	0	0
25		Total Out	0	0						Total In	0	0	0
26													
27		Net Flow	DC 1	DC 2									
28			0	0					**Total Shipping Cost**		0		
29													

Table 8.5. Optimal Minimum Cost Network Flow Problem solution by use of calculation table

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Minimum Cost Network Flow Problem												
2													
3	Unit Shipping Costs								Arc Capacities				
4	**Transportation Costs ($ 000/Ton)**								**Transportation Capacities**				
5		Plant to DC	DC 1	DC 2		Costs				Plant to DC	DC 1	DC 2	
6		Plant 1	5	5		Capacities			Costs	Plant 1	200	200	
7		Plant 2	1	1		Flows			Flows	Plant 2	200	200	
8		Plant 3	1	0,5		Payments			Payments	Plant 3	200	200	
9													
10		DC to Customer	DC 1	DC 2						DC to Customer	DC 1	DC 2	
11		Customer 1	2	2						Customer 1	200	200	
12		Customer 2	12	12						Customer 2	200	200	
13													
14	**Shipments**								**Payments**				
15													
16		Plant to DC	DC 1	DC 2	Total Out	Supply				Plant to DC	DC 1	DC 2	Total Out
17		Plant 1	180	0	180	200				Plant 1	900	0	900
18		Plant 2	200	100	300	300			Costs	Plant 2	200	100	300
19		Plant 3	0	100	100	100			Capacities	Plant 3	0	50	50
20		Total In	380	200	580				Flows	Total In	1100	150	1250
21	Costs												
22	Capacities	DC to Customer	DC 1	DC 2	Total In	Demand				DC to Customer	DC 1	DC 2	Total Out
23	Payments	Customer 1	200	200	400	400				Customer 1	400	400	800
24		Customer 2	180	0	180	180				Customer 2	2160	0	2160
25		Total Out	380	200						Total In	2560	400	2960
26													
27		Net Flow	DC 1	DC 2									
28			0	0					**Total Shipping Cost**		4210		
29													

The use of computer and computer applications has become basic tool in logistics network optimisation process. This is especially important because logistics network management represents new management concept that is trying to manage resources on the entire logistics network. In order for participant to complete their tasks it is necessary to have the logistics network competitively profiled. This is done through improvement of at least one of following three dimensions: service, speed and property. When solving the problems on the network, user orientation of calculation tables has been proved, as it is not necessary to use programming methods, or writing of programming instructions. In the example shown for use of calculation table in network problem solving it is clear that all the activities are automated by use of functions and formulas in preparing the table through user application Solver.

A Solver Model is build in this way: Objective: Minimize $K$28

9. IDENTIFICATION AND ANALYSIS OF SPECIFIC PROBLEMS IN THE RATIONALIZATION OF MACRO-LEVEL LOGISTICS NETWORKS SALESMAN PROBLEM*

The following text is the identification and analysis of specific problems in the optimization of macro-level logistics networks. Using mathematical models based on Exhaustive Search Algorithm, and graphical models in resolving the travelling salesman problem, two specific problems in the optimization of macro-level logistics network have been identified and analyzed:

a) Problem with multiple optimal solutions, and
b) Problem with redundant relation.

The possibilities of use of the TSP model, using exhaustive search algorithm in the rationalization of distribution in macro-level logistics networks has been proven.

* Co-authorship with D. Pupavac

Macro-level logistics networking aims at ensuring an adequate supply to numerous logistics centres, their sub-systems and all logistics subjects in a particular area at regional and national level. Such networks are built to enable hundreds of millions of different products to be supplied to millions of consumers. Satisfying various desires and needs of such a large number of consumers with different financial possibilities in the process of assuring optimal flow development in logistics network represent a true challenge for logistics managers.

Choosing the relevant information technology and computer software to enable us to create optimal node connections (cities, distribution centres, ports, and terminals), and arrange the optimal transportation routes, is the key factor of macro-level logistics network modelling for an effective distribution of goods. In investigating the problem above, the following scientific hypothesis has been proposed: Object-oriented programming allows us to architect and visualize exhaustive search algorithm to solve the Travelling Salesman Problem, and identify multiple optimal solutions and problems with redundant relations aimed at optimising the distribution channels in macro-level logistics networking.

9.1 Traveling Salesman Problem Determinants

Travelling Salesman Problem (TSP) can be formulated in the following way: TSP, is to find the best possible route based on given criteria, where minimum distance between cities or minimum travelling cost are the most commonly used optimization criteria. TSP, is to visit all the cities and return to the starting point under the condition of visiting each city only once. The travelling salesman problem (TSP) is one of the most studied problems in management science. Optimal approaches to solving travelling salesman problems are based on mathematical programming. But in reality, most TSP problems are not solved optimally. When the problem is so large that an optimal solution is impossible to obtain, or when approximate solutions are good enough, heuristics are applied. Two commonly used heuristics for the travelling salesman problem are the nearest neighbour procedure and the Clark and Wright savings heuristic (Heizer and Render, 2004).

Table 9.1 reveals the exponential (factorial) growth of number of possible solutions and computation time in relation to the number of nodes in a logistics network. Computation time is calculated on the assumption that a single instruction takes 1 nanosecond to execute. In terms of combinatorial optimization, the Travelling Salesman Problem (TSP) can be formulated in the following way: Given a list of ***n*** cities C and distance $\mathbf{d_{ij}}$ from city ***i*** to city ***j***; TSP, is to find the best possible way of visiting all the cities by visiting each city only once finding minimum total travel distance. In analogy to the above definition, the following formulations are valid:

- Travel distance or distance between cities is symmetric: (1) $d_{ij} = d_{ji}$;
- Final list of cities is defined as incoming variable by the formula $C = (c_1 \ldots c_n)$, while distance matrix containing distance between city c_i and city c_j for each pair i,j is defined by $d(c_i,c_j)$. In view of the fact that distance matrix is symmetric, the following equation is valid: $c_{ij} = c_{ji}$;

– Permutations or in other words all permuted relations that can be achieved for a given number of cities are computed as resulting variables.

Table 9.1. Number of alternative routes with *n* cities

Broj gradova	Broj riješenja	Vrijeme (sekunde)	Vrijeme (sati)
3	1	0,000000001	2,77778E-13
4	3	0,000000003	8,33333E-13
5	12	0,000000012	3,33333E-12
6	60	0,00000006	1,66667E-11
7	360	0,00000036	1E-10
8	2520	0,00000252	7E-10
9	20160	0,00002016	5,6E-09
10	181440	0,00018144	5,04E-08
11	1.814.400	0,0018144	0,000000504
12	79.833.600	0,0798336	0,000022176
13	239.500.800	0,2395008	0,000066528
14	3.113.510.400	3,1135104	0,000864864
15	43.589.145.600	43,5891456	0,012108096
16	6,54E+11	653,837184	0,18162144
17	1,046E+13	10461,39494	2,90594304
18	1,778E+14	177843,714	49,40103168
19	3,201E+15	3201186,853	889,2185702
20	6,082E+16	60822550,2	16895,15283

Source: Author's prepared

Permutations p(1), …, p(n) in the list 1, …, n are calculated and compared to give the minimum sum. Table 1 realistically captures the travelling salesman problem complexity. It follows from the above, that the following equation can represent the travelling salesman problem (CM30073 Advanced Algorithms and Complexity, http://people.bath.ac.uk/ masnnv/ Teaching/ AAlg12_1.pdf):

$$\sum_{1 \leq i \leq n-1} d(c_{\pi(i)}, c_{\pi(i+1)}) + d(c_{\pi(n)}, c_{\pi(1)}) \qquad (1)$$

Above equation is the sum of length of routes that begin in city $c_{p(i),\ i=1}$ visiting each city in defined pattern ($c_{p(i)}$, $c_{p(i+1)}$) and returning to the starting point $c_{p(1)}$. This algorithm gives travel distance for all possible routes and finds the shortest route. In addition, the number of possible routes is the factorial of *n* cities, or number of permutations of *n* elements.

9.2 Real Distribution Problems in Macro-Level Logistics Networking

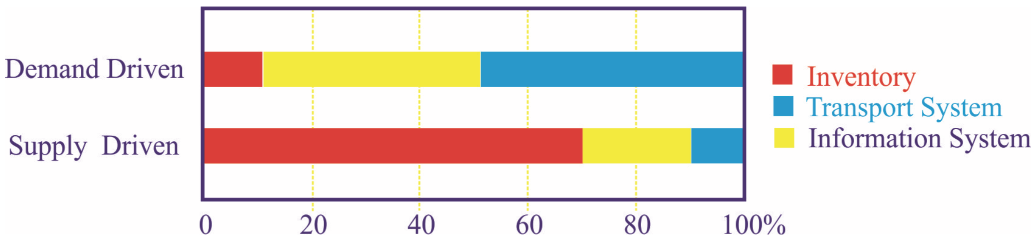
Logistics Network can be defined as a system of interrelated logistics centres, communications, corridors, ports, terminals, lines or services (…), logistics chains, logistics and distribution chains, transportation chains, transportation networks (…) built to enable fast, safe and rational production process of logistics products (Zelenika and Pupavac, 2008). The growing flows of freight have been a fundamental component of contemporary changes in economic systems at the global, regional and local scale. These changes are not merely quantitative (more freight) but structural and operational. The fundamental question does not necessarily reside in the nature, origins and destinations of freight movements, but how this freight is moving. Accordingly, it is important to identify different types of logistics networks such as conventional logistics networks, multimodal logistics networks, micro-level logistics networks, macro-level logistics networks and global logistics networks, and carry out their optimization.

Unlike micro-level logistics networks, which are functioning within a relatively small geographical area, *macro-level logistics networks* are created and designed for a particular market at national scale, or macro-level logistics system i.e. *macro-level logistics network in the Republic of Croatia*. It is indicative for such logistics networks that they are primarily composed of multiple small-sized, mid-sized and large *logistics centers*, which network, horizontally and vertically, multiple producers, manufacturers, suppliers, warehouses, trade centers, industrial centers, agents (..), clients, consumers (..).

When discussing *optimization of macro-level logistics networks*, it must be borne in mind that optimization of transportation chains, logistics chains, logistics and distribution chains and transportation networks essentially means optimization of logistics network. More important issues that have to be borne in mind when revolving possibilities of logistics network optimization are the following:

- Selecting optimal routing, or communications (roads), railways, ship lanes, air corridors, river shipping routes, pipelines (...), and all sorts of infrastructure objects, plants and systems;
- Selecting the most acceptable mechanization and transportation means;
- Selecting the most acceptable combination of advanced transportation technologies;
- Selecting the most convenient goods manipulation, transportation and distribution time;
- Selecting the most suitable combination of methods of goods stock optimization;
- Selecting the most acceptable transportation chains, logistics chains and logistics and distribution chains;
- Selecting the most appropriate information technology and information systems to effectively support all logistics activities in logistics networking;
- Selecting the most suitable models for goods flow management, information flow management, financial flow management, and ownership management;
- Selecting the most appropriate human resources combination.

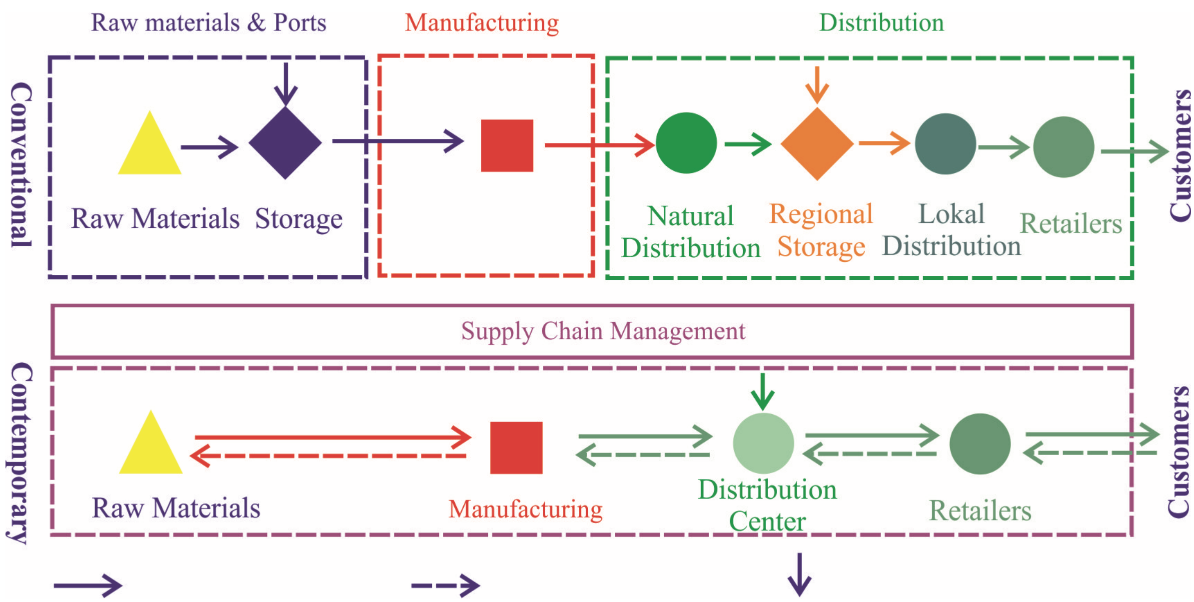
Figure 9.1. Changes in the Relative Importance of Logistical Functions in Distribution Systems



Source:Federal Highway Administration, Office of Freight Management, available at: http://ops.fhwa.dot.gov/freight.

Logistics network is a fundamental prerequisite for efficiency of distribution system. The expansion of classical infrastructure such as highway, terminal and airports are essential for the development of modern distribution system. Distribution systems are embedded in a changing macro and micro economic framework, which can be roughly characterized by the terms of flexibilization and globalization (Rodrigue et al., 2006). Distribution systems have become increasingly driven by demand instead of by supply (cf. figure 9.1).This implies many organizational changes in logistics network, especially in flows, nodes and locations and network setting (cf. figure 9.2).

Figure 9.2. Conventional and contemporary arrangement of goods flow



Source: Hesseand and Rodrigue, 2004, p. 175.

Flows. Recent freight flows tend to be of lower volumes, of higher frequency, often taking place over longer distances. In the supply chain now we have unlimited flow of information without time lag. Reverse flows are also important part of supply chain. Concentration of storage or warehousing in one facility, instead of several and this facility is increasingly being designed as crossdocking. According to recent research, fully 33% of firms are choosing consolidated and/or closed warehouses and distribution centres aiming at optimization of logistics network (Napolitano, 2011).

Nodes and locations. Concentration of logistics function in certain facilities at strategic locations is prevalent. Many improvements in freight flows are achieved at terminals. Facilities are much larger than before. Freight flows are directed through large ports and major airports, also highway intersections with access to a regional market.

Networks. The setting of networks leads to a shift towards larger distribution centres, often serving significant transnational catchments. Some goods still requiring a three-tier distribution system, with regional, national and international distribution centres.

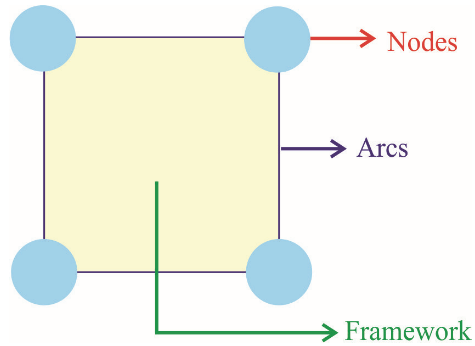
Problems and characteristics that have been identified in distribution systems in macro-level logistics networks ask for an advanced approach to the optimization of flows in logistics network, which may offer multiple optimal solutions. Sub-optimal solutions are likely to contribute to the logistics network optimization if within acceptable tolerances. Furthermore, empirical research confirms redundancy of flows in logistics network. In view of SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats), the problem with multiple optimal solutions may be considered an opportunity for selecting or building optimal flows in logistics network.

On the other hand, the problem with redundant relations represents a threat or weakness in modelling and choosing optimal flows in logistics network. This whole process of identifying problems, gathering data, creating work environment to evaluate existing logistics network and design optimal logistics network profile is a demanding task that can be executed successfully only using a scientific approach.

9.3 Rational Solution Modeling in Macro-Level Logistics Network – Definition and Elements of Logistics Network

In this work, we discuss modelling of rational solutions in macro-level logistics networks, and need to define logistics network elements. By using a subtle qualitative and quantitative approach to analyze the logistics network definition, we are able to establish that each logistics network is made up of nodes, directed arcs, connecting pairs of nodes and network framework (See Chart 9.3).

Figure 9.3. Logistics Network Model Elements



Source: Zelenika, 2005.

Each element of logistics network has its own significant characteristics:

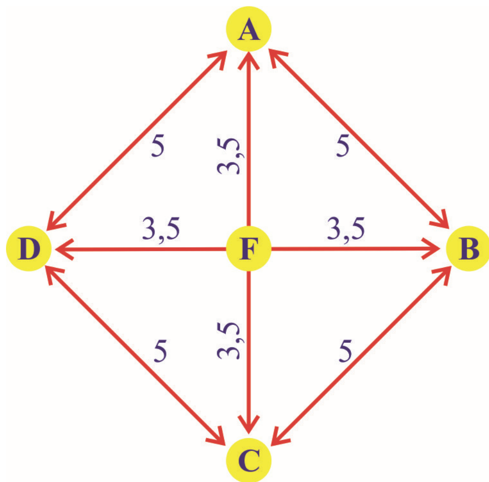
- **Logistics framework** are smaller or larger geographical areas having various forms, bordered by communications, corridors, channels, lines or services (…). Multiple areas or 'eyes' can refer to smaller or larger logistics gravitational zones around smaller or larger logistics and distributions centres or logistics centres within logistics networks where logistics and transportation chains are operating (…).
- **Logistics nodes** are commonly smaller or larger logistics centres, where warehouses, terminals, free zones, trade centres, industrial zones (…) are located, and are interrelated by logistics and distribution chains or logistics and transportation chains (…). Logistics network nodes can also refer to logistics and distribution centres or industrial centers that are operating in particular logistics gravitational zones through logistics and distribution chains, or logistics and transportation chains (…).
- **Logistic arcs** or routes are a single link between two nodes that are part of a larger network that can refer to tangible routes such as roads and rails, or less tangible routes such as air and sea corridors.

Linear programming models with a mathematical structure corresponding to networks are called network models (Shapiro, 2001).

