St. Petersburg University

Graduate School of Management

Master in Management

CHOOSING LOGISTICS SERVICE SUPPLIERS: CUSTOMERS` PERSPECTIVE IN BENCHMARKING CONTAINER TERMINALS

Master's Thesis by the 2nd year student

Concentration —International Logistics and Supply Chain Management

Dvoryaninova Yulia

Research advisor:

Associate Professor Yury V. Fedotov

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ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

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26.06.2016

АННОТАЦИЯ

Автор	Дворянинова Юлия Сергеевна
Название магистерской диссертации	Выбор поставщиков логистических услуг: бенчмаркинг контейнерных терминалов со стороны потребителей
Факультет	Высшая Школа Менеджмента (СПбГУ)
Направление подготовки	Международная логистика и управление цепями поставок
Год	2016
Научный руководитель	Федотов Юрий Васильевич, профессор
Описание цели, задач и основных результатов	Данная магистерская диссертация посвящена проблеме выбора контейнерных терминалов потребителями. В качестве потребителей мы рассматриваем экспедиторские фирмы. Целью работы является разработка ориентированной на потребителей модели, позволяющей провести бенчмаркинг контейнерных терминалов. В результате использования данной модели потребитель получает ранжированные терминалы. В данной модели учитываются предпочтения потребителя относительно важности тех или иных атрибутов порта. Мы применили данную модель для бенчмаркинга пяти терминалов Санкт-Петербурга. В данной работе предложена типология потребителей на основе их предпочтений. Для каждого из типов предложено решение в форме ранжированных терминалов, позволяющее потребителю выбрать лучший. Данное исследование способствует развитию литературы по проблеме выбора контейнерных терминалов со стороны экспедиторских компаний. Практическое значение состоит в предложении модели для потребителей, которая позволила бы им выбрать лучший терминал. Кроме того, данная работа дает судоходным компаниям, а также портам представление о том, как экспедиторские компании делают выбор относительно терминалов и какие атрибуты важны для них.
Ключевые слова	Морские перевозки, выбор порта, поставщики логистических услуг, бенчмаркинг контейнерных терминалов, экспедиторские компании, метод рандомизированных сводных показателей

ABSTRACT

Master Student's Name	Dvoryaninova Yulia
Master Thesis Title	Choosing logistics service suppliers: customers` perspective in

	benchmarking container terminals
Faculty	Graduate School of Management
Main field of study	International logistics and supply chain management
Year	2016
Academic Advisor's Name	Ass. Prof. Yury V. Fedotov
Description of the goal, tasks and main results	This master thesis deals with the problem of the choice of container terminals from customers` perspective. We consider freight forwarders` perspective as they are the main port`s customers and they often make a choice about container terminals. The goal of this thesis is to develop a customer-oriented benchmarking model to choose a container terminal. By using this model, a customer gets ranked terminals. This model takes into account customers` preferences regarding the importance of various attributes of the port. We have implemented this model for benchmarking of five St. Petersburg terminals. In this paper, we also propose a typology of customers based on their preferences. For each type we provide a solution in the form of ranked terminals, allowing to a customer to choose the best one. This study contributes to the literature on the problem of the choice of container terminals from the perspective of freight forwarders. The practical contribution is that we propose the model for customers to choose the best-suited terminal. In addition, this study gives to the shipping companies and ports the idea on how freight forwarders make choice about the terminals and which port attributes are important for them.
Keywords	Maritime transportation, port selection, logistics service suppliers, benchmarking of the container terminals, freight forwarders, aggregated indices randomization model

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Introduction

Maritime logistics plays an extremely important role in global trade of goods. According to the International Maritime Organization, 90% of the world trade is carried by the sea.[1] The huge part of all shipped goods falls at those transported in containers. Recent crisis created challenges for container shipping industry. According to McKinsey&Company[2] research many shipping companies started to cut costs by different ways in order to regain profitability. However, these cutting-costs measures influence the quality of service provided to the customers. Shippers face the problems of lengthening the supply chain, operational complexity, communications gaps between shippers and shipping companies and others, which emerged as a consequence of those cost-cutting measures. However, in crisis situation, cutting the costs is not the only one measure that needs to be undertaken by maritime logistics service suppliers. Understanding of customers` needs and overall customer orientation is necessary so as to retain customers.

Maritime transportation service, which shipping company provides to the customers, include many components. The services that delivered in container terminals play a critical role in overall customer satisfaction about shipping of goods. Home port and port of destination play the strategic role of network node in the chain of cargo transportation. The speed of operations in the terminals directly influences the whole supply chain responsiveness of customer`s business. That is why, from customer perspective it is important to understand which container terminal would satisfy the best any particular need. The right choice of terminal would influence the speed and overall quality of transportation of goods.