9.4 Square Pyramid Model in Generating Multiple in Macro-level Logistics Network

Macro-level logistics network model that uses a base of a square pyramid allow us to demonstrate and analyze possibilities of generating a large number of optimal solutions that have equal or similar values. The base of a square pyramid (Vukmirovic, Kovacevic, and Grubic, 2007) is a square having equal sides and equal angles. The base of a square pyramid is also made of diagonals that intersect at right-angles. The intersection of diagonals is the central node of the base that is equally distant from all other nodes. Square Pyramid Model is described in the Figure 9.4. The nodes and arcs have been marked up according to the Figure 9.3.

Figure 9.4. Macro-level Logistics Network



Source: Author's prepared

Table 9.2. Finding solution by use of Visual Basic for Excel

	A	B	C	D	E	F	J	K	L	M	N	O	P	Q
1	1	2	3	4	5	1	**22**	1,0	5,0	7,0	5,0	3,5	**1**	**A**
2	1	2	3	5	4	1	**22**	5,0	1,0	5,0	7,0	3,5	**2**	**B**
3	1	2	5	3	2	1	**22**	7,0	5,0	1,0	5,0	3,5	**3**	**C**
4	1	5	2	3	4	1	**22**	5,0	7,0	5,0	1,0	3,5	**4**	**D**
5	1	5	4	3	2	1	**22**	3,5	3,5	3,5	3,5	1,0	**5**	**E**
6	1	4	5	3	2	1	**22**	**1**	**2**	**3**	**4**	**5**		
7	1	4	3	5	2	1	**22**	**A**	**B**	**C**	**D**	**E**		
8	1	4	3	2	5	1	**22**							
9	1	2	5	4	3	1	**24**							
10	1	2	4	3	5	1	**24**							
23	1	3	5	2	4	1	**26**							
24	1	3	2	4	5	1	**26**							

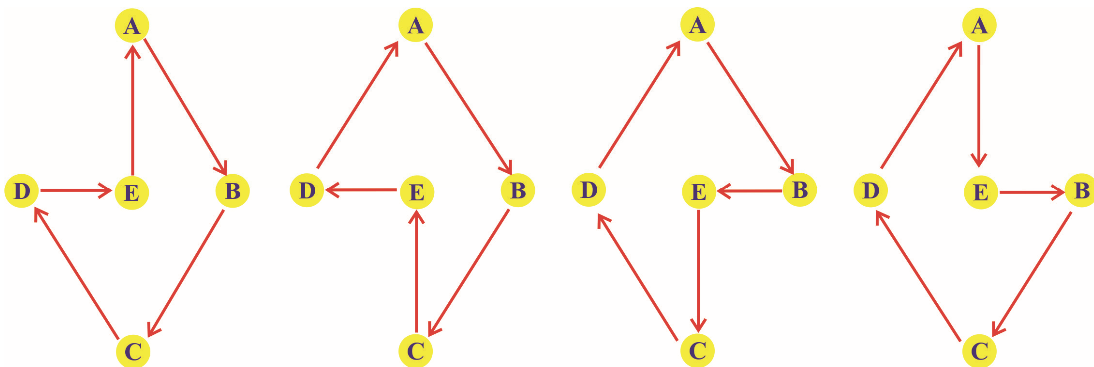
Source: Author's calculations

Figure 9.4 is an example of use of the square pyramid model in resolving and analyzing the travelling salesman problem. Table 9.2 describes an example of use of the square pyramid model in resolving and analyzing the travelling salesman problem. Table 9.2 shows input data and the solution obtained in VBA for Excel. The cell range K1:O5 contains transportation route lengths (arcs) that correspond to the dimensions indicated in the pyramid diagram in the Figure 9.4.

The cell range J1:J24 offers all possible solutions, which have been categorized from the lowest to the highest. The Table 2shows that there are 8 optimal solutions which result in equal minimum values of the total transportation route (22). Considering the matrix from the cell range K1:O5 is symmetric, it follows that the model has generated 4 optimal solutions.

Figure 9.5 is a graphical display of optimal solutions for the square pyramid model.

Figure 9.5. Optimal Solution Graphical Display



Source: Author's prepared

9.5 Macro-level Logistics Model in Redundancy

Redundant relation may occur in case of a difference between mathematical and physical TSP model. In such a case, in a mathematical model, each city (node) is visited only once exactly, while in a physical model, a city can be visited twice meaning that the car goes two times the same route, or is repeating the route.

The mathematical model is described in the Table 9.3, while the physical model can be displayed graphically as shown in the Figure 9.6. It can be concluded from the optimal relation A-B-E-C-D-A generated by use of mathematical model, that each node has been computed one time exactly. In other words, each city is visited exactly once. On the other hand, the graphical model reveals that the node C has been repeated two times. Here follows the interpretation of difference between the mathematical and graphical (real) model.

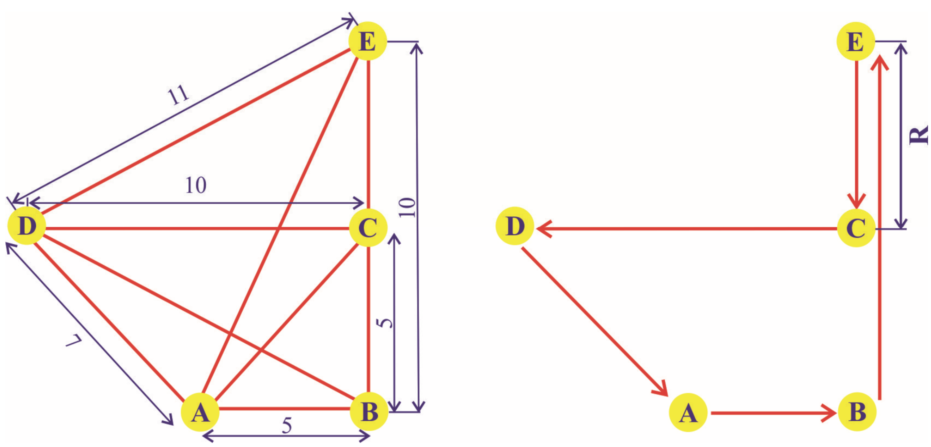
In the graphical model, redundant relation can be explained in the following way: Given the relations AB and BC that belong to the same straight line, where BC$\subseteq$ AB, are the graph elements (arcs), we can conclude that the relation BC is redundant. In this example, the graphical model of redundant relation is shown in the Figure 9.6. The chart reveals the optimal relation A-B-E-C-D-A. The chart also reveals that the straight lines BE and EC, where EC$\subseteq$BE, belong to the group of arcs (straight lines) that make the optimal solution meaning that EC is the redundant relation.

Table 9.3. Redundancy Problem Mathematical Model

	A	B	C	D	E	F	J	K	L	M	N	O	P	Q
1	1	2	5	3	4	1	**32**	1,0	5,0	7,0	7,0	11,0	**1**	**A**
2	1	4	3	5	2	1	**32**	5,0	1,0	5,0	11,0	10,0	**2**	**B**
3	1	2	3	5	4	1	**33**	7,0	5,0	1,0	5,0	5,0	**3**	**C**
4	1	4	5	3	2	1	**33**	7,0	11,0	5,0	1,0	11,0	**4**	**D**
5	1	2	3	4	5	1	**37**	11,0	10,0	5,0	11,0	1,0	**5**	**E**
6	1	2	4	3	5	1	**37**	**1**	**2**	**3**	**4**	**5**		
7	1	5	4	3	2	1	**37**	**A**	**B**	**C**	**D**	**E**		
8	1	5	3	4	2	1	**37**							
23	1	5	4	2	3	1	**45**		**Optimal relation**					
24	1	3	2	4	5	1	**45**		**A - B - E - C - D - A**					

Source: Author's calculations

Figure 9.6. Redundancy Problem Graphical Model



Source: Author's prepared

It can be seen from the Figure 9.6 that redundant relation means running in place in the context of return and double movement along the same relation. In mathematical terms, an optimal relation line, as in this example as well, passes exactly once through each node. The real optimal relation passes two times through the node C, where the mathematical model recognizes the relations BE and EC, but not the relation BC that is part of the relation BE.

9.6 TSP Based Distribution Rationalization in Macro-Level Logistics Network

In this work, we explore the travelling salesman problem based distribution rationalization in macro-level logistics networks at regional scale. In our example, the macro-level logistics network binds up together the following cities of Croatia: Rijeka (RI) and Zagreb (ZG), Italy: Trieste (TR) and Udine (UD), Slovenia: Ljubljana (LJ), Celje (CE) and Maribor (MB), and Austria: Klagenfurt (KL) and Graz (GR). The cities have been interrelated via major and regional roads intended exclusively for motor vehicles. Table 9.4 contains distance between the cities.

Distance data has been calculated with Google Maps, digital mapping that can be found in a variety of computer applications, offering many services such as browsing satellite images, planning travel routes, locating places etc. Google Maps technology allows us to obtain an automatic graphical display of a chosen relation on digital map.

Table 9.4. Distance between selected European cities

			1	2	3	4	5	6	7	8	9
RB	**City**	**Abb**	RI	LJ	ZG	GR	MB	CE	UD	KL	TR
1	Rijeka	RI	1	141	166	331	266	220	147	220	75
2	Ljubljana	LJ	142	1	143	195	130	79	159	85	101
3	Zagreb	ZG	160	139	1	183	118	152	291	224	232
4	Graz	GR	329	195	189	1	70	123	300	139	296
5	Maribor	MB	260	127	121	70	1	55	272	186	228
6	Celje	CE	220	77	154	121	56	1	237	161	179
7	Udine	UD	147	159	295	296	289	238	1	160	75
8	Klagenfurt	KL	220	88	227	136	185	162	161	1	178
9	Trieste	TR	75	94	230	289	224	173	74	173	1

Source: Author's calculations

Google Maps is a web mapping service application and technology provided by Google that offers maps of the whole world. Google Maps satellite images are not updated in real time; we see images stored on the server. Google Maps also offers street view, address browsing, a route planner for travelling by foot, car, bike or public transport.

Table 9.5. Finding Solution by use of Visual Basic for Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	**1**	**3**	**4**	**5**	**6**	**2**	**8**	**7**	**9**	**947**	1	141	166	331	266	220	147	220	75	**1**	**RI**
2	**1**	**9**	**7**	**8**	**2**	**6**	**4**	**5**	**3**	**948**	142	1	143	195	130	79	159	85	101	**2**	**LJ**
3	**1**	**9**	**7**	**8**	**4**	**5**	**6**	**2**	**3**	**950**	160	139	1	183	118	152	291	224	232	**3**	**ZG**
4	**1**	**3**	**5**	**4**	**6**	**2**	**8**	**7**	**9**	**950**	329	195	189	1	70	123	300	139	296	**4**	**GR**
5	**1**	**9**	**7**	**8**	**2**	**6**	**5**	**4**	**3**	**951**	260	127	121	70	1	55	272	186	228	**5**	**MB**
6	**1**	**3**	**2**	**6**	**5**	**4**	**8**	**7**	**9**	**960**	220	77	154	121	56	1	237	161	179	**6**	**CE**
7	**1**	**9**	**7**	**2**	**8**	**4**	**5**	**6**	**3**	**968**	147	159	295	296	289	238	1	160	75	**7**	**UD**
8	**1**	**7**	**9**	**2**	**8**	**4**	**5**	**6**	**3**	**976**	220	88	227	136	185	162	161	1	178	**8**	**KL**
9	**1**	**3**	**6**	**5**	**4**	**8**	**2**	**7**	**9**	**980**	75	94	230	289	224	173	74	173	1	**9**	**TR**
10	**1**	**9**	**7**	**2**	**8**	**4**	**6**	**5**	**3**	**989**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**		
11	**1**	**3**	**6**	**5**	**4**	**8**	**2**	**9**	**7**	**993**	**RI**	**LJ**	**ZG**	**GR**	**MB**	**CE**	**UD**	**KL**	**TR**		
12	**1**	**3**	**5**	**6**	**4**	**8**	**2**	**7**	**9**	**996**											
40319	**1**	**6**	**8**	**3**	**7**	**5**	**9**	**4**	**2**	**2042**											
40320	**1**	**6**	**7**	**5**	**9**	**4**	**2**	**3**	**8**	**2045**											

Source: Author's calculations

In the rationalization of regional macro-level logistics network, Exhaustive Search Algorithm built in Visual Basic has been used. Object-oriented programming in VBA for Excel has been used to build and visualize exhaustive search algorithm in order to compute one or multiple optimal transportation routes. Table 9.5 contains TSP problem results in the given example. The results have been calculated by program Visual Basic in Excel spreadsheet environment, created by the authors of this work. It can be seen from the Table 9.5, that 40,320 possible transportation routes (relations) have been computed with the minimum route length having 947 km.

Table 9.6. Optimal relations within acceptable tolerance limits

RB	**RBS**	**Transport relation**										**Length**	**Tol.**	**Time**
1	1A	1	3	4	5	6	2	8	7	9	1	**947**	**0,0%**	**11,15**
		RI	ZG	GR	MB	CE	LJ	KL	UD	TR	RI			
2	2A	1	9	7	8	2	6	4	5	3	1	**948**	**0,1%**	**11,11**
		RI	TR	UD	KL	LJ	CE	GR	MB	ZG	RI			
3	3A	1	9	7	8	4	5	6	2	3	1	**950**	**0,3%**	**10,52**
		RI	TR	UD	KL	GR	MB	CE	LJ	ZG	RI			
4	2B	1	3	5	4	6	2	8	7	9	1	**950**	**0,3%**	**11,18**
		RI	ZG	MB	GR	CE	LJ	KL	UD	TR	RI			
5	1B	1	9	7	8	2	6	5	4	3	1	**951**	**0,4%**	**11,14**
		RI	ZG	UD	KL	LJ	CE	MB	GR	ZG	RI			
6	3B	1	3	2	6	5	4	8	7	9	1	**960**	**1,4%**	**10,57**
		RI	ZG	LJ	CE	MB	GR	KL	UD	TR	RI			

Source: Author's calculations

Table 9.6 reveals optimal transportation routes having values within an acceptable tolerance of 1% as compared to the best optimal value, or minimum route length as computed. Based on the data obtained from the Table 9.6, it can be seen that five optimal relations have been computed within an acceptable tolerance of 1% using object-oriented programming in VBA for Excel by use of a method based on exhaustive search algorithm. To place route relations in order, in the Table 9.6, we used ordinal numbers RB, beginning with the lowest distance. RBS means routes that refer to the same communication flow and have opposite directions. It can be seen from the Table 4 and results given in the Table 9.5 that those routes are nearly, but not completely symmetric. For instance, the distance from Rijeka to Zagreb is 166 km, while the distance between Zagreb and Rijeka is 160 km. Besides distance and deviation, the table contains estimated driving time for each route. The value of optimal relation has been tested by summation of transport directions in optimal relation (Table 9.7) and has been compared with solution which has been calculated by usage of programming language for mathematical modeling Xpress (Figure 9.7).

Table 9.7. Testing of optimal solution

1	3	4	5	6	2	8	7	9	1	**Ukupno**
RI	ZG	GR	MB	CE	LJ	KL	UD	TR	RI	
	166 +	183 +	70 +	55 +	77 +	85 +	161 +	75 +	75 =	**947**

Source: Author's calculations.

Figure 9.7. Optimal solution calculated by usage of programing language Xpress

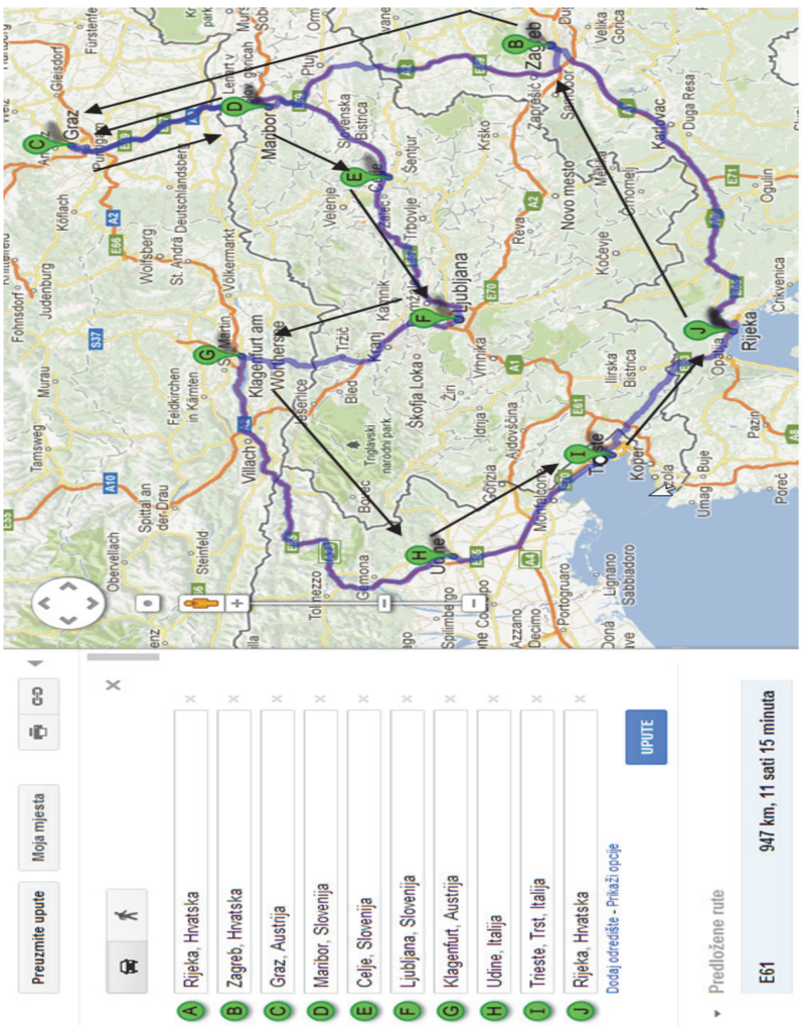
230

The Figure 9.7 shows that calculated optimal solution calculated in program Xpress (948) has deviation of 0,1% in comparison with optimal solution calculated in Visual Basic (947).

In our regional macro-level logistics network example, the optimization criterion (factor) is the minimum travel distance. Considering multiple optimal solutions within particular acceptable tolerance we are able to make comparative analysis and create synergy of all relevant factors that determine the best (optimal) solution, or group of optimal solutions.

After analyzing results, the most acceptable arises to be the first relation (RB – 1). If analyzing estimated driving time as well, the most acceptable would be the third relation (RB – 3) with minimum distance deviation as compared to the first one, while the estimated driving time of the third route (10,52) is considerably shorter than the first one. These results have largely confirmed multiple optimal solutions within given acceptable tolerances.

Figure 9.8. Optimal transportation route RB-1



Source: Author's prepared according to Google map

Optimal relations are displayed on the maps 1, 2 and 3. Figure 9.8 is the graphical display of the optimal transportation route RB-1 having the least length. The map and route direction are shown in the right part of the image, while distance values and estimated driving time are indicated in the left part of the image.

The map reveals the redundant relation Maribor–Graz-Maribor, which means that Maribor is visited twice. The relations Zagreb-Maribor and Maribor-Graz, where Graz–Maribor is the sub-group of the relation Zagreb–Maribor, belong to the group of communication flows (arcs) that compose the optimal solution. This means that there is a redundant relation Graz – Maribor, which is marked on the map by arrows of opposite directions. Redundancy problem can be solved in several ways:

- Accepting redundant relation. In case of increased traffic on the route Graz-Maribor with optimal use of transportation capacities, this redundant relation may be considered an opportunity.
- Changing route and adding new city. In this example, instead of the route Graz – Maribor – Celje, another route can be proposed: Graz – Wolfsberg – Velenje –Celje, where two more cities would be added (Figure 9.9.1). The proposed route will probably not be accepted as in that case the total distance would be 1004 km, which is a devia-tion of 5,6% with respect to the minimum distance.
- Replacing city. In the example, Graz can be replaced with Varaždin (Figure 9.9.2). In such a case, the total distance is 868 km, or 8% shorter than the minimum distance as computed before introducing the modification; this proposal, therefore, is likely to be taken into account.

Figure 9.9.1. Resolving problem with redundant relation 1

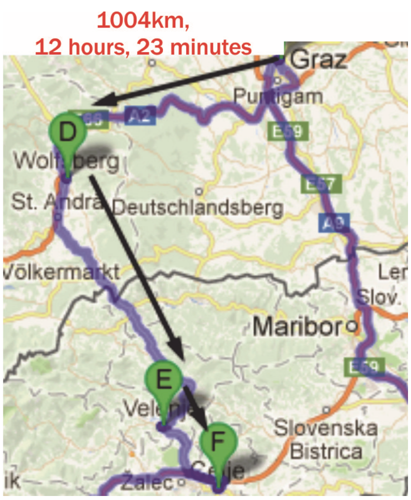
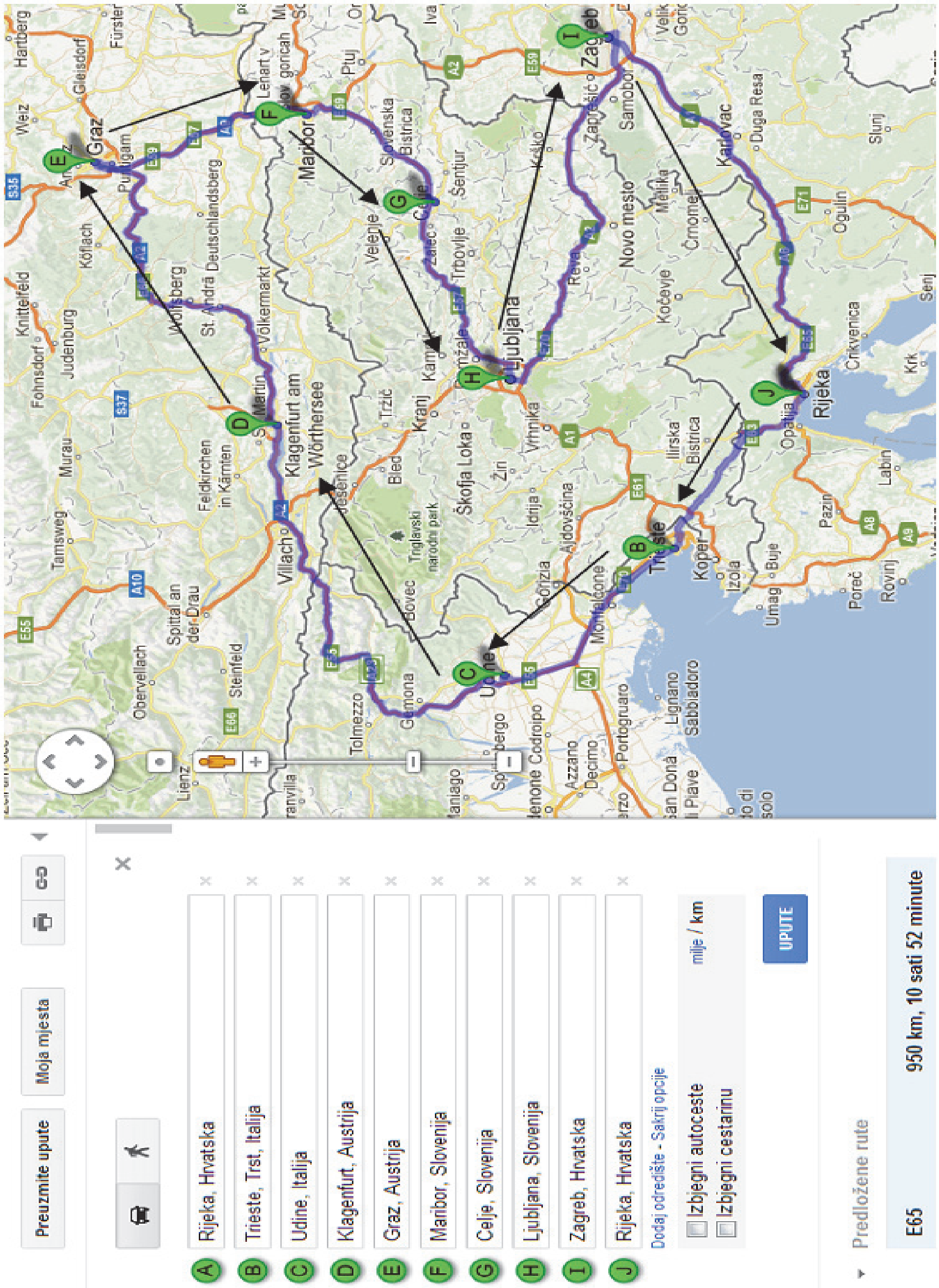


Figure 9.9.2. Resolving problem with redundant relation 2

Source: Author's prepared according to Google map

Figure 9.9.3 graphically displays the optimal transportation route (RB-3 in Table 9.6) that integrates the best results in terms of minimum distance and shortest driving time.

Figure 9.9.3. Optimal transportation route RB-3



Source: Author's prepared according to Google map

In the rationalization of regional macro-level logistics networks, exhaustive search algorithm built in Visual Basic was used. Object-oriented programming in VBA for Excel was considered in modelling and visualization of exhaustive search algorithms to compute one or multiple optimal transportation routes. Scientific contribution of this work reflects in the fact that most modern software solutions enable computation and insight into one optimal solution. In this work, we have proven that using visual and object-oriented methods of programming and modelling in building exhaustive search algorithm, we are able to simulate models with multiple optimal solutions for smaller samples, up to 10 transportation centres with clear interpretation of results not only for equal optimal values but also nearly equal values, and defining acceptable tolerances.

Identification and scientifically founded analysis of problems with multiple optimal relations and problems with redundant relations allow us to make a significant influence to the synergy of parameters of successfulness and effectiveness of transportation from the starting point to the destination: minimum distance, minimum time, minimum cost, and maximum exploitation of transportation capacities. Integrated modelling and programming, based on object-oriented technology and visualization in VBA for Excel can serve as a tool for understanding and solving problems in macro-level logistics networks, and may become a mean for creating and interpreting ideas. In the very process of building models and developing programs we are able to conceive essential problem particulars that have not been previously clearly identified, enabling us not only to resolve the problem, but redefine it and upgrade the program accordingly.

Methodological frame of use of Visual Basic as a development tool in the visual modelling of exhaustive search algorithm in VBA for Excel can serve as an incentive in creating new highly sophisticated algorithms, which will enable us to compute multiple optimal solutions with possibility of integrating a bigger number of samples (cities, transportation centres).

10. SOLUTION OF THE PROBLEM OF CRITICAL PATH'S FINDING IN EXEL ON THE BASIS OF REDUCING IT TO ORDINARY TRANSPORTATION TASK*

The problem of determining the critical path for the scheduling tasks has been considered. An original technique for practical calculations using the available Solver add-on in Excel has been described. The proposed approach is based on reducing the task to solving the ordinary transportation problem, in particular to the problem of finding the longest path. Examples of solutions with the test input data and corresponding screenshots are given.

The practical steps of the user's action in the process of direct solution in Excel are consistently described. The analysis of the results of the proposed method has been performed and presented. It is established that presented method for calculating the critical path requires minimal efforts from the users, regardless of the dimension of the tasks.

* Co-authorship with L. Malyaretz, and O. Dorokhov

As it is well known, there are many practical problems, including transport character and project management which are formulated and solved with use of network models. Almost in each manual on economic-mathematical methods and models mathematical bases of network planning and management (Kuznetsov, 1999; Eddous and Stensfield 1997; Shimko, 2004; Malyaretz, 2006; Kremer, 2007; Taha, 2010) are stated.

Necessity of development of effective ways of planning of complex processes has led to creation the essentially new methods of network planning and management. More often for construction of network models five basic algorithms are used: findings of minimal tree; findings of the shortest way; definitions of the maximal stream; minimization of cost of a stream in a network with the limited throughput; findings of a critical path (way) - Taha, 2010. Thus the algorithm of a critical path is the most known method in planning, drawing up of time schedules and managements of projects.

10.1 Description of the Researshes

The main, basic problem in calendar network planning of manufacture is definition of "a critical path". It represents sequence of the operations which are not having a reserve, a stock of time. Operation is considered as critical if the delay of its beginning leads to increase in a termination date of all process (part of which is considered operation) as a whole.

10.2 Graphic Representation of the Network Schedule

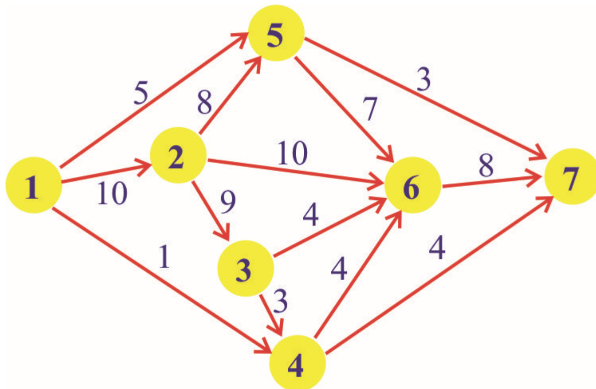
In case of graphic representation of the network schedule, its arrows (focused arches) represent the certain operations. The figure near each arrow means duration of corresponding operation. Initial and final points of any operation correspond to meeting events (initial and final). The operations which are starting with some event cannot begin while the operations entering into this event will not be completed yet all.

“The critical path (way)” on the network schedule represents the continuous chain of operations connecting initial event of a network with finishing. The purpose of our work is reduction of a problem of search of a critical path to usual transport task, namely a task of search of the longest way.

By analogy to a transport task we shall consider units of the network schedule (except for initial and final), as transit points. Certainly, thus for a critical way the requirement that it is possible to arrive to each transit point only from one previous point and to go only to one subsequent point is carried out.

Earlier in work of authors (Kremer, 2007) the task of finding of the shortest way by ***"Solver"*** tool in spreadsheet ***Excel*** has been examined.

Figure 10.1. The network schedule for a test example



The offered approach can be applied to calculation of a critical path. For an illustration of the offered approach we shall consider an example of the network schedule (Figure 10.1) from work of A. Taha (2010)

It is necessary to emphasize, that as a whole the idea of use of methods of linear programming for definition of a critical path expressed and earlier, but its computer realization in this case is important. In fact practical network models can be much more difficult than simple graph, represented on Figure 1.

Therefore it is necessary to organize calculations so that it was feasible for the usual user. Usually in real network model there are some tens events (points). Accordingly, it is necessary to fill tables of initial data of the big size with dimension in some tens elements. There is a problem to reduce this work up to a possible minimum and to receive thus the optimum decision.

10.3 Technique and the Order of Practical Calculations

Let's consider an offered technique and practical actions for an example of graph, shown on Figure 10.1.

Firstly, we shall enter in ***Excel*** corresponding with the network schedule (Fig. 10.1) data for durations of works ***tij*** between each pair of points T_t - ***Tj*** (Table 10.1).

All points, except for last point T_7 , we will consider as points of departure. They are listed in the left column of the table ***tj.*** All points, except for start point T_1***,*** we will count as points of destinations. They are listed in the top line of the table ***tj.*** Transit points T_2 - T_6 are considered both as points of departure and as points of destinations.

Table 10.1. Data for the test example

	I	*J*	*K*	*L*	*M*	*N*	*O*
4	***Duration of works between each pair of points***						
5	***tiL***	*T2*	***Ts***	*T4*	*T5*	*T6*	*T7*
6	***Ti***	*10*	*-100*	*1*	***5***	*-100*	*-100*
7	*T2*	*0*	***9***	*-100*	*8*	*10*	*-100*
8	***Ts***	*-100*	*0*	***3***	*-100*	***4***	*-100*
9	***T4***	*-100*	*-100*	*0*	*-100*	***5***	***4***
10	***T5***	*-100*	*-100*	*-100*	*0*	*7*	***3***
11	*T6*	*-100*	*-100*	*-100*	*-100*	*0*	*8*

The durations of works between identical transit points T_k- T_k are equal to zero. Between some points there are no communications, therefore we set the corresponding duration of works equal to very big negative number ***(tj= -100),*** that by search critical (the longest way) these forbidden transitions automatically were rejected.

Let's describe practical steps for filling the given table. To exclude from consideration fictitious durations on the forbidden transitions, it is expedient to represent (by means of conditional formatting) it's by their grey colour on a grey background. For this purpose we bring in any free cell number ***-100*** (duration for the forbidden transitions) and copy it in the buffer of an exchange.

Then, keeping pressed key ***Ctrl,*** we allocate by the mouse the table ***tj*** (without headings) and insert contents from the buffer of an exchange (at once into all cells of the table). Further (not removing allocation) in menu ***Format*** we use item ***Conditional formatting.*** On the panel of conditional formatting we fill a field ***Condition 1: Cell Value Is*** and ***less than*** by ***-99.***

We press the button ***Format*** and on panel ***Format Cells*** (item ***Font)*** we set colour of numbers, and on item ***Patterns*** - colour of a background. After that we enter real duration of works for all possible transitions between points. Similarly zero duration of works between pairs of identical transit points also can be entered by one operation. For this purpose it is necessary to copy a cell with value ***0*** on the buffer of an exchange. Further it is necessary to allocate by mouse (with pressed key ***Ctrl)*** the cells on diagonal T_k - T_k and to insert ***0*** from the buffer of an exchange at once into all allocated cells. By the described actions work on data input is shown up to a necessary minimum.

In the following table (the same size) for ***Xj*** we shall define transitions between points (Table 10. 2). If between points T_t - ***Tj*** there is no transition then we accepted ***Xj = 0*** and if transition is exist then ***Xj = 1.*** First we fill all cells of the table ***Xj*** with 1 (all ***Xj*** = 1). Naturally, they are written into all cells of the table by one operation (by copying from buffer of an exchange at once in all the allocated cells).

Table 10.2. Transitions between points start (initial) position

	I	*J*	*K*	*L*	*M*	*N*	*O*	*P*
13			***Transitions between points***					
14	***Xj***	***T2***	***Ts***	***T4***	***T5***	***Te***	***T7***	***Sum 1***
15	***T1***	*1*	*1*	*1*	*1*	*1*	*1*	*6*
16	***T2***	*1*	*1*	*1*	*1*	*1*	*1*	*6*
17	***T3***	*1*	*1*	*1*	*1*	*1*	*1*	*6*
18	***T4***	*1*	*1*	*1*	*1*	*1*	*1*	*6*
19	***T5***	*1*	*1*	*1*	*1*	*1*	*1*	*6*
20	***T6***	*1*	*1*	*1*	*1*	*1*	*1*	*6*
21	***Sum 2***	*6*	*6*	*6*	*6*	*6*	*6*	***36***

However, as follows from a condition of a problem, the critical path passes through transit points only once. Therefore in each line and in each column of the table ***Xij*** for a critical path there should be only one ***1*** (similarly a task about destinations). Therefore in the table ***Xj*** are added final right column and below line in which formulas of summation (by function ***SUM)*** are entered. For this purpose it is necessary to allocate the table ***Xij*** without headings, but with additional right column and below line, and to press on tools panel the auto summa button X Then in all cells of an additional column and an additional line will be automatically written down formulas of summation. Certainly, for a critical path all these sums should be equalled to ***1***.

On an empty place of spreadsheet ***EXcel*** for calculation of critical path duration we write formula ***SUMPRODUCT (Range tj; Range tj).*** At first, before calculation's start, this duration is equal ***-1723*** (Table 10.3).

Table 10.3. Length of a critical path

	K L M		
22	**Duration of a critical path**		
23		Max	
24	Function of the purpose	**-1723**	

10.4 The Finding of the Critical Path

Now we shall go directly to search of a critical path. We put the table cursor on a target cell and through the menu ***Tools*** call "***Solver*** " Add-In (Figure 10.2).