The topic of choosing the container terminal is explored in different studies. However, just a little attention is paid to the issue of customer decision-making process and the preferences that might differ from one customer to another and that influence the final choice of container terminal. In our study we are going to look closer to the decision-making process of terminal selection from customer perspective and provide the benchmarking solution for customer problem of port selection, according to their specific preferences. Moreover, the subjective aspect of decision-making process will be explored, which include relational and interpersonal characteristics.

1 http://www.imo.org/ International Maritime Organization
2 McKinsey&Company report, Container Shipping: the untapped value of customer engagement. Travel, Transport& Logistics, March 2016

Therefore, the goal of this paper is to develop a customer-oriented benchmarking model to choose a container terminal. Within this goal the following objectives are set:

1. To identify the key port`s customers
2. To select the port`s attributes taken into account by the customers when they assess the port's attractiveness
3. To conduct a survey of customer typologies based on various criteria and to develop the customer typology for the ports
4. To select and argument the methodology for solving the port selection choice problem with regard to the customer preferences
5. To provide a solution for each customer type in the form of benchmarking the alternative ports

The first chapter is devoted to analyzing the scientific sources for covering the first and the second objectives. It includes the port evaluation from different parties` perspectives and the port competition issue. First of all, it helps to identify the main port customers. Second, analysis of these two parts reveals the attributes that are important for port customers. The research gap is identified as a result of relevant literature review. In order to cover this gap the answering to the following 4 research questions is necessary:

1. What kind of typology can be implemented to differentiate different port customers?
2. How does the process of choosing a port differ from one type of customer to another?
3. How do relational aspects influence the decision-making process?
4. How to rank the alternatives of ports for each type of customer?

The second chapter of thesis includes the methodological issues. First, we suggest the hypothetical model of customers` typology for consideration. As a tool for data gathering we use questionnaire for customers and for industry experts. In this study we use quantitative model, which allows to rank alternatives. The second chapter includes model description and specification.

In the last chapter we discuss the main findings and results. The main customer typologies are defined and ranked alternatives are provided for each type.

1. Review of the state of the art

Choosing logistics service suppliers is a common problem, which businesses face very often. The role of service providers can be performed by different actors, third-party logistics

companies, freight forwarders, shipping companies (maritime, air etc.). In this study we consider port as a subject of service supply for different groups of customers. Hereinafter, we can use both terms – a port and a container terminal as synonyms.

The port choice is a process, which implies the element of port competition. In order to be chosen, ports have to compete for customers. That is why let us start from the defining of concept of port competition.

The issue of choosing a port was examined in many researches. The process differs depending on the subject who makes a decision and the criteria which are used to do it. These criteria that customers considered to be important changed over time. Let us look at this process more closely.

To start with, it should be noticed that all ports can be classified in terms of the operations as general ports and transshipment ports. Main functions of the general ports are the following:

- maritime access to navigational waters;
- maritime interface to support maritime access through dedicated space (capacity),
- infrastructure (e.g. piers, basins, stacking or storage areas, warehouses, terminals) and equipment (e.g., cranes)
- land access to inland transportation (e.g., rail, truck)[3]

For transshipment ports in addition to mentioned functions there is also transshipment function which implies intermediating role of a port. The containers can be stored in a transshipment port so as to be delivered in other destination. A port that represents a transshipment point is often considered a hub port where cargoes are either consolidated or break-bulked to be delivered to a destination point. The considered in this chapter articles contain researches either for general or transshipment ports.

In the context of the discussed problem, ports compete to each other to be chosen by the customers. The concept of competitiveness therefore needs to be considered.

1.1 Seaport competition and competitiveness

The issue of port competition is examined in different studies. However, it is hard to find one common definition and concept of competition conformably to ports due to its complex

3 Park, B. I., & Min, H. (2011). THE SELECTION OF TRANSSHIPMENT PORTS USING A HYBRID DATA ENVELOPMENT ANALYSIS/ANALYTIC HIERARCHY PROCESS. *Journal of Transportation Management*, *22*(1).

nature and different characteristics that port possesses, according to Notteboom and Yap (2011). These characteristics depend on the type of port (gateway port, local port, transshipment port) and type of commodities this port handles (containers and liquid bulk). Moreover, the concept of port competition can be defined in different ways in accordance with the level at which this competition takes place. Voorde and Winkelmans (2002) identified 3 such levels: at first level intra-port competition takes place, when different terminal operators compete within one port; at the second level, inter-port competition occurs between different ports, however, within one region or country. The third level is defined when inter-port competition takes place between different ports which cover different port ranges. It means that ports serve different geographical areas and customers with no overlapping of hinterland. These differences in the level of competition, types of port and commodities are among factors that define the criteria, according to which the port performance is assessed.