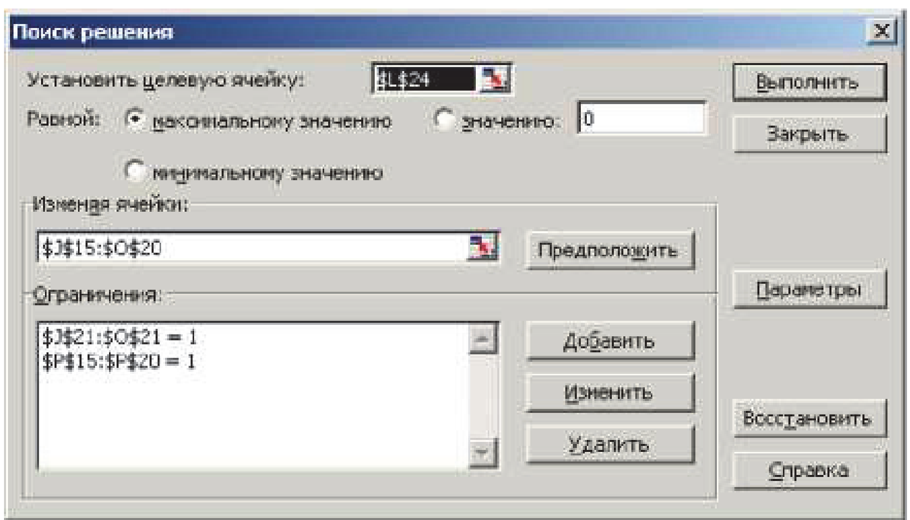
On the ***Solver*** panel window we set ***Target Cell*** equal ***Maximal value.*** In a field ***Changing cells*** we specify a range ***xy.***

We set two restrictions: ***Sum1*** on table lines and ***Sum2*** on table columns should be equal 1.

Then we press the button ***Parameters*** and put flags ***Linear model*** and ***Non-negative values.***

Finally we press the button ***To execute*** and have received the optimum decision.

Figure 10.2. Window with the parameters of decision search in Solver Add-In



In the transformed table of transitions (Teble 10.4-10.6) now in each line and in each column is only one ***1*** unit, all other numbers are zero. For simplification of results visualization it is expediently to allocate all zero in the table so that they did not prevent to see a critical path. For example, by means of conditional formatting it is possible to show zero (numbers, smaller then ***0,01)*** as a grey colour on grey background. Numbers on diagonal T_k - T_k also do not have any helpful information. Therefore it is possible to set a grey background for these cells too for what it is necessary to click mouse (at pressed key ***Ctrl)*** on diagonal cells and to set a demanded background at once for all of them.

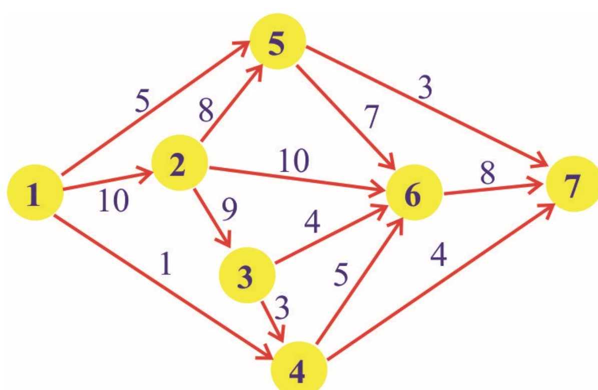
Table 10.4. The received decision

	I	J	K	L	M	N	O	P
13			***Transitions between points***					
14	***Xj***	***T2***	***T3***	***T4***	***T5***	***T6***	***T7***	***Sum 1***
15	***T1***	*1*	*0*	*0*	*0*	*0*	*0*	*1*
16	***T2***	*0*	*1*	*0*	*0*	*0*	*0*	*1*
17	***T3***	*0*	*0*	*1*	*0*	*0*	*0*	*1*
18	***T4***	*0*	*0*	*0*	*0*	*1*	*0*	*1*
19	***T5***	*0*	*0*	*0*	*1*	*0*	*0*	*1*
20	***T6***	*0*	*0*	*0*	*0*	*0*	*1*	*1*
21	***Sum 2***	*1*	*1*	*1*	*1*	*1*	*1*	*6*

Now on Table 10.4 only the critical path is allocated. From initial point T_1 there is a transition to point T_2. From point T_2 there is a transition to T_3. Further from point T_3 there is a transition to T_4 , and from point T_4 there is a transition to T_6. At last, from point T_6 there exists transition at once to finish point T_7 . The critical path does not take place through point T_5 , therefore in the optimum decision fictitious transition from T_5 to T_5 is specified.

On Figure 10.3 found critical path T_1—T_2—T_3—T_4—T_6 —T_7 is represented.

Figure 10.3. Found critical path



Duration of a critical path is equal 70+9+3+5+8=35. As clear from Figure 10.3, there is a reserve of time in ***21*** unit for performance of work ***1-4; 4*** units for work ***3-6; 7*** units for ***2-6;*** in the sum of ***2*** units for works ***2-5*** and ***5-6;*** in the sum of ***27*** units for works ***1-5*** and ***5-7.***

10.5 The Example for More Difficult

Let's shortly examine one more example of calculation of a critical path for the network schedule represented on Figure 10.4. The filled corresponding table for work's durations is shown on Table 10.5.

Figure 10.4. The network schedule for a test example of greater dimension

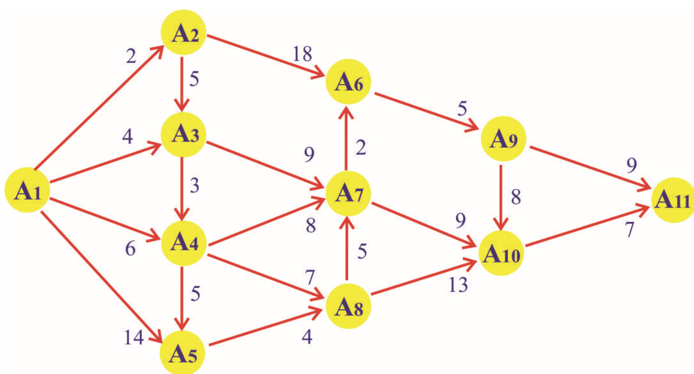


Table 10.5. Duration of works for a test example of greater dimension

tij	*A2*	*A3*	*A4*	*A5*	*A6*	*AJ*	*A8*	*A9*	*A10*	*A11*
Ai	*2*	*4*	*6*	*14*	*-100*	*-100*	*-100*	*-100*	*-100*	*-100*
A2	*0*	*5*	*-100*	*-100*	*18*	*-100*	*-100*	*-100*	*-100*	*-100*
A3	*-100*	*0*	*3*	*-100*	*-100*	*9*	*-100*	*-100*	*-100*	*-100*
A4	*-100*	*-100*	*0*	*5*	*-100*	*8*	*J*	*-100*	*-100*	*-100*
A5	*-100*	*-100*	*-100*	*0*	*-100*	*-100*	*4*	*-100*	*-100*	*-100*
A6	*-100*	*-100*	*-100*	*-100*	*0*	*-100*	*-100*	*5*	*-100*	*-100*
AJ	*-100*	*-100*	*-100*	*-100*	*2*	*0*	*-100*	*-100*	*9*	*-100*
A_s	*-100*	*-100*	*-100*	*-100*	*-100*	*5*	*0*	*-100*	*13*	*-100*
A9	*-100*	*-100*	*-100*	*-100*	*-100*	*-100*	*-100*	*0*	*8*	*9*
A10	*-100*	*-100*	*-100*	*-100*	*-100*	*-100*	*-100*	*-100*	*0*	*J*

The size of the second task is larger than the previous one. Data, which are necessary for typing manually, make a small part of the table (for this example nearly 20%).

The optimum decision was received in the form (see Fig. 10) where owing to conditional formatting the critical path is allocated. We write out it from the lines (Table 10.6): ***A_1^A_2^A_3^A_4^A_5^A_8^A_7^A_6^A_9^A_{10}^A_{11}.*** The summary (total) duration of works on a critical path is equal ***2+5+3+5+4+5+2+5+8+7=46*** time units.

Table 10.6. The final decision for a test example of greater dimension

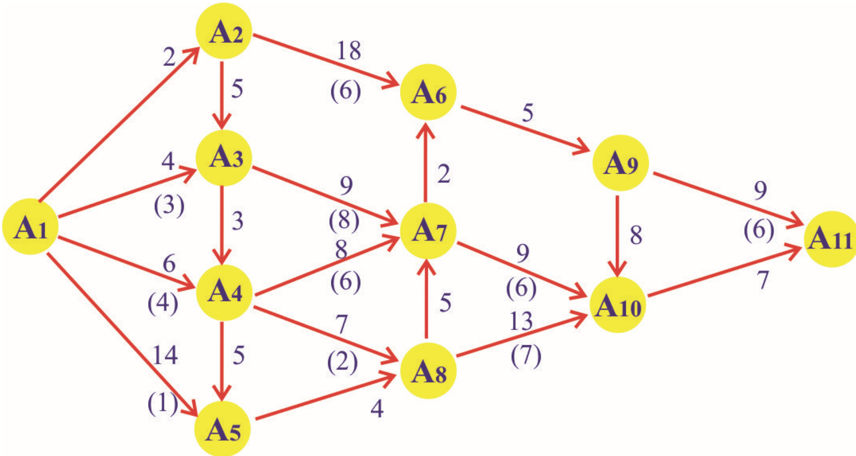
xij	*A2*	*A3*	*A4*	*A5*	*A6*	***AJ***	*A8*	*A9*	*A10*	*A11*	***Sum 1***
A1	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
A2	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
A3	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
A4	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
A5	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*1*
A6	*0*	*0*	*0*	*0*	*0*	*-100*	*-100*	*1*	*0*	*0*	*1*
AJ	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*1*
A8	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*1*
A9	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*1*
A10	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*-100*	*0*	*1*	*1*
Sum 2	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*10*

On Figure 10.5 the found critical way on the network schedule is represented. Numbers in brackets near arrows show reserves of time for performance of noncritical operations.

Finally, it is necessary to deals with two important moments confirming an opportunity of practical use of the offered technique.

The first concerns the maximal dimension of a task. As it is well known, the standard tool ***Solver*** (built in standard *Excel)* has the general limitation on quantity of cells with initial data (the greatest possible to use about 200 cells). For overcoming of this restriction in practical tasks with big dimensions we recommend to use more powerful tool *Premium Solver* (accessible free of charge on a site of the developer), which practically supposes usage of matrixes of any dimensions.

Figure 10.5. The critical path on the network schedule for a test example of greater dimension



The second moment concerns the uses of newer versions of spreadsheet *Excel*. Though the material stated in the paper has been received in *Excel 2003,* check of a technique in *Excel 2010* shown its working capacity. Certainly, the sequence of commands, their arrangement on panels and names can be others.

The described design procedure to find the critical path demands the minimal labour expenditures from the user irrespective of the task's sizes. In spite of the fact that the special methods considering their structure are developed for network models, many network tasks can be solved as a tasks of linear programming (in particular, in transportation). In this paper the expediency of the solving of the examined tasks by their reduction to problem of the longest path search has been shown. The demanded decision is easy for receiving by tool ***Solver*** from spreadsheet ***Excel*** by the offered technique.

11. FUZZY MODEL IN FUZZYTECH ENVIRONMENT FOR THE EVALUATION OF TRANSPORTATION'S QUALITY FOR CARGO ENTERPRISES *

The basic criteria of quality vehicle servicing and operation of road transport enterprises in the transportation market of Ukraine have been reviewed, classified, described and structured. Their formalization by linguistic variables with appropriate terms has been held. Usage of methods of fuzzy inference to determine the integral generalized level of freight transportation's quality has been proposed. Corresponding computer model has been developed in fuzzy TECH specialized package of fuzzy modeling.

* Co-authorship with O. Dorokhov, and L. Dorokhova

In conditions of hard competition in the freight market in Ukraine defining components for the commercial success of carriers are both economic performance and quality of transport service for customers. Transport companies must constantly monitor both the level of their own work and activities of competitors by a significant number of diverse economic, technical, technological and market criteria. This problem can be efficiently solved only by using modern mathematical methods, computer simulation and information technologies (Nagorny et al., 2004; Dorokhov, 2003; Dorokhov et al., 2010).

11.1 Overview of the Main Indicators of the Transportation's Quality and Customer's Service for Transport Enterprises

Issues of transport service quality in general and freight transportation in particular are constantly receiving considerable attention of researchers in Ukraine. Analysis of the literature and practical state of the problem based on autor's expert researches (surveys among carriers and customers of transportation services), allows to identify for further analysis four main groups of service quality criteria in the Ukrainian freight market (of course, the list is not exhaustive) (Nagorny et al., 2004; Dorokhov, 2003; Dorokhov et al., 2010; Dorokhov and Dorokhova, 2009).

There are the technological characteristics of individual transportation flight, the quality of customer service in transport company for a certain time period, the criteria for evaluation of transport service from its customers (clients) and the images characteristics of the transport service producers on the market. Purely economic criteria in this model will not be considered, as they will be the subject of a separate investigations. Next, we briefly examine the criteria for each of these groups, given that some of them may simultaneously belong to multiple groups. In this case, the difference will consist in the method and estimation's units for the same parameter.

11.2 Parameters of Quality For Performance of a Single Trip

Evaluation of the separate trip is an important part of operative, daily control of quality for a single driver in his performance of a particular trip. This assessment may include, inter alia, the following parameters (Dorokhov, 2003; Dorokhov et al., 2010):

- implementation of speed limits during the process of truck's motion („speed mode");
- timely passage of geographic reference points on the route motion („time mode");
- performance of the ordered (prescribed) route of vehicle movement („route mode");
- fuel consumption within the planned for trip („fuel expence");
- the number of recorded traffic violations or accidents („road incidents" and „road rule");
- loss or damage of the cargo at a separate trip;

- delay to the customer upon delivery of the cargo or supply of transport for loading;
- the time of truck's preparing for the next trip after previous („readiness").

11.3 Summary Measure of Service Orders for a Certain Period of Time

For identify and evaluate the work of the transport company as a whole, and during a certain time period, it can be used next indicators:

- powerful of the transport park ("park power");
- degree of satisfaction (on the requested amount) of customer orders ("park cover");
- total transportation safety - environmental and road motion ("road safety");
- overall style of trips ("trip style");
- safety of cargo and claims of customers ("maintenance" and "claim");
- timeliness of customer service - delays, trucks failures and replacements ("delays").

11.4 Criteria for Assessing the Transport Service by Clients

With heightened competition and the struggle for the customer to the market in Ukraine rating service, completeness and quality of execution of clients becomes an important component of a lasting market position, competitive advantage for the carrier.

For customers it is usually not as important economic components of transportation other than price. At the same time, customers primarily concerned with the characteristics of service quality and range of additional services provided by freight transport companies:

- speed of movement and safety of cargoes;
- timeliness and flexibility of service conditions;
- information support and maintenance services;
- provision of such services as customs clearance, temporary storage of cargoes etc;
- forwarding and cargo handling services.

11.5 Image Components of the Transport Service Producers in the Transportation Market

We should separately identify some image characteristics of the transport company's on freight transportation market, in particular:

- duration and work's experience in the market;

- presence of large and well known corporate clients and the amount of their services;
- structure of the vehicle fleet (types, models of trucks, its age);
- staffing drivers, availability and feasibility of transport firm's own repair facilities.

Often for owner clients listed characteristics play a role commensurate with the cost and other technological conditions of transportations.

11.6 Features Practical Estimation of Transport Companies

Practical evaluation of the transport services quality, especially external (from other members of the transport market - customers, competitors, regulatory organizations), is faced with considerable difficulties in gathering accurate and complete source information. Its objectivity is the main basis for obtaining adequate and reliable results. However, we can see corporate secrecy, trade secrets, a small amount and unreliability of statistical data available for outside use. As result, it makes very difficult (and often, almost impossible) to use for the analysis the traditional, classical probability and statistical techniques and approaches. This situation require the use fundamentally different modeling techniques.

11.7 The Appropriateness and Necessity of Using Fuzzy Modeling

Obviously, that the competitive transport market, the interaction of producers and consumers of transport service contains a large amount of uncertainty of various actions and backgrounds.

Among them the uncertainty of nature, own market, demands, preferences and desires of clients, customers, actions of competitors, government agencies and other internal and external factors.

Under these conditions, one of the most efficient methods of modeling are presented hikes based on the theory of fuzzy sets using appropriate computer software.

11.8 Features and benefits of using the program fuzzy TECH for computer model's implementation

In several previous papers of the authors (Dorokhov et al., 2010; Dorokhov and Dorokhova, 2009; Dorokhov, Chernov and Dorokhova, 2010) multicriteria estimations of the transport service quality were calculated using fuzzy-set approach and it's implementation in the software component Fuzzy Logic Toolbox from the MATLAB package.

However, this tool has some serious limitations, including:

- model can be only one-level and in case of tree-structure data trasfer from lower to upper level could be achieved only by writing software code, but is impossible through operations in the user interface;
- for single-level model with the number of input variables more than three, there is excessive number of decision rules that clutters the model and makes the practical work with it very difficult;
- user can select only the standard membership functions of linguistic terms and fuzzy variables from the available limited list, but creation of own custom functions in arbitrary forms is provided that does not correspond with practical situations.

These drawbacks may be are overcomed in professional fuzzy modeling package fuzzy TECH, wich we have chosed for practical computer implementation of the problem.

11.9 Definition of the Integral Index of Customer Service Quality

Thus, aims of further study was to develop a practical computer model of multicriteria assessment for transport service quality of freight customers in an environment of fuzzy modeling fuzzyTECH5.5. The article presents light variant of model with using a demo version of this program tool.

11.10 Taken Into Consideration the Parameters of Service Quality

As a result of holding and processing the results of experts polls on several large transport enterprises in Kharkiv we have identified for further consideration and inclusion in the model the following parametrs (their corresponging numbers are listed in table 1):

- speed mode (2), time mode (3), route mode (1), which in common define intermediate parameter motion mode (14);
- number of road incidents (4), infringements of the traffic regulation - road rules (5), which in common define intermediate parameter road safety (15);
- time for truck's prepare to next trip – readiness (6), age of trucks (7), which toget-her define intermediate parameter trucks (16);
- park power (9), park cover (8), which both define intermediate parameter park possibilities (17);

- client's claim (10), time delays (11), cargo maintenance (12), which together define intermediate parameter service level (20).

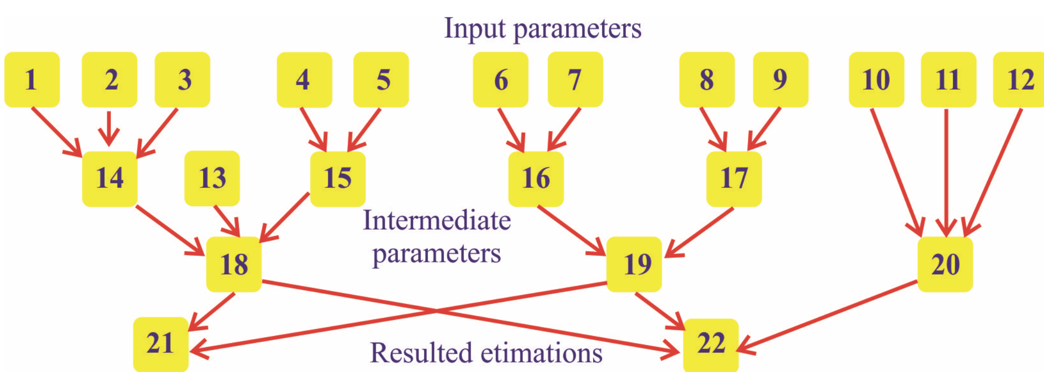
In turn, intermediate parameters (14 and 15) together with fuel expence(13) define parameter trip style(18); (16 and 17) define parameter park(19).

At last, parameters (18, 19 and 20) define overall integrated, total estimation (21), and (18 with 19) provide for transport enterprise an internal estimation of it's work's level (22). Graphic representation for relationships between input, intermediate and output parameters in the model is represented in Figure 11.1.

Several of these parameters (2, 3, 4, 6, 10, 11, 12, 13, 14, 18) previously has been discussed in detail in (Dorokhov, Dorokhova and Zorina, 2010). Therefore, let's concern only some of the newly introduced parameters.

Route mode (1) characterizes the degree of deviation of truck's motion from the preplanned and approved route. It is clear that the change of the route even though it may lead to faster delivery, but on the other hand it may interfere with the truck's weight and size requirements and restrictions, other terms and requirements of safety. And eventually the deviation from the route is a important factor in the reduction of transport safety.

Figure 11.1. Relationships between input, intermediate and output parameters of trip quality model



Traffic rules violations (5) which fixed and recorded properly by police (road control, automobile inspection, service safety of the enterprise or by technical means of verification) drastically reduce the safety of transportation. Age (7) for a single car and for the whole truck's park of transport firm is a serios parameter influencing on technical conditions of park, also it, in many respects, defines the image of carrier, transportion cost and safety , working conditions for drivers etc.

Coverage of orders (8) describes the ability of transport companies to cover peak for orders on transportation of constant clients. Suppose, during 30 days with regular daily orders of various amounts of transport from the customer, he was required to provide 140 trucks. The carrier has provided 105, then cover will be 75%. If total requirement was 80, but received was only 40 trucks - covering will be 50%.

Park power (9) is determined as the degree of satisfaction (by the carrier) of orders for transportation from regular clients during a certain period of time. Let's assume, that during the month (30 days), the carrier every day receives requirements of transport (a certain number of trucks) from the client. For example, if 15 requirements (from 30) were made in full (but other 15 - only partially), the power will be 50%. In the case of providing transport in full only for 10 requirements total capacity will be 33%.

11.11 Fuzzy Formalization of Quality Parameters of Transportation by Membership Functions and Sets of Linguistic Variables

As mentioned above, as well as described in (Dorokhov et al., 2008; Dorokhov and Chernov, 2010), first step to develop a model must be formalize of the selections linguistic variables and corresponding membership functions. The corresponding numerical values were obtained from expert surveys and subsequent statistical analysis by the methods described in (Dorokhov and Chernov, 2010). Without loss of generality and without compromising the reliability of the model, for its simplified representation in the paper, we will use the linear membership functions (triangular and trapezoidal). Also, all linguistic variables will be represented by sets of three terms. Their characteristics are presented in table 11.1, and process of their construction was described in detail in the works (Dorokhov, Dorokhova and Zorina, 2010). Now, consider a graphical representation of the input, output parameters and decision rules in the interface software fuzzy TECH5.5.

Graphical representation (kinds and views of membership functions) for input parameters (1-13) are shown in Figure 11.2, and for the output parameters of all levels are shown in Figure 11.3. At each of the drawings picture of one of the options given in an enlarged form. It should be noted that given in the table (and reflected on the grafics) performances of variables can be changed directly in the graphical mode, moving the necessary points with the mouse on the relevant parts of the graph, or typed numeric values directly in the appropriate fields interface.

The next step to create a model is construction of fuzzy inference rules for all model variables and sets of their linguistic terms. For each set of the "*group of input variables - the output variable*" we construct fuzzy inference rules (a decision on the estimation), similar to those was described in (Dorokhov, Dorokhova and Zorina, 2010; Dorokhov and Chernov, 2010). It should be remembered that we must consider all possible combinations for values of linguistic variables of input parameters. And for each terms combination from this set it is necessary to determine corresponding term from output parameter.

Example of graphical representation of the rules for the input variables “park power” and “park cover” and the corresponding intermediate output variable „park possibilities“ in the used package fuzzy TECH5.5 are shown in Figure 11.4.

Table 11.1. Characteristics of linguistic variables for the model parameters

№	*Name of the parameters and levels*	Unit of measurement	*Terms of variables, values of membership function*					
			Starting		*Middle*			*Finishing*
			Equal 1	Decrease from 1 to 0	Increase from 0 to 1	Equal 1	Decrease from 1 to 0	Increase from 0 to 1
1	Route mode (good fair poor)	%	0-10	10-30	15-30	30-35	35-45	40-55
2	Speed mode (good fair poor)	%	0-1	1-5	2-10	10-15	15-20	16-35
3	Time mode (good fair poor)	%	0-2	2-5	3-8	8-12	12-15	13-30
4	Road incident (few normal lot)	%	0-1	1-3	2-3,5	3,5-4	4-5	4-6
5	Road rule (few normal lot)	%	0-3	3-5	4-7	7-10	10-14	12-18
6	Readiness (high medium low)	day	0	0-2	1-4	4	4-5	4-8
7	Trucks age(small medium large)	year	0-1	1-3	2-3,5	3,5	4,5-5	4-7
8	Park cover (low medium high)	%	0-20	20-40	25-40	40-60	60-80	60-85
9	Park power (low medium high)	%	0-10	10-30	15-30	30-60	60-90	60-90
10	Claim (low medium high), number	%	0-2	2-3,5	2,5-7	7	7-10	8-15
11	Delay (low medium high), time	hour	0	0-1,5	1-2,5	2,5	2,5-4,5	3-6
12	Maintenance (low medium high), coast	%	0-1	1-3	2-5	5	5-8	7-10
13	Fuel expence (normal medium high)	%	0-5	5-10	6-14	14-20	20-30	23-45
14	Motion mode (poor fair good)	point	0	0-5	2,5-5	5	5-7,5	5-10
15	Road safety (low medium high)	point	0	0-5	2,5-5	5	5-7,5	5-10
16	Trucks (satisfactory good excellent)	point	0	0-5	2,5-5	5	5-7,5	5-10
17	Park possibility (low medium high)	point	0-2,5	2,5-5	2,5-5	5	5-7,5	5-7,5
18	Trip style (poor fair good)	point	0	0-5	3-5	5	5-8	6-9,5
19	Park (insufficient medium enough)	point	0-2,5	2,5-5	2,5-5	5	5-7,5	5-7,5
20	Service level (low good excellent)	point	0-2,5	2,5-5	2,5-5	5	5-7,5	5-7,5
21	Work level (poor fair good)	point	0-25	25-50	25-50	50	50-75	50-75
22	Total estimation (low good excellent)	point	0-25	25-50	25-50	50	50-75	50-75

Figure 11.2. Computer representation of input variables of model

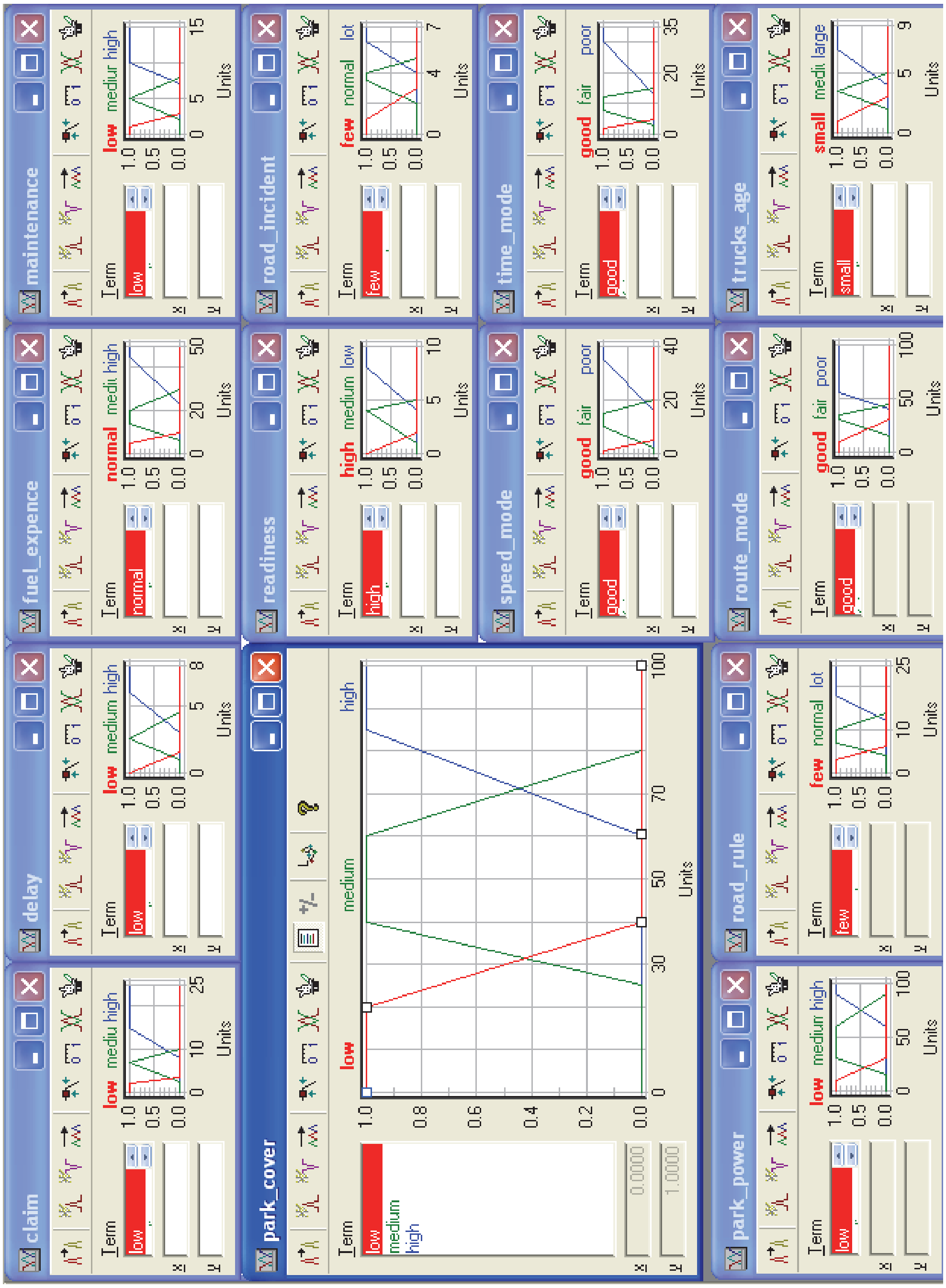
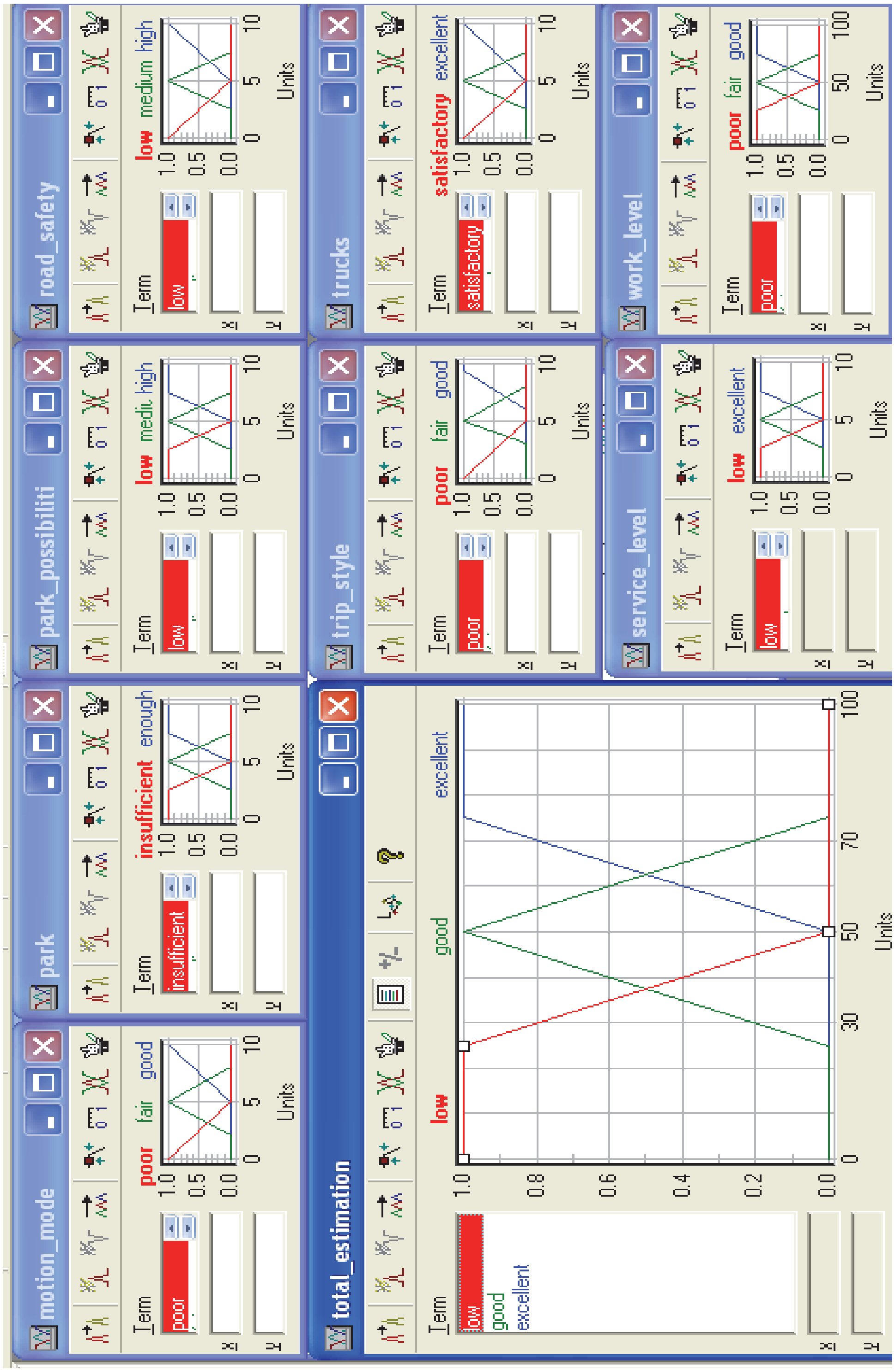
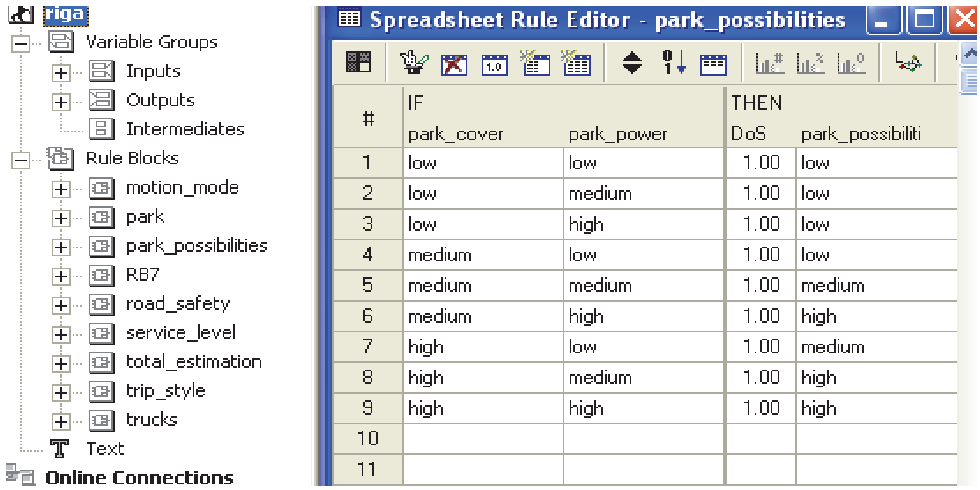


Figure 11.3. Computer representation of output variables of model



Parameter DoS (see Figure 11.4) determines the relative weight for each of the rules (in this case they are the same weight) and can be changed by the user in the process of setting up a model. In our case, there are 9 of these units make decisions.