One of the important aspects that was taken into account in the most of studies concerning port competitiveness is the degree of hinterland connectivity. The factor of transport integration was closely examined in different studies. Ducruet and Van Der Horst (2009) showed the significant influence of hinterland integration on port performance. Notteboom (2010) also supported the idea of dependence of level of competitiveness from the inland transport cooperation. lvarez-SanJaime et al (2014) closely consider the problem of how the port`s inland transport service integration influences port competitiveness, namely they consider ports as profit maximizing entities deciding whether to cooperate with road transport companies or not. They found that despite ports often find it advantageous to cooperate with inland transport, it can be deleterious to the welfare, as shippers' aggregate surplus decreases – those who are far away from the ports benefit at the expense of those who are close to the ports. The authors also suggest the strategies aimed at eliminating this negative effect: asymmetries in port capacities, government regulation and efficiency gains.

Port competitiveness itself was examined in some studies considering the problem of assessing port efficiency. Oliveira and Cariou (2014) revealed that the dependence from the degree of competitiveness exists, but needs to be examined from the different perspectives: global, regional and local. They showed that only for regional competition (covering the distance of 400-800 km) the interdependence is the following: the higher competition, the lower is the efficiency score.

The concept of competitiveness in the economic sense is closely related to the performance of a unit, the level of competitiveness of which is assessed. Therefore, let us look at the concepts of performance evaluation for ports.

1.1.1 Physical performance evaluation

Traditionally, port`s performance and the level of competitiveness was considered from the operational point of view, Talley (2007). It compares optimal and actual throughput over time, and if the actual one approaches to the optimal one, then it is concluded that the performance has improved. The optimal throughput is usually defined from the technical prospective, namely the maximum possible throughput that port can handle under certain circumstances (or under certain level of inputs). Mostly such evaluation of performance was widespread in the beginning of the process of containerization, when a lot of investments were made for the ports` re-equipment, and a lot of studies aimed at analyzing to which extent those investments were effectively allocated. Performance was mostly associated with port`s productivity. Thus, ports competed for being more productive with the focus on operational efficiency. At that time most studies concerned operational efficiency. Neufville and Ysunokawa (1981) considered 5 container ports in USA for the purpose of its operational efficiency: they analyzed, how resources, invested in ports, influence the production output. They used engineering production function method, in which quay length and number of cranes were inputs and container cargo was an output. The authors also suggest that container ports show significant returns to scale throughout the range of observations. Williamson and Daunt (1982) explored the problem of improving the performance in different developing countries. They elaborated the framework of operational changes which aimed at enhancing port`s productivity. All operational changes were divided into 2 parts: improvements in operational methods and investments in new facilities. After, this methodology was applied to different ports and showed as a result higher rate of cargo handling.

In the last decade of 20th century deeper analyses of port performance were carried out. They steal appealed to number of containers handled in port as an output, but used more factors influencing this level as inputs. Tongzon (1994) empirically proved that at least the following factors are determinants of ports` efficiency: economic activity of the region, geographical location, frequency of ship calls and terminal efficiency, which represent combined estimate of efficiency of terminal equipment and resources. It should be mentioned that the abovementioned studies used so-called “single port” approach, which means that efficiency of particular port was estimated with no relation to other ports` performances.

The development of the mathematical models which allow to estimate the efficiency of different decision-making units, made it possible to implement multi-port approach in evaluating port performance. It means that the efficiency evaluation of a particular ports is estimated in comparison to other ports. Such analysis as DEA (data development analysis) is commonly used

in assessing port`s performance, applying “benchmark” approach. This model uses multiple-inputs (which play the role of resources) and multiple-outputs (which result is obtained) in order to estimate efficiency of resource allocation. The concept of port performance also evolved from engineering perspective towards broader one. Besides facilities and equipment, that previously were used as main determinants of production efficiency, other resources (land and labor) were paid close attention in different studies as well.

The first applications of DEA to maritime industry are dated by early 2000th. Previously, Roll and Hayuth (1993) applied DEA to ports, although their analysis was not based on real data. Tongzon (2001) compared and benchmarked four Australian ports and twelve other international ports in terms of its efficiency by use of DEA-model. He used throughput and ship working rate as outputs; number of cranes, berths and tugs, number of port employees, terminal area of the port serve as inputs. Applying DEA-model he found that 10 out of 16 ports were inefficient and identified the sources of inefficiencies in these 10 ports. This study gives the framework of how to implement this model in port efficiency assessing, and which kinds of conclusions and recommendation can be made. The same year, another study of Song et al. (2001) also showed how to apply DEA to container terminals by looking at those in Korea and the UK.