Figure 11.4. Set of decision making rules for input variables park cover, park power and output variable park possibilities



#	IF		THEN	
	park_cover	park_power	DoS	park_possibiliti
1	low	low	1.00	low
2	low	medium	1.00	low
3	low	high	1.00	low
4	medium	low	1.00	low
5	medium	medium	1.00	medium
6	medium	high	1.00	high
7	high	low	1.00	medium
8	high	medium	1.00	high
9	high	high	1.00	high
10				
11				

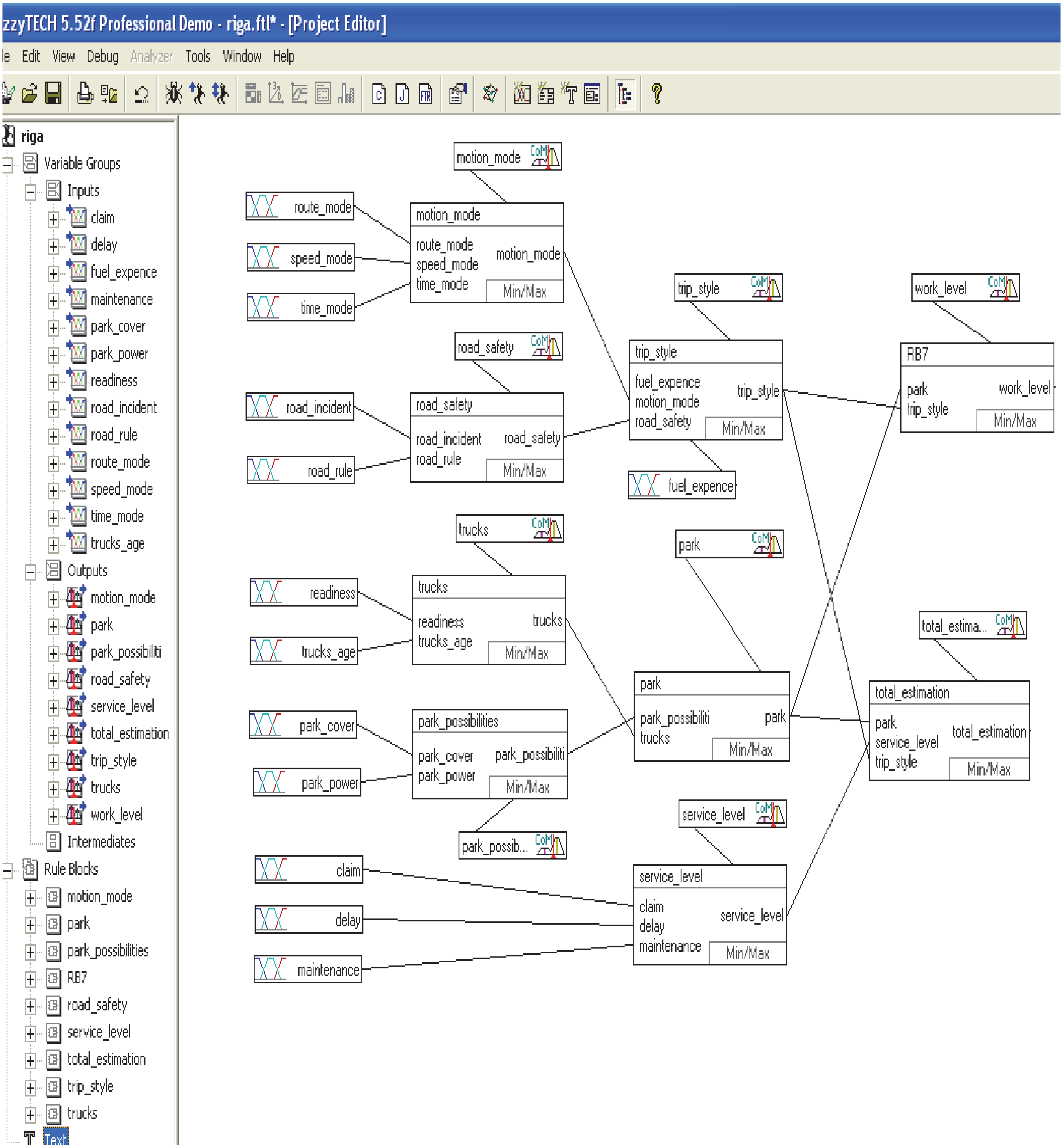
11.12 The Resulting Computer Model of the Problem, Making Calculations and Analysis of its

The general form of a computer model of the problem, in particular, the causal interaction of input, intermediate and output variables in the environment of the fuzzy modeling fuzzyTECH5.5 presented in Figure 11.5.

Clicking on each element of the structure (that take access to corresponding parameters) allows to open the appropriate box and change the necessary characteristics of the selected variable and the rules of decision-making assessment.

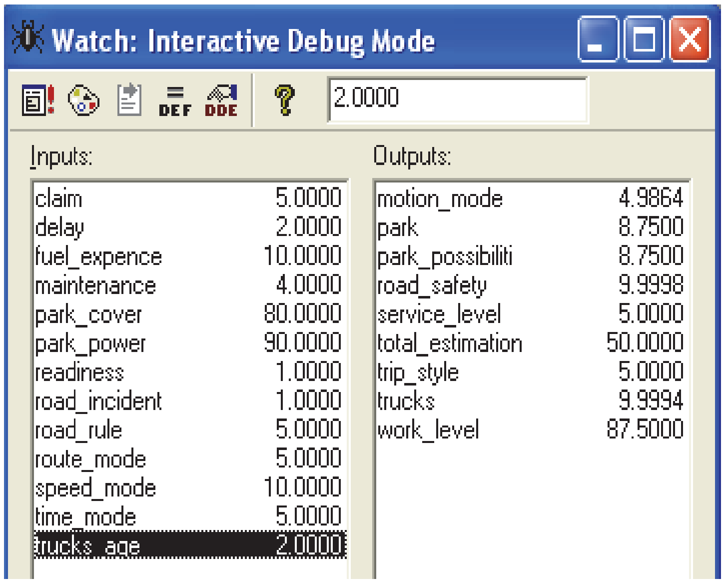
After a description of all variables and entering of all the fuzzy rules all input data and calculation results are displayed in the intractive debug calculation's window which is shown in Figure 11.6. The Figure 11.6, as an example, shows two screenshots of interactive recalculation windows. In each of them (in the process of work within the program) the user enters (on the left) the numerical values (evaluation) of input parameters and (on the right)) program displays the results of calculations for all output parameters (intermediate and final). These screenshots differ only in the numerical values of the parameter „delay" (for left - 2 hours, for right -5 hours). The result is an overall assessment of quality of transportation („total estimation") varies from 50 points (left) to 13 points (right), which is caused almost unacceptable value „delay“ (it is very important for the recipient of transport services) in the second case.

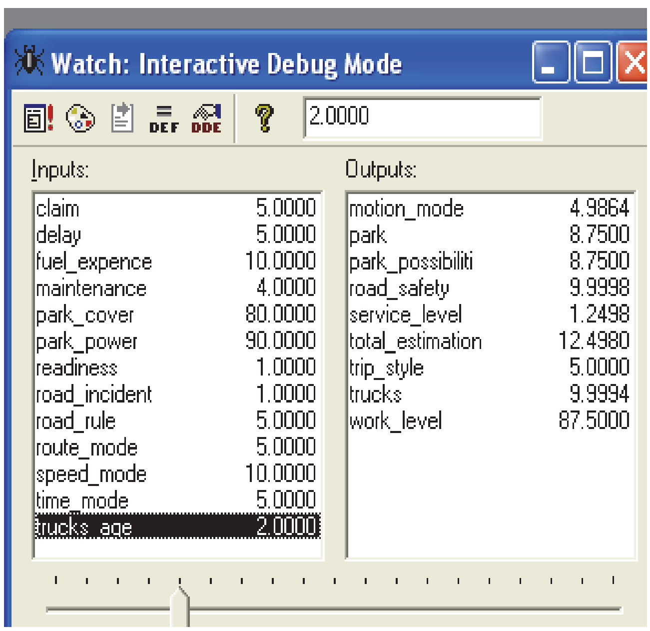
Figure 11.5. General computer model



At the same time, the characteristic „work level“, which is an internal generalizing measure of the technological side of work for the transport company has 87 points and not changed (for other parameters remaining constant, of course). A described window (see Figure 11.6) enables modeling the general level of transportation, changing some or all input parameters and analyzing the results. In the same purposes can be used the surfaces of interdependence between parameters, one of which is shown in Figure 11.6.

Figure 11.6. Intractive debug calculation’s window





A more detailed analysis of the direct numerical simulation in the already constructed model is the subject of our further research. We assume, in particular, to consider (the list is not exhaustive and closed) issues such as:

- practical construction of membership functions based on statistical analysis of expert interviews;
- use of more complicated form of membership functions, including custom's (no standart);
- different forms of representation of the resulting data in fuzzyTECH5.5 package and they provide opportunities for analysis;
- opportunities for learning and adjustment of the constructed system of fuzzy inference using neural networks;
- increasing the number of initial parameters in the model;
- expert determination of weights of parameters;
- development of the model to using of different values of the weights for the various initial, intermediate parameters and the relevant rules of decision-making;
- the creation of executable modules (not requiring from the end user to have the program fuzzyTECH5.5) by compiling a model from fuzzyTECH5.5 to the C programming language, and then into an executable code.

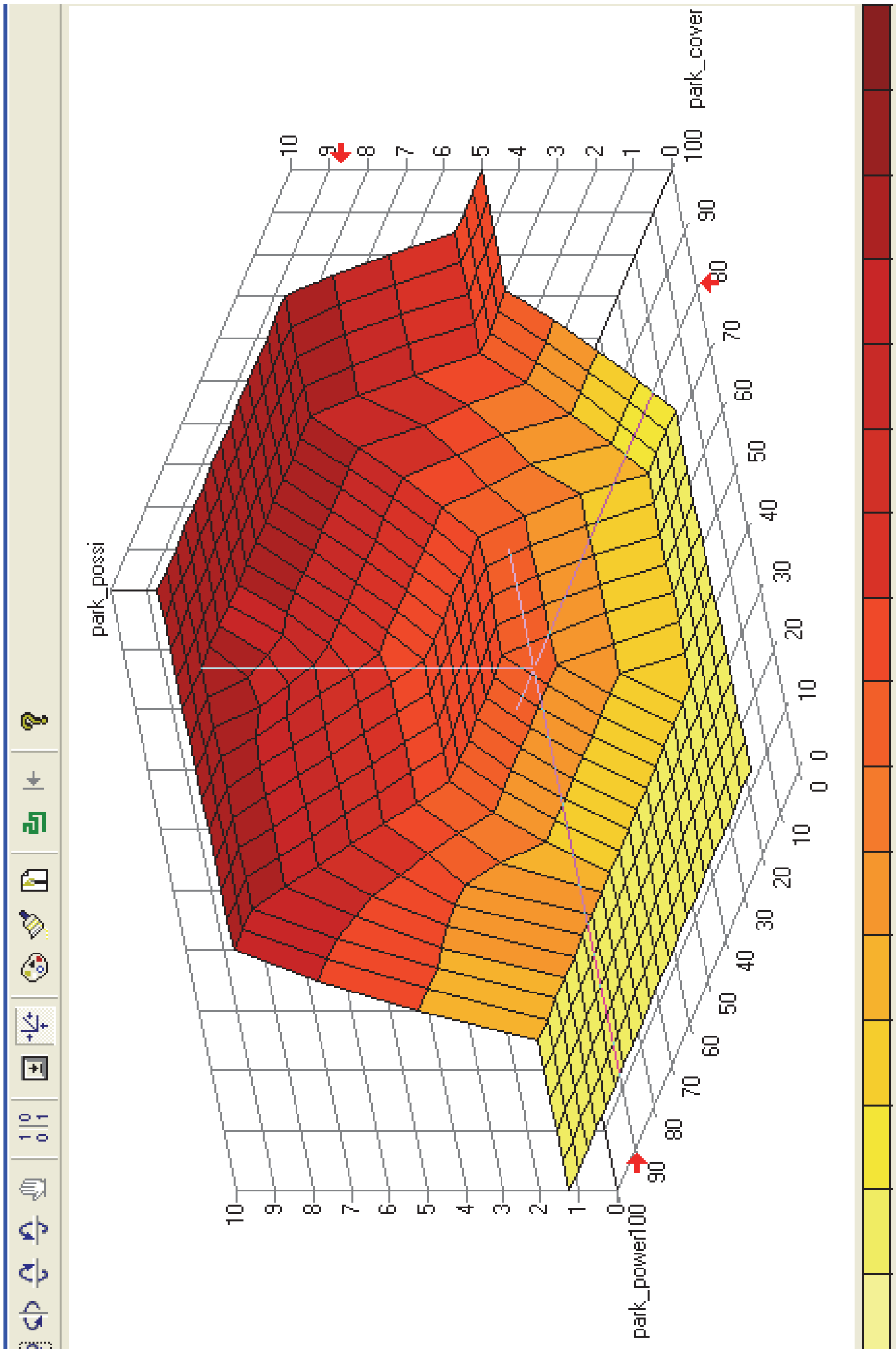
Thus, has been developed a multicriteria model for evaluate the quality of freight transportation. Theoretical basis for constructing the model was the fuzzy set theory and practical tool for the creation was a special fuzzyTECH5.5 software.

Model is sufficiently substantiated and reliable. It takes into account a significant number of quality parameters of freight services, and take possibilities to create and use these parameters with corresponding decision rules for generalizing estimates.

User can submit and save the results in a clear, understandable and suitable for further analysis form, and can perform calculations interactively. Using this model, management of transport enterprises and consumers of transport services can efficiently control the quality of transportation, the level of transport and associated services, which are very important tasks in market conditions.

The obtained results will be presented in detail in a later publications.

Figure 11.7. Surface of dependence between park power, park power and resulting park possibility



12. NEGATIVE EXTERNALITIES ON THE LOGISTICS DEVELOPMENT OF ADRIATIC SEAPORTS

The subject of the paper is to investigate the hypothetical perceptions of the impact of negative externalities on the expansion and development of selected Adriatic seaports. The aim of the paper is to show that Adriatic seaports must accept and apply the integration strategy for as a key business and logistic competence, which can be the basis their expansion and development.

Therefore, this paper starts with the basic hypothesis that a partner business performance and cooperation between the Adriatic seaports of Koper, Rijeka, and Bar is a crucial condition for easier finding of large foreign investors and global logistics providers. It also starts with the auxiliary hypothesis that it is necessary to overcome many business barriers, which are treated as negative externalities.

For researching the perception of the impact of negative externalities, the multiple linear regression method is used. It is concluded that the level of selected negative externalities is different in individual selected ports, but also between them. The research results verified the initial hypothesis.

Seaports are constantly adapting to the changes in the world maritime market in several ways: increasing the size of their infrastructure and suprastructural capacities, technological and information improvement, cooperation with logistics providers and integrating their logistics functions. It is indisputable that investments played a major role in their modernization. Given the long-standing crisis situation, as well as the need to increase business efficiency, the development of logistics services (in terms of marketing logistics and transport logistics in order to achieve a satisfactory degree of integration), outsourcing (Bilan et al., 2017), and regional competitiveness, strategy formulation of Adriatic seaports of Koper, Rijeka, and Bar (the sequence is in terms of development) in the near future should focus on three basic (general) development directions:

- attracting FDI and engaging a well-known global logistics provider as a key and long-term strategic partner,
- building an efficient logistics and information system and outsourcing, and
- wider and greater connection with the hinterland, with the possible organization of free zones and logistics-distribution centers in the wider Montenegrin area.

Bearing in mind the extremely favorable geographic and strategic position of Adriatic seaports, with a high level of safety, it can be assumed that the implementation of the partial business *integration* strategy will significantly contribute not only to the realization of the aforementioned basic (general) relevant development goals, but also to the following:

- increase the level of quality, the supply universality of their port services and competitiveness in relation to other relatively close seaports (Marlow and Paixao, 2003, p. 195),
- better and advanced logistic and transportation links between the Adriatic seaports, as well as the links with European and world seaports (UNCTAD, 2009; Draskovic, 2013);
- stability and profitability of all their port operations in the long run,
- sustainable development in the considered Adriatic seaports, which implies concern for the natural environment (UN, 2015; Zuzeviciute et al., 2017; Mikalauskiene et al., 2018),
- increase the employment and living standards of the population in the wider area, which gravitate towards the mentioned seaports,
- strengthen and improve the overall institutional environment in the countries to which the seaports belong (Delibasic, 2016; Popov et al., 2016: Yerznkyan et al., 2017, Draskovic, 2017, Draskovic et al., 2017), and
- greater overall economic and other benefits for the countries to which the sea ports belong.

It is implied that the realization of the stated goals would not only increase the port traffic, but also a certain redistribution of transport and port services in the region (primarily referring to the considered Adriatic seaports of Rijeka, Koper, and Bar), strengthening their key competences in terms of transport and logistics performance. It is assumed that this would overload the freight transport corridors in some parts of Europe. This is particularly relevant for goods of Chinese and Korean origin, hence it would be logical to employ well known global logistics providers as strategic business partners and investors, mostly from China and South Korea.

It has allready been conceptually and hypothetically explained (Draskovic, 2013) that realization of the considered idea implies large foreign investments, which should be directed to deepening and leveling the sea gauge (especially in the port of Bar). This would lead to a reduction in and/or significant elimination of the existing feeder service, which significantly increases the total transport of container cargo cost towards the Adriatic seaports, epsecially the port of Bar, which gets a significant portion of container cargo from the seaports of Rijeka and Koper.

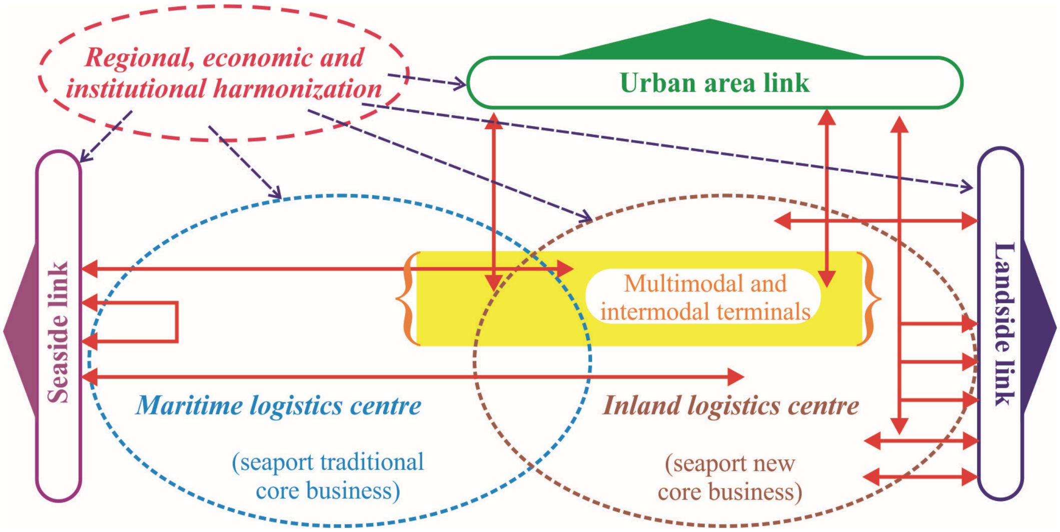
Implementation of this idea also includes a significant degree of partnership cooperation, and the related long-term forms of partial business integration between these ports. It is a necessary condition for overcoming many political, economic, and other problems that objectively exist between the countries belonging to the considered seaports. Achieving such a partnership agreement would enable the synergistic strengthening of the competitiveness and key competencies of all these ports, as well as the consequent increase of their involvement in the global flows of integrated marketing logistics.

12.1 Theoretical approach

Development and implementation of discussed ideas must be seen at the practical regional level (political, economic, and institutional level), with the wider participation and cooperation of all interested regional partners (govenrmental entities, mentioned Adriatic ports, and the selected global logistics provider). It is also necessary to bear in mind the theoretical model, proposed by A. Montwiłł (2014, p. 260) in accordance with UNCTAD recommendations (2004). It implies the compulsory (minor or greater) integration of particular operating port functions with city and regional functions (i.e. "*objective functions*" with "*spatial functions*") in order to build and strengthen logistics centers in the seaport and its hinterland (Figure 12.1).

This idea could highly correlate with the activation of the wider hinterland of the listed Adriatic seaports (regardless of the existing degree of their infrastructure, logistics, and traffic development). The hinterland of Adriatic seaports can be adjusted to the development of assembly industries and distribution centers for exporting to European countries, banking services and insurance, ecotourism and organic food production for the needs of tourism and export. It also suggests the development of industrial and economic administrations, inspections, quarantines, tax authorities and banks, telecommunications and insurance companies, low taxation and profit repatriation.

Figure 12.1. Possibilities of logistical and economic development of seaports



Source: adapted from UNCTAD, 2004; Montwiłł, 2014.

The implementation of the partial business integration requires maximal respect for regional, economic, and institutional harmonization, given the specific, complex, crisis and disruptive (mainly inherited) political and economic conditions that still exist to a significant extent in the observed region between the countries in which the said seaports operate. In this respect, we consider that implementation of the discussed idea of expansion, development, and partial business integration of Adriatic seaports and their possible future partnership and cooperation requires the elimination of several obstacles that objectively exist. In the past, these obstacles have created a specific braking mechanism, made of several negative externalities, among which the following are the main ones:

- Insufficiently developed mutual political relations between the countries belonging to the selected seaports, and relatively weak consequent regional economic cooperation, with the presence of suspicion and distrust due to unfavorable war events and other political conflicts in the recent past;
- Differences in the institutional development of the countries in which the discussed Adriatic seaports are located (according to the indicators noted by A. Denzau and D. North, 1994; G. Hodgson, 2006; D. Acemoglou and J. Robinson, 2012; B. Yerznkyan, 2012; O. Williamson, 2014; M. Delibasic, 2014, 2016);
- Underdeveloped system of port infrastructure and port superstructure, in accordance with the criteria stated by K. Misztal, 2010; S. Markusik (2009), and A. Grzelakowski and M. Matczak (2012), as well as underdeveloped system of port logistics, in accordance with the criteria stated by UNCTAD (2009), K. Bichou and R. Gray (2004);

- Poor seaport performance indicators, in accordance with the criteria stated by P. Marlow and Paixao (2003), K. Bichou (2006), S. Esmer (2008), M. González and L. Trujillo (2009), P. De Langen and K. Sharypova (2013) and UNCTAD (2016).

12.2 Adriatic ports case study

As a methodological framework for the quantitative analysis - a linear multiple regression model was used, with 180 selected citizens surveyed (60 respondents in each country to which a specific seaport belongs - Slovenia, Croatia, and Montenegro). All respondents had a high education in the field of economics or logistics, which assumes that their logical thinking was at a high level. In addition, most of them were experts in the port management. They were asked to evaluate, based on their best knowledge, experience and/or intuition, the *dependent variable* in the model, defined as the *degree of economic and logistic development* of the selected Adriatic seaports of Koper, Rijeka, and Bar (each respondent for the corresponding seaport in his/her own country).

They were also asked to evaluate the values of three independent variables in the model, defined as the key obstacles (i.e. negative externalities) for the implementation of the considered idea of business cooperation and integration of selected seaports, which related to:

- differences in institutional development of the observed countries,
- underdeveloped system of port infrastructure, port superstructure, and port logistics, and
- poor seaport performance indicators. In all cases, respondents used a scale (1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0), where 1.0 was the lowest impact, and 5.0 was the highest impact.

Designing the survey and the analysis took into consideration the existing underdeveloped mutual political and economic relations between the countries where the said seaports are located. It is assumed that their improvement is a condition for the future business economic and logistic cooperation.

12.3 Multiple linear regression model

The idea is to create a mathematical model using multiple linear regression analysis, that is, a functional relationship between the dependent variable (Y): *level of economic and logistic development of port* and independent variables (X_1, X_2 and X_3): (i) *institutional development of port,* (ii) *port infrastructural, suprastructural and logistic development,* and (iii) *port performance indicators*.

The task is to estimate the expected mean value of the dependent variable ($\overline{Y}$), based on individual estimations of the respondents. Since the respondents have given the estimations based on their own discretion, in line with the requirements of multiple linear regression model, the coefficients (b_0, b_1, b_2, b_3) are to be determined and $\overline{Y}$ calculated by using equation (1):

$$\overline{Y} = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 \quad \ldots (1),$$

Where

$\overline{Y}$ - is the mean expected value of the dependent variable;
b_0 - is Y-axis intercept, determined on the basis of an appropriate sample;
b_1, b_2, b_3 - are coefficients of variables $X_i, i = \overline{1,3}$, respectively, or slopes of the corresponding lines.

This practically means that for any new value of each independent variable from a predefined interval, one can estimate the value of the dependent variable. It should be said that $\overline{Y}$ is *average* estimated value, because it is the mean value of the probability distribution of possible values of Y for given values $X_i, i = \overline{1,3}$. To determine $\overline{Y}$ is used the least-squares method (Bertskas et al., 2008). In fact, our aim here is to determine the coefficients (b_0, b_1, b_2, b_3), so as to minimize the sum of squared errors (SSE), which is represented by formula (2):

$$SSE = \sum_{k=1}^{n} \left(Y_k - \overline{Y}_k\right)^2 = \sum_{k=1}^{n} \left(Y_k - \left(b_0 + b_1 X_{1k} + b_2 X_{2k} + b_3 X_{3k}\right)\right)^2 \ldots (2)$$

Where

Y_k - is actual value of the dependent variable, given by the k respondents ($k = \overline{1,n}$);
$\overline{Y}_k$ - is the estimated value of the dependent variable on the basis of the model, in the case of k respondents ($k = \overline{1,n}$);
n – is the total number of respondents (here, per 60 related to the Port of Bar, Port of Rijeka and Port of Koper), $k = \overline{1,n}$.

Using the least-squares method, in the paper is actually determined a straight line, which minimizes the sum of vertical differences for each pair of points (Balakrishnan et al., 2007). In other words, identified is a straight line that best fits the given set of points, by determining the optimal value of Y-axis inter-cept (b_0), as well as coefficient (b_1, b_2, b_3), in order to obtain a more accurate value of $\overline{\mathrm{Y}}$ for the given values of $X_i, i = \overline{1,3}$ and Y (for $\forall k$, $k = \overline{1,n}$).

The realization of multiple linear regression model is very complex, and therefore it is better to leave it to the computer. For this purpose can be used SPSS (Sheridan and Coakes, 2013; Pallant, 2011), special Excel VBA tools as Excel Modules Solver, which has been used in this analyzes, while other similar tools can be used, as well.

12.4 Key statistic descriptors

In addition to the forecasted average value of the dependent variable $\overline{Y}$ and vectors (b_0, b_1, b_2, b_3), based on the model applied, the following statistical values can be calculated: mean absolute deviation, mean square error, mean absolute percent error, standard error of regression estimate, correlation coefficient and coefficient of determination. The formulas used to calculate these values are given below, as well as related brief explanations.

Mean absolute deviation (MAD), indicates the numbers on how much the value of the dependent variable, obtained through multiple regression analysis, corresponds to the estimated value by the respondents, or in other words, to what extent the model reflects the perception of the respondents (3). *Mean square error* (MSE) is the mean value of squares of the individual errors of assessment. In other words, if we have n number of respondents, MSE value is calculated using the formula (4). MSE values expressed deviations.

Mean absolute percent error (MAPE), indicates the error between the estimated value and value of dependent variable as a percentage, obtained by using the model (5).

The formulas for determining the values of the previously generally described errors in the model are given below:

$$MAD = \sum_{k=1}^{n} \left| A_k - F_k \right| / n \ldots (3)$$

$$MSE = \sum_{k=1}^{n} \left(A_k - F_k \right)^2 / n \ldots (4)$$

$$MAPE = 100 \sum_{k=1}^{n} \left[\left| A_k - F_k \right| / A_k \right] / n \ldots (5)$$

Where

A_k - is an actual value of a variable (value estimated by respondents), $k = \overline{1, n}$;

F_k - is an estimated value (by model), $k = \overline{1, n}$;

n – is a number of respondents (per 60 in the Port of Bar, Port of Rijeka and Port of Koper).

Standard error of the regression estimate (SE), is also called the standard deviation of regression. This statistical value is suitable for the formation of the so-called confidence intervals around the regression line. It indicates how much the value of the dependent variable, obtained by model, can vary numerically (6).

Correlation coefficient – r, is used to estimate the strength of linear relationships. Generally, if correlation coefficient is higher than 0.6, it is considered to be a strong linear relation (7).

Coefficient of determination - r^2, is a value between 0 and 1, which indicates to what extent (percentage) dependent variable depends on the independent variables included in the model (8).

General formulas for calculating the standard deviation, correlation coefficient and coefficient of determination are given below:

$$SE = \sqrt{\sum (A_k - F_k)^2 / (n-2)} \quad \dots (6)$$

$$r = \frac{n\sum A_k F_k - \sum A_k \sum F_k}{\sqrt{\left[n\sum A_k^2 - \left(\sum A_k\right)^2\right]\left[n\sum F_k^2 - \left(\sum F_k\right)^2\right]}} \quad \dots (7)$$

$$r^2 = \left\{\frac{n\sum A_k F_k - \sum A_k \sum F_k}{\sqrt{\left[n\sum A_k^2 - \left(\sum A_k\right)^2\right]\left[n\sum F_k^2 - \left(\sum F_k\right)^2\right]}}\right\}^2 \quad \dots (8)$$

Where

A_k - is an actual value of a variable ($k = \overline{1,n}$);

F_k - is an estimated value ($k = \overline{1,n}$);

n – is a number of respondents (per 60 in the Port of Bar, Port of Rijeka and Port of Koper).

12.5 Results and discussion

The respondents, namely per *60 experts for port management* in Montenegro (*Port of Bar*), Croatia (*Port of Rijeka*) and Slovenia (*Port of Koper*) were asked to estimate the dependent (Y) and three independent variable in the model (X_1, X_2 and X_3), each with a number on a scale from 0.5 to 5.0. In fact, respondents were supposed to estimate the *level of economic and logistic development of port* (dependent variable), as well as the extent to which the following independent variables: (i) *institutional development of port*, (ii) *port infrastructure, supra-structure and logistic development*, and (iii) *port performance indicators* - affect the dependent one. Also, the values of statistical parameters, described in the previous section, have been determined in order to analyze the reliability of the proposed predictive model.

Using Excel Modules Solver are obtained the results of multiple regression analysis, for all respondents, for each of the analyzed ports. In fact, determined are coefficients in a function of the dependent variable, that is, the slice on the Y-axis (b_0) and coefficients (b_1, b_2, b_3) which correspond to the independent variables, $X_i, i = \overline{1,3}$ seriatim.

Based on these values and average values, estimated by the respondents, for each of the independent variables, are calculated *average* values of the dependent variable $\overline{Y}$. These values are shown in Table 8.1.

Using model are obtained the approximate values: **1.25**; **1.50** and **2.25**, respectively for the case of *Port of Bar*, *Port of Rijeka*, and *Port of Koper* (Table 12.1). By taking into account that the participants have evaluated the level of economic and logistic development of the analyzed ports by one number on a scale of 0.5 to 5.0, these are relatively low levels.

Table 12.1. Mean values of the dependent variable $\overline{Y}$ in the case of Port of Bar, Port of Rijeka and Port of Koper

	Port of Bar	*Port of Rijeka*	*Port of Koper*
b_0	1.302	1.789	1.393
b_1	-0.030	-0.079	0.005
b_2	-0.064	- 0.098	0.166
b_3	0.007	0.028	0.159
$\overline{Y}$	approx. **1.25**	approx. **1.50**	approx. **2.25**

Table 12.2 contains numerical values: mean absolute deviation (MAD), mean square error (MSE), mean absolute percent error (MAPE), standard error of the regression estimate (SE), correlation coefficient (r), and coefficient of determination (r^2) for the analyzed sets of respondents' estimations per each of the considered ports.

Table 12.2. Errors, coefficients of correlation and determination

	Port of Bar	*Port of Rijeka*	*Port of Koper*
MAD	0.383	0.326	0.315
MSE	0.198	0.162	0.152
MAPE	42.92%	23.97%	15.00%
SE	0.461	0.417	0.404
r	0.091	0.159	0.309
r^2	0.008	0.025	0.095

Following are the graphs (Figures 12.2-12.4) showing the actual values of the dependent variable Y, determined on the basis of subjective estimation of *3x60 respondents – port management experts* from Montenegro (*Port of Bar*), Croatia (*Port of Rijeka*) and Slovenia (*Port of Koper*), as well as those calculated by the model, i.e. $\overline{Y}$.

Figure 12.2. The values of the dependent variables, estimated by respondents and those determined by the model, in the case of *Port of Bar* (Montenegro)

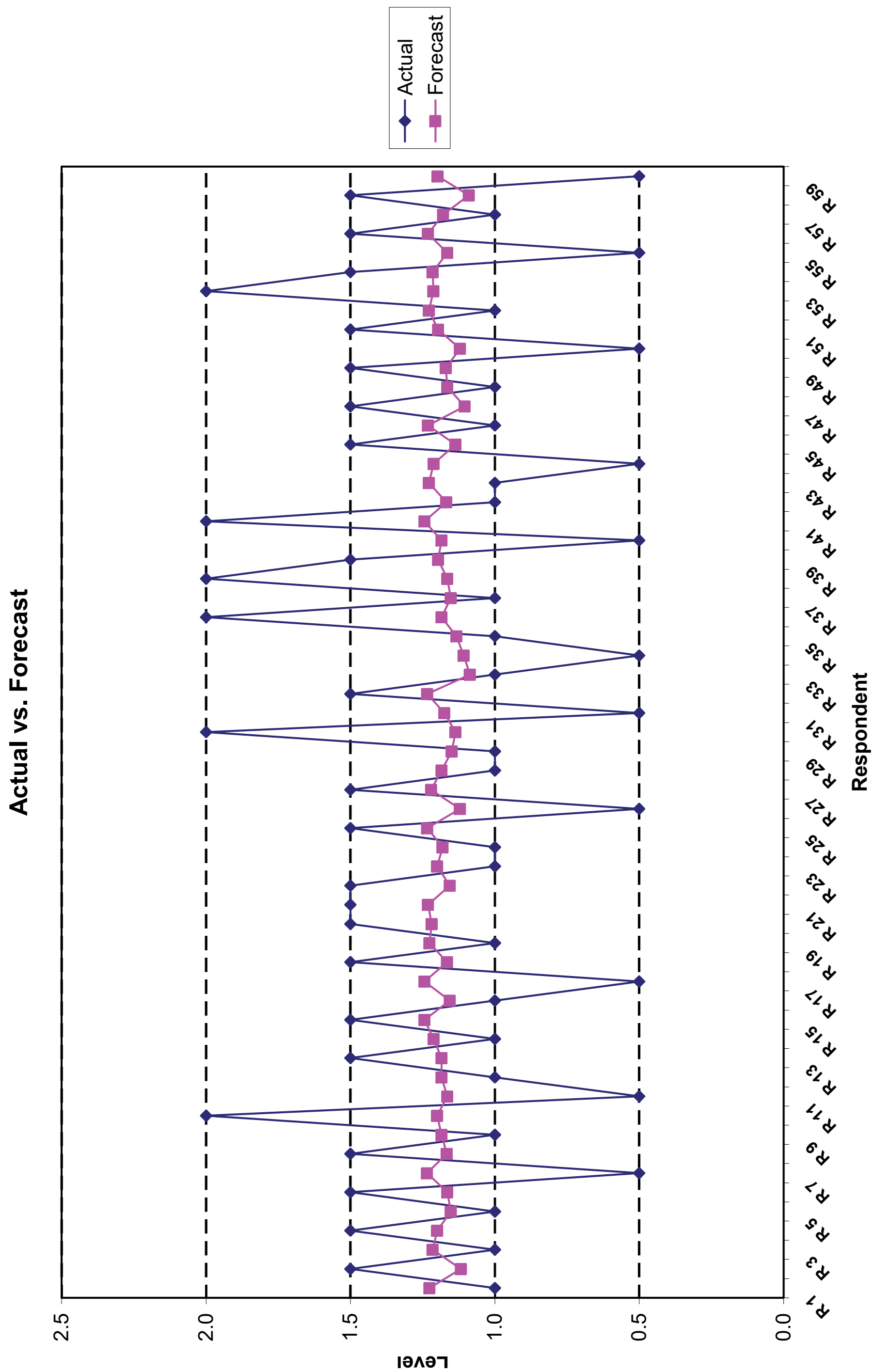


Figure 12.3. The values of the dependent variables, estimated by respondents and those determined by the model, in the case of *Port of Rijeka* (Croatia)