Since that moment numerous studies dealt with the problem of port performance assessing, in different parts of the world, using approximately the same framework. At the same time, different models and extensions of DEA were applied to the estimating port performance, with different variables and different concepts of decision-making units. For example, Wang et al. (2003) and Cullinane et al. (2005) considered a broad series of DEA variants. They considered and compared results from DEA-CRS (constant return to scale), DEA-VRS (variable return to scale), and FDH (free disposal hull) models. Moreover, some studies compared the results from DEA models and other different models. The most frequent comparison is used for DEA and SFA (stochastic frontier analysis).

Koster et al. (2009) conducted the research, the goal of which was to implement DEA analysis for assessing real (primary) data and to compare it with the previous research based on secondary data. The results differed in a large extent in a new research in comparison to the previous one. The authors conclude that it happened not only because of the usage of secondary data, which turned out to be non-reliable, but also because researches mix up ports and terminals. The authors argue that only primary, verified data of port terminals` characteristics should be used for using in the model. New results showed that larger terminals performed better than small ones and that those terminals that provided transshipment operations showed higher

efficiency scores than those provided export/import operations, whereas in previous studied result differed in terms of ranking of ports.

DEA is not the only one model, which is used for evaluation of port physical performance. One of the recent studies uses the concept of TOPSIS (Technique for Order Preference by Similarities to Ideal Solution), which belongs to the class of multi-criteria decision making models (Kim and Lu, 2016). The model is based on the calculations of distances from the chosen alternative to the Positive Ideal Solution (should be the shortest), and to the Negative Ideal Solution (should be the longest). After the alternatives are ranked according to the results. In this study authors consider the ports of Busan and Shanghai and aim to compare the competitiveness of these two ports. The criteria are purely physical and objective – port throughput and port facilities factors (such as depth, the number of C/C, berth length, the number of berth, total area, storage area. The results indicated that Shanghai port is more competitive than Busan port in total competitiveness and in throughput competitiveness, whereas Busan port has a higher score in port facility competitiveness.

1.1. 2 Economic performance evaluation

However, Brooks and Cullinane (2007) state that in the presence of competition the physical performance evaluation should be implemented along with economic performance estimation. The authors suggest that in the competitive environment ports should evaluate performance from the economic (or financial) perspective. In such situation ports should assess not only the physical ability to handle the cargo, but also the ability to compete for cargo. According to authors, in a competitive environment there are two important determinants in the process of port selection: port charges and time-related costs that both shippers and carriers incur. Both these actors are willing to reduce these two types of costs. Ports can be distinguished according to these criteria. If the approach of comparing optimal and actual throughput is used in the competitive environment, then the optimal one should be defined from the perspective of economic objective (for example, profit maximizing). Another way to assess port performance is to compare port performance indicators (benchmarks) that are chosen so as to optimize port`s economic objective and the actual ones. [4]

Indeed, the topic of economic perspective of port competitiveness and performance was illustrated in different studies. BANÄ OS-PINO and RODRÂIGUEZ-AÂ LVAREZ (2000) applied stochastic frontier cost function to estimate economic efficiency of Spanish ports. They found that smaller in size ports and those managed under centralized regime are more

4 Brooks, M. R., & Cullinane, K. e. (2007). *Devolution, Port Governance and Port Performance*. Research in Transportation Economics series, vol. 17

economically efficient. By economic efficiency the authors imply the degree at which port costs are minimized given a certain output level.

Pricing strategies directly impact economic efficiency, which is, in turn, influences the competitiveness, according to Marlow (2000). He found that for short shipping price strategies have implications for competitiveness. He suggested that price differentiation would be based not on the value of cargo, but rather on the quality of port service (which are the time in port, and the punctuality of handling the vessel and its cargo). Such strategy provides ports with efficiency enhance, and in regard to short shipping, ports can compete with road transportation if they use efficient pricing strategy.

However, commonly used financial ratios are not suitable for evaluating port`s performance and its benchmarking. Bichou (2006) argued that financial performance can be overestimated (e.g. high profit) due to some external reasons (such as price inflation, for example) being not really effective and efficient in resources utilization. Another reason why port`s financial performance should not be considered alone is that it is used mostly for assessing short-term profitability, which contradicts the nature and goals of long-term investments. According to Bichou, there are other aspects which differ from country to country and influence financial performance, which are access regulation, statutory freedom, access to private equity and market power. That is why economic perspective of ports` performance evaluation is relatively less considered in studies rather than physical perspective.

Considered above physical and economic perspective are evaluated from internal perspective. However, the external assessment from customers` point of view is paid attention in las years. Let us look more closely on what studies exist on the topic of evaluation of port`s performance from customer perspective.