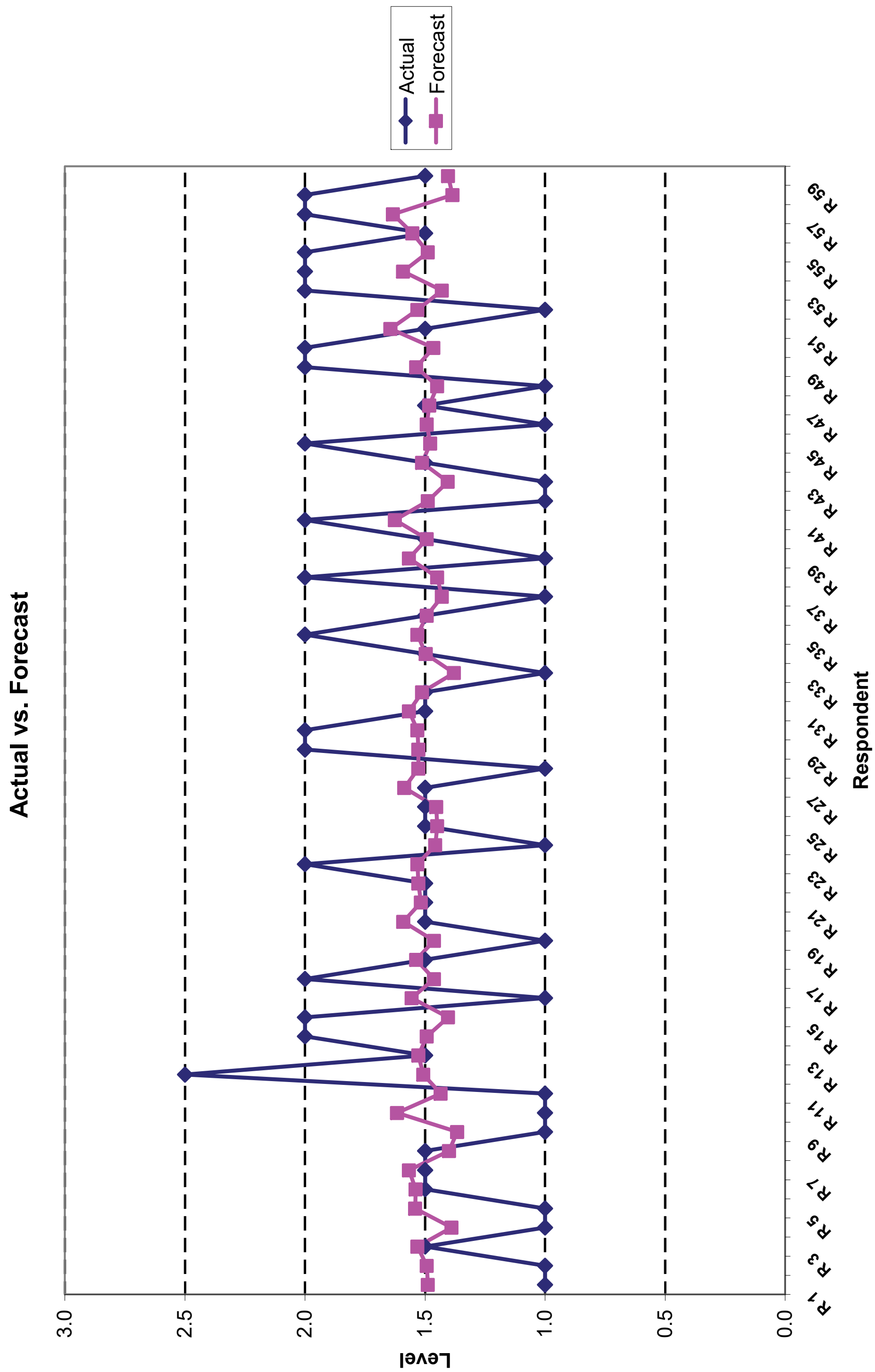
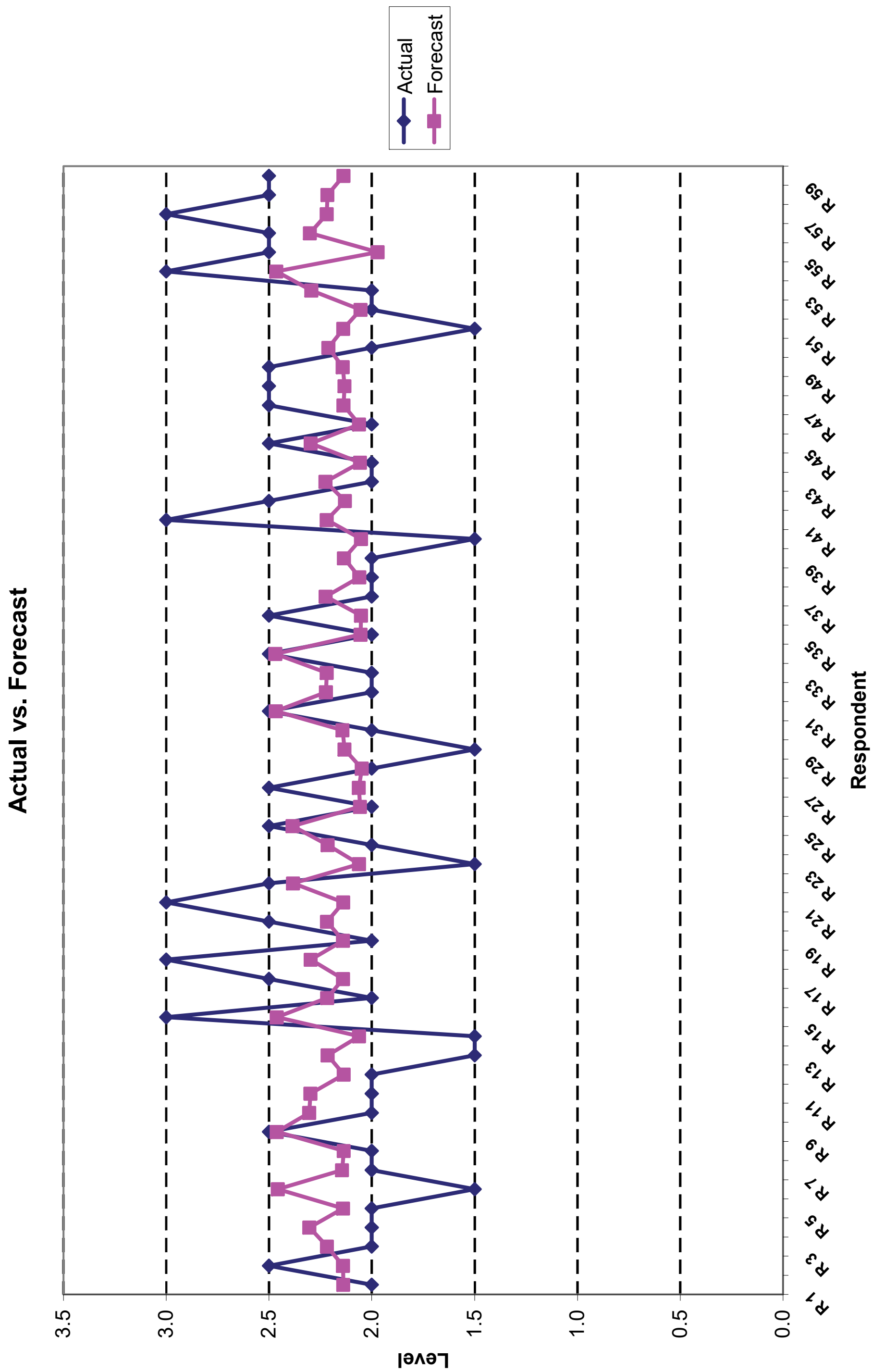


Figure 12.4. The values of the dependent variables, estimated by respondents and those determined by the model, in the case of *Port of Koper* (Slovenia)



On the basis of statistical modeling it has been shown that mean expected values of the dependent variable are: 1.25; 1.50; and 2.25 in the cases of Port of Bar (Montenegro), Port of Rijeka (Croatia) and Port of Koper (Slovenia), respectively. Analysis are done over the representative set of input data composed of the truthful responds of a large number of the experts in the field.

Linear functional dependence in all three considered case show acceptable level of consistency, with mean absolute percentage errors of: 42% (Port of Bar); 23% (Port of Rijeka); and 15% (Port of Koper).

The proposed regression model can be eventually refined by introducing additional independent variables. Also, lager parent population, or input data set of experts' responds, might be considered in the future research work.

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EXCERPTS FROM REVIEWS

Prof. dr ***Borut Jereb***,
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In the textbook, the author has gathered and summarized the essence of logistics with an emphasis on one of his favorite areas – maritime logistics. Related processes should be managed with logistics resources, which are recognized in the flow of goods or services, information flow, logistics infrastructure and suprastructure, and finally people. The book takes each of these five resources in turn and treats them in equal depth.

The flow of goods and services should be managed from the point of origin to the point of consumption in order to meet the requirements of customers. The information flow causes a change in a dynamic system provided that the system was able to decode data and to attribute them with a relevant meaning. Further to that, it also delivers a change of knowledge in accordance with certain rules where the system has access to them. Logistics infrastructure and suprastructure are basic physical and organizational structures needed for the operation of logistics. People are the personnel required to plan, organize, acquire, implement, deliver, support, monitor and evaluate the logistics systems and services. They may be internal, outsourced or contracted as required.

With logistics resources we actually 'do logistics', thus they are needed to manage the logistics processes as they represent a given environment, which should also be protected in order to assure the right item in the right quantity at the right time at the right place for the right price in the right condition to the right customer.

This professional work is dedicated to students who are just getting to know the basic rules of logistics, as well as to professionals. The content that is covered in 12 chapters takes the reader from the basic concepts to the application of mathematical approaches and computational tools for solving the essential everyday challenge encountered in logistics – the problem of optimization.

The first chapter provides an overview of the management of maritime container transport and its development in recent decades with the review of the development of ports around the world, of the Mediterranean ports, and finally of the Adriatic ports such as Trieste, Koper and Rijeka, the review being based on statistical data. The second chapter provides a theoretical overview of logistics and SCM as well as their mutual relationship with a thorough, in-depth description of the logistics resources. The insights provided by the top management of the leading logistics companies are a special value of this chapter. The third chapter introduces the concepts and management models 3PL, LLL and 4PL with examples of major global logistics companies. The fourth chapter provides a comparison of the most important ports on the east coast of the Adriatic – Koper, Rijeka and Bar. On the basis of statistical data and SCM models, the importance of cooperation between these ports for their faster development is demonstrated. The fifth chapter introduces the concept of Performance Management in logistics as an effective business model. The following chapter describes the particularities of the management of logistics processes during transport by ship and port activities at the strategic, tactical and operational management level with the emphasis on the importance of supporting documentation and ICT. The seventh chapter presents the technological advantages of RFID technology over the classical barcode system – pros and cons of RFID. The eighth chapter provides the basics of a graph as a key mathematical tool for the study of the dependencies between logistics resources to optimize logistics systems according to various criteria (such as costs, time, etc.) using heuristics. The ninth chapter presents the old optimization problem, which, however, is crucial for logistics – the traveling salesman problem.

A theoretical example of four cities is introduced, which is explained and upgraded with the real case of calculating the optimal routes. In the tenth chapter, the use of technological tools such as spreadsheets are demonstrated to calculate the critical route. The last chapter is devoted to the presentation of the calculation of the optimization of the real logistics case by using mathematical tools, taking into account more realistic parameters that define logistics resources. (ali …mathematical tools, whereby more realistic parameters that define logistics resources are taken into account.)

The work is written smoothly and systematically. Furthermore, it is also didactically well-balanced as explanation throughout the textbook is very consistent and each chapter builds on the previous one(s). The text is accompanied by relevant visual material, while examples are clearly presented.

The book can certainly be of great benefit not only to students of logistics, but also to students of other disciplines dealing with decision-making process. For all these reasons I strongly recommend the publication issuance of the textbook.

Prof. dr hab. ***Yuriy Bilan***,
Faculty of Management,
Rzeszow University of Technology,
Poland

Scientific monographs on logistics are rare, especially in maritime marketing logistics. Mimo Draskovic has written this quality monograph after many years of experience in this scientific field, including many articles and projects. It consists of two parts, and each part contains six functionally-adjusted and compatible chapters. The book has 287 pages of A4 paper format due to technically difficult fitting of numerous images and tables, having significant size. The author managed to creativelly explain Business Logistics in Seaports (Part one) and Application of Logistics Optimization (Part Two).

In addition to the high-quality scientific text, enriched with numerous original ideas and research by the author, its technical presentation of color images (151) and tables (51) is impressive, which required great and long-term efforts of the author.

The monograph is expertly and competently written, with clear, concise, and focused text, using recognizable good style and gradative logic of presentation. It abounds not only with graphic and tabular, but also with mathematical modeling of the most important phenomena and categories in marketing logistics. It contains useful practical examples which enhance the abstractness of the basic text by various practical components. That is a special author's contribution, increasing the quality of the monograph considered.

Using the original concept and structural creation (selection and arrangement of thematic issues, parts, and chapters, their structure, scope, etc) the author has made not only scientific-methodological and analytical but also a technical step forward in comparison to the earlier rare scientific monographs in this field. Technical solutions are particularly high-quality, as well as the use and the adaptation of the latest bibliographic sources, which will significantly help students of master's and doctoral studies in writing their papers and theses.

The monograph structure contains many innovations and adjustments to the modern marketing trends. It represents a very significant and serious research effort by the author, which will surely have a lasting character, both due to the mentioned innovation, and due to the thematic comprehensiveness, content, problem roundness and harmonization of individual chapters. Also, due to the exceptional visual, practical, and educational aspects of the offered text, which the author has approached with high world publishing standards that are still rare in the former Yugoslavia region.

It is my pleasure to participate as a reviewer in the international publication of this valuable scientific monograph of lasting significance, which sublimates the dedicated and longtime author's work on marketing logistics issues. I am sure it will receive the highest marks in the critical scientific circles, and that in that sense it will inspire further achievements in this area by Mimo Draskovic, as well as by other authors of this scientific field.

Prof. dr ***Ratko Zelenika***,
Faculty of Economics,
University of Rijeka,
Croatia

We have here an unusual, rare and useful scientific study in the area of theory and applied business logistics – the area that is facing a theoretical and practical deficit not only in the author's country – Montenegro, but in the wider region as well. It is very positive and opportune that this serious scientific task of collecting, processing, structuring and presenting the extensive theoretical material in the area of business logistics was undertaken by this young Montenegrin scientist, Mimo Draskovic, PhD. It is even more positive that he managed to present to the readers various opportunities for its application in the propulsive sector of seaports. He did so in a convincing, competent and methodologically correct manner.

Another important fact in my opinion is that the author presented five co-author papers in the second part of this scientific study. In this way, he demonstrated successfully all the advantages of team work that so important for business logistics. Yet another reason to congratulate the author and co-authors of this valuable book.

This book is rich in analytical, methodological, professional and scientific qualities that will make it one of the important works in marketing logistics in Montenegro and the region. With the selected applied research it may serve as a guideline for new, further research in this field.

In over 220 pages of a clear and concise text the author managed to respond in a quality way, in line with the global scientific, analytical-methodological standards, to all of the posed conceptual questions in two thematic areas: business logistics in seaports, and application of logistics optimization. In doing so, he used an impressive list of contemporary literature (over 200 items in literature), while technically enriching the text with pictures, tables, logical schemes and graphs.

In the fast changing environment, with the global changes characteristic of the information era, basic resources of the so-called “new economy” are information and know-how. Integrated business logistics became one of the most propulsive economic sectors exactly because of the transportation and communication technologies. This sector is continuously moving the borders of multidisciplinary knowledge and organizational capacity.

The book is structured in an original way. It is the result of many years of author’s work on this issue. We believe that it will be useful, interesting and educational for a wide audience. One of the reasons being that in the first part of the book the author managed to present a rather complex, important, topical and relatively difficult subject matter in a simple and understandable manner. In the second part he demonstrated some of the possibilities for application of logistics modeling in the optimization of business processes.

It was a pleasure for me to participate, as an editor, in this important publishing project, with the renowned publishers from several EU member states, which gives an even greater importance to this book.

For all of the aforementioned, I take this opportunity to sincerely recommend the publishing of this important scientific work.

ABOUT THE AUTHOR

Mimo Draskovic was born in Niksic (Montenegro) in 1981, where he completed elementary and high school. He is Associate Professor at the University of Montenegro, Maritime Faculty Kotor.

He is employed at the Faculty of Maritime Studies in Kotor, where he holds lectures in *Maritime Management, Customs and Customs Operations, Organization of Maritime Companies, Global Strategies of Marketing Logistics and Free Zones and Foreign Investments.*

He is the author of 3 scientific monographs, 3 textbooks, co-author of 7 scientific monographs, 8 textbooks, 7 manuals and scripts, over 70 scientific papers, and numerous articles, editorials, proceedings, contributions and interviews.

Elementary fields of his academic interest are: *marketing logistics of sea ports, strategic management, economy and international relations, knowledge economy, new economy and he is also interested in media phenomenology.*

At the Faculty of Maritime studies in Kotor he is currently the Head of the Maritime Management Department.

M. Draskovic is a member of the Association of Young Scientists at the Montenegrin Academy of Science and Arts.

Also, since 2014, he is the Vice President of the Radio Television of Montenegro Council.

Draskovic is the Chief Editor of the international scientific journal *Media Dialogues* and one of the founders of the International Scientific Conference „Montenegrin Media Dialogues“.

He is a member of the editorial board of the following international Journals: *Economics and Sociology* (Szczecin)*, Economics of Development* (Kharkiv), *Montenegrin Journal of Economics* (Podgorica), *Economics & Economy* (Podgorica), *European Journal of Economics and Management* (Banja Luka), *Financing* (Banja Luka), *Montenegrin Journal of Ecology* (Podgorica), and *Economic Essays* (Podgorica and Moscow).

M. Draskovic has published scientific papers in journals and conference proceedings: *Transformations in Business & Economics* – Vilnius (**SSCI**)*, Amfiteatru Economc* – Bucurest (**SSCI**), *Sociological Studies* – Moskow (**SSCI**)*, Economics and Sociology* – Szczecin (**ESCI and Scopus**)*, Montenegrin Journal of Economics* – Podgorica (**ESCI and Scopus**)*, Economy of Region* – Ekaterinburg (**Scopus**)*, Journal of Central Banking Theory and Practice* – Podgorica (**Scopus**)*, Public Policy and Administration* – Kaunas (**Scopus**) *Actual Problems of Economics* – Kiev (**Scopus**)*, Journal of International Studies* – Szczecin (Scopus)*, Theory and Practice of Institutional Reforms in Russia* – Moscow, CEMI, Russian Academy of Sciences*, Economicc of Kontemporary Russia* – Moskow*, Economics and Economy* - Podgorica*, Economic themes* – Nis*, Strategic Management* – Subotica*, Media Dialogues* - Podgorica*, Economic Ideas and Practice*, Belgrade, *Economics / Ekonomija* – Zagreb, *Proceedings International University of Travnik* – Travnik, *Technology, Culture and Development* – Belgrade, *Montenegrin Journal of Ecology* – Podgorica, *Logistics & Sustainable Transport* – Maribor, *Bjuleten of the International Nobel Economic Forum* – Dnepropetrovsk, *Economics of Development* - Kharkiv*, Economic Essays* – Podgorica, *Proceedings of the Faculty of Maritime Studies of Kotor* – Kotor, *Economics and Management Enterprises, Proceedings of the Faclty of Economics* – Kragujevac*,* and others.