1.2 Customers` perspective

Recent research studies, concerning port competitiveness, more and more focus on customers` perspective in assessing ports` performance, in addition to the physical and economic perspectives. Understanding of customer needs has been discussed in business and management studies. At the same time port industry is highly competitive nowadays, that`s why ports are seeking for sustainable competitive advantage that would give them opportunity to stay steady in competitive environment. Pardali and Kounoupas (2014) argue that orientation toward market is

a key strategic tool for achieving port competitiveness. They assert that right interaction with customers by means of marketing tools and techniques influence port performance.

According to the Forte (2013), customer-oriented attitude is the approach that ports should implement to keep and extend hinterland and foreland, and that directly influences annual cargo throughput. The authors also argue that it concerns not only the relationships that ports have with its external customers, but also with those within a port. "Internal customers" within a port environment are all port`s employees who are suppliers and buyers of the services performed within a port that when brought together contribute to the stream line port operations and procedures to deliver the services requested by the external customers.[5]

Due to existing difference between customers, we can distinguish between customers` groups, which have different goals, needs and preferences concerning ports` services.

Because of the complex nature of port business and operations let us first identify the main ports` users. The criteria, which help to identify the port`s competitiveness, depend on the party, assessing the port.

According to the Talley (2011), key users of port include the following parties:

1) Shippers, passenger and transportation carriers (freight forwarders)

2) Maritime carriers (liner shipping companies)

3) Providers of port services

The last group represents significant part of port users, especially port (or terminal) operator plays big role for cargo handling because it performs interchanging service for cargo received from shores and waterways, and vice versa for export operations. The other service providers of ports are:

1) The stevedore: a company which is hired by shipping line; it provides loading and discharging cargo from/to the ships;

2) The ship agent: represents ship-owner interests and looks after the ship while it is in port;

3) The pilot: helps to ship`s master when ship is entering and leaving a port;

4) The towage company: uses a tugboat for the berthing and unberthing of ship to/from the ports` wharf

5 E. Forte (2013), Economics and logistics in short and deep sea market, Franco Angeli

5) Customs broker: clears cargo through customs at a port;

Among above-mentioned users we identify the following customers for ports, which perspectives we are going to consider: shippers, freight forwarders, shipping companies, port operators. By shippers we name individual companies which need to transport goods, while freight forwarder - is a person or a company that organizes shipments for individuals or corporations to get goods from the manufacturer or producer to a market, customer or final point of distribution. [6] Individual shippers often appeal to freight forwarders which are experts in logistics network, and they arrange transportation of goods by organizing the network, combining different modes of transportation: rail, road, maritime of air. The liner shipping company is a carrier that performs regular transportation of goods overseas.[7]

Considering the customers` perspective in port competitive environment it is important for port to maintain and increase customer equity. For achieving these goals it is necessary to understand, what exactly customers need in ports, what they expect to achieve as a result of a service, and how they make a decision of choosing a port. In early 90-s a few researches were conducted by Dalenberg, Daley, Murphy who examined different parties` perspectives in choosing port, namely the viewpoints of worldwide water ports (1988), water carriers (1989), U.S.-based international shippers (1991, 1992), international freight forwarders (1992), and purchasing managers (1994). According to the researchers, the most significant difference in factors exists between worldwide water ports and the rest of players. U.S.-based international shippers, water carriers and international freight forwarders also have different perspectives on significant factors that port should possess. Therefore, we find it reasonable to consider different parties` perspectives separately.

2.1 Shippers` perspective

Traditionally, it was shippers itself, who made a decision about the choice of a port. That is why their perspective is considered in numerous studies, with the use of a wide range of methods. Let us look on how these studies evolve over time.

Slack (1985) in his paper explored different criteria, which could be important for shippers when choosing a port. He argued that cost factors are not the only one that determine the choice. The results of the survey he conducted confirmed it. It turned out that among numerous factors that could be applied to ports just a few matter for the shippers, which are price and service quality offered by land and ocean carriers. The port facilities were considered as taken for granted and were not too important for shippers. Interesting result that was revealed is

6 "Freight forwarder." *Random House Unabridged Dictionary* (1997). Random House, Inc.
7 http://www.businessdictionary.com/

that the minimum price criteria was often mentioned by small companies, whereas for larger ones quality of service was more important since they wanted to avoid congestion and other problems that might influence negatively the flow of products. This finding is explainable: large companies work on a constant basis and with large volumes, which imply economy of scale. Study also revealed increasing role of shipping lines not only as a direct users of port facilities, but also as a source of information for exporters and importers of cargo. This study aimed at defining factors that would determine the carrier, and most of the respondents pointed out that a port played a role of decision facilitator.

Further studies from shippers` perspective indicated the importance of other different factors. D`Este and Meyrick, (1992) found that the most important port`s characteristics are: proximity to point of production, port turnaround time, and availability of appropriate loading facilities. Such factors as port charges and railway access to the port were hard to identify in terms of importance because of too much dispersion in answers of respondent. It means that it highly depends on the particular shipper. There are also factors that were identified to be relatively important such as tradition of company to ship through a particular port and marketing initiatives of port management. This study complements the previous one, first considering a port as a part of logistics network.

However, the problem of a port choice requires not only understanding of which criteria are important for a customer, but also the order of ranking of these criteria. There is a set of methods that is commonly used for dealing with a problem of a port choice. The huge part of the methods belongs to the Multi-Criteria Decision-Making models, which generally imply several alternatives to evaluate according to a set of criteria (factors or attributes). Such models results in numeric score that shows overall “attractiveness” of an alternative. The other part of methods belongs to the regression analysis models, and usually is used to evaluate the probability of choosing any particular alternative given a set of attributes.

That is why a lot of studies are dedicated to constructing a model, which would result in the most appropriate solution according to a decision-maker`s preferences. Nevertheless, the insight on a decision-maker`s preferences about the importance of criteria is of huge importance as well.

Let us first consider the most frequently used model, when the problem of choice is considered. Analytical Hierarchy Process, which belongs to the class of MCDM models, is one of the most used models for dealing with the problem of port choice. AHP is a multi-objective, multi-criteria theory of measurement. This model implies decomposing of problem on simple

components and processing of decision-maker`s estimations. At the beginning the hierarchy is defined, which includes goals, criteria and alternatives to be estimated according to these criteria. The elements of each level are pairwise compared and the coefficients of importance are derived. As a result, the quantitative estimation of each alternative is calculated and the best alternative is determined.

In this paragraph we consider shippers` perspectives. That is why in the terms of MCDM analysis in this case a decision maker is a shipper. The authors, who used this model, and the considered criteria are listed below in the Table 1.

Table 1. AHP use in different studies: shippers` perspective

Authors	Criteria	
	Service	Cost
Ugbomai et al. (2006)	• Efficiency • Frequency of ship visits • Adequate infrastructure • Location • Port's reputation for cargo damage • Quick response to port users' needs	• Port charges
Song and Yeo (2004)	• Cargo volume • Port facility • Port location • Service level	

Analytical hierarchy process (AHP) uses rankings of different criteria to model system of preferences in the selection process. However, other models use different techniques to predict the choice of a port. For example, discrete choice model (Multinomial Logit Model) offers a different approach. The theory of discrete choice is developed in a tradition where probabilistic concepts and formulations play a key role. The model implies predicting possible outcomes of categorical dependent variables (alternatives), given the independent variables, which can be binary-valued, categorically valued etc.

Nir et al. (2003) and Malchow and Kanafani (2004) have used the Multinomial Logit (MNL) model to estimate the effect of important factors on port choice. Tiwari et al. (2003) have studied the port choice behavior in China by using shipper's survey data on the discrete choice model and concluded that distance and port congestions are the most important factors influencing port choice. Nir et al. (2003) have employed survey data on the model and found that proximity of port, recent use and port cost are more important in comparison to competition, frequency, route, port facilities or service. Malchow and Kanafani (2004) have reported that

inland distance and frequency of shipments are negatively correlated with the probability of a port-shipper combination being chosen.

Multinominal logit model was also used for the process of choosing ports in Spain. Veldman et al. (2011) showed that the location of a port, both in terms of origin and the destination of its traffic, is the most significant factor for explaining the observed container port choice in Spain. The authors also considered such variables as hinterland transport costs, maritime transport costs and broad group of variables for quality of service provided. The suggested model can also be used for the analysis of cost sensitivity of port choice. The table below reflects theconsidered factors from shippers` perspective.

Table 2. Use of MNL model in different studies: shippers` perspective

Authors	Considered factors
Veldman et al. (2011)	• Port location • Hinterland transport costs • Maritime transport costs • Quality of service
Malchow and Kanafani (2004)	• Oceanic distance • Inland distance • Sailing headway • Vessel capacity • Probability of last port
Tiwari et al. (2003)	• Inland distance • Port congestions • Ship calls • Total TEU handled at port • Number of berths • Number of cranes • Water depth • Routes offered • Usage factor (hauling volume/length of quay line) • Port and loading charges
Nir et al. (2003)	• Travel cost • Travel time • Route • Frequency

To sum up, different methods were used in order to identify the important criteria for shippers and suggest the best solution for them. The studies and considered factors evolved over time: starting from considering purely physical characteristics of the ports and costs, and moving towards looking at the port as a part of logistics network.

However, shippers not always directly communicate with shipping lines and choose a port themselves. More and more companies delegate the logistics function to the freight forwarders or third-part logistics companies (3PL), which also perform a duty of freight forwarders. Hereinafter we will name this perspective "freight forwarder", implying both pure freight forwarders and 3PL companies. That is why the perspective of freight forwarders needs to be considered.

2.2 Freight forwarders` perspective

Just a few researchers consider the problem of a port choice from the perspective of freight forwarders, whereas nowadays they play an important role in this process. Hesse and Rodrigue (2004) introduced the term "supply chain power" and refer the essence of such power to the third-party logistics providers (3PL), or freight forwarders due to the fact that "they are able to command the conditions of delivery that have to be fulfilled by service providers."[8] Tongzon (2008) also admits the growing power of 3PL in supply chain functioning. Moreover, Murphy et al. (1992) and Nazemzadeh (2015) found that shippers` and freight forwarders` perspective, regarding the important factors of ports, differ to certain extent. That is why we find it reasonable to consider this perspective as well.

Grosso and Monteiro (2008) implemented statistical approach to the problem of identifying the most important criteria of port selection for freight forwarders. They used factor analysis in order to define groups of factors. Initially explored 39 characteristics were reduced to 31 due to irrelevance of those 8 ones. Further, these 31 variables were grouped in 4 factors which are: connectivity of the port, cost and port productivity, electronic information, logistics of the container. Analysis revealed that the most important criteria for freight forwarders are connectivity of the port which includes the following characteristics: customs procedures, electronic customs procedures, followed by customs efficiency, customs hours and fill in and clear out procedures. This factor also includes road, rail and hinterland connections. Cost and port productivity factor also plays role in the process of port choosing, but less prominent. This consolidated factor consists of the 10 variables, among which the most influential ones are road cost and port charges.

Freight forwarders` perspective was further examined by Tongzon (2009), who found that for Southern Asian freight forwarders the most important criteria are the following: high port efficiency, good geographical location, low port charges, adequate infrastructure, wide range of

8 Hesse, M., & Rodrigue, J. P. (2004). The transport geography of logistics and freight distribution. *Journal of transport geography*, *12*(3), 171-184.

port services, and connectivity to other ports. Author also provides the analysis of a decision-making process, which shows that forwarders first choose a shipping line, and only then they choose a port among those, served by the line. Moreover, the results showed that ports are not viewed by the freight forwarders in isolation but are considered together with other requirements associated with the movement of cargoes across the port-oriented supply chain. The results of this study complement the results of previous ones, concluding that port infrastructure and quality of services are also important for freight forwarders.

Freight forwarders as port`s users were also considered by Nazemzadeh (2015) upsides with shippers and carriers. 3 ports were examined: Antwerp, Rotterdam and Hamburg. The AHP model was used in order to offer the most appropriate alternative for each type of the customers. The order of important criteria differs from one group of customers to the other, which is explained by their respective positions and responsibilities within the supply chain, and the contract of carriage concerned (carrier haulage or merchant haulage). The overall results indicate the following order of port selection criteria in decreasing order of importance: port costs, geographical location, quality of hinterland connections, productivity and capacity. In respect of general port attractiveness, Antwerp turned to be the most attractive, followed by Rotterdam in second place, and Hamburg in third.

The studies considered above aim to solve two main problems: first – to identify, which criteria are important for decision-makers when choosing a port; second – to suggest the best alternative for a customer, taking into account the preferences about port`s attributes. However, the list of possible research directions is not limited to these two problems.

According to Mazzarino (2004), there is a class of choice models that deal with the replicating of the process of choice making. Such models are called process-oriented. In such models the decision-makers estimate the situation, using qualitative characteristics, goals, hierarchies of needs, preferences and values, which not always can be mathematically represented. The sense of process-oriented models is that it tries to analyze, how different factors which enter decision-making process interact in order to yield results. Such models mostly result in behavioral framework.

There are just a few studies that emphasize the process of analyzing different port alternative and the decision making. Mazzarino (2004) considers ro-ro (roll-on/roll-off) sector (which deals with the shipment of wheeled cargo, such as cars, trucks and so on) for building the behavioral framework of taking a decision of carrier/port choosing. The author uses qualitative approach by conducting in-depth interviews and survey among key users of port services –

shippers and carriers. After, they come up with the port-shipping choice model in the Adriatic ro-ro sector. The specific of this model is that it gives an insight on how the decision-making process is built on the different hierarchal level: from the perspectives of shipper or freight-forwarder the first-level choice should be made when establishing a partnership agreement with a shipping company. The interesting fact here is that the shipper/freight forwarder chooses the shipping company first (which was already noticed by Tongzon (2009)), and only then he makes a decision about the port, rather than putting port choice decision on the first forefront. According to the empirical study personal relationships, perceptions, conservative attitude prevail on the rationality of choices. The second-level choice is made when the shipper/freight forwarder chooses a port from those suggested by a shipping company. During this stage the decision-makers mostly concern about the quality of service, rather than about monetary aspects. Other discoveries regarding the decision-making process are the following:

- Decision-makers often are not rationally conscious about the characteristics of decision-making process. Instead they appeal more to the intuition, perceptions, experience and other more subjective matters;
- Decision-makers of port are quite conservative: once they made a choice, they continue taking the same choice in other times, thus adopting routine behavior;
- Overall, the procedure of decision-making process can hardly be called rational and formalized, instead, the personal experience and relationships matter. As authors conclude it demonstrates that the choice process of carrier/port is human activity.

All in all, there is a lack of studies for freight forwarders in the literature, whereas their role in a decision-making has increased during the last decade. The researches demonstrate the evidence that freight forwarders` preferences about the attributes of ports differ from those of shippers. In comparison to the shippers` perspective, studies, concerning freight forwarders mainly focus on the identification of important criteria of a port, while the problem of the choice is not underexplored.

2.3 Maritime carriers` perspective

Maritime carriers (or shipping lines) play the intermediate role between shippers/freight forwarders (end customers) and ports. They represent a party that directly collaborates with port. They sign contracts with those ports, which are of interests to the end customers. That is why the perspective of maritime carriers is also paid great attention in the literature.

The first papers of Malckow and Kanafani (2001 and 2003) consider the problem of port choice of being strongly connected to the problem of vessel choice. The authors state that while selecting a port a customer indeed chooses the vessel. That`s why in their researches they

look at the problem of choosing vessel/port. Moreover, the authors initially assume that a shipper does not choose a port, but instead, he chooses a carrier, which in its turn already has some port preferences. Thus, carriers` perspective is explored in the problem of port choice. Because of the initial assumptions factors, that hypothetically influence port`s overall systematic utility, mostly reflect vessel`s and geographical characteristics such as: the distance between the port and point of destination (oceanic distance), the inland distance to the port, the average headway between voyages by carrier from port to the destination of shipment and others. The multinomial logit function was used in order to estimate the importance of different characteristics in overall port "attractiveness". It turned out that it mainly depends on oceanic distance and inland distance, whereas vessel capacity is not significantly important. These factors remain significant for discretionary cargo as well (cargo originating in a region that does not contain a port), but in this case some other ones can also be important.

Ng (2006) continued exploring this topic and analyzed transshipment ports in Northern Europe. He carried out the research from the shipping lines` perspective, which are the permanent users of ports. By carrying out a survey he found out that besides cost and location criteria, qualitative ones are important. Among others, the most important ones turned out to be: port infrastructure, advanced technology, availability of dedicated facilities for container transshipment and the availability of professional personnel in ports.

Yeo et al. (2008) explored the competitiveness of ports in North-east Asia, namely in Korea and China due to Chinese ports` developments and its threat to be superior to Korea`s ports. The authors came up with the proper framework of factors influencing port`s competitiveness form the point of shipping companies. Applying factor analysis they found that such factors as port service, hinterland condition, availability (which include such sub-factors as "availability of a vessel berth on arrival in port" and "port congestion"), convenience (namely "water depth in approach channels and at berth", "sophistication of port information and its application" and "the stability of port labor"), logistics cost, regional center and connectivity are the determining factors for ports` competitiveness in these regions. They also noticed that some sub-factors that were significant in previous studies have been replaced by other ones. For example, the key factor has shifted from hardware and labor towards software and technology, which means that the most competitive ports rely on efficient hinterland logistics systems. Another attribute that has become important is the availability of a vessel berth on arrival in port, whereas in preceding studies it was such components as the numbers of loading and unloading facilities and the capacity of the container yard. The authors conclude that in the considered

region shipping companies perceive port service and technology to be not less important than investments in infrastructure development.

Another perspective from which the problem of port choice is considered is how well the port is integrated in overall logistics network. Tran (2011) developed the model which focuses on total costs and aims at minimizing it. In total costs the author includes ship costs, port tariffs, inland transport costs and inventory costs. He applied brute-force algorithm for solving this optimization problem on real data: the author considered cargo flows between USA and Northern Europe. He concluded that the port choice should be assessed not only from the perspectives of sea port activities and sea routing, but also include inland component.

The abovementioned studies concern mainly the determination of the significant factors of a port by conduction a survey or factor analysis from shipping line`s perspective. However, besides the goal of discovery these factors, some studies aim to provide the solution to the problem of a port choice by implementing the mathematical models. The employed for shipping lines` point of view models are the same as were implemented for the shippers.

The AHP model was used for predicting the best choice of a port and identifying the most important criteria in several studies. Lirn et al. (2004) viewed an extensive set of factors (47) that are attributable to the ports. He distinguished between cost and facility/service factors, the sub-factors of which are shown in the table below. The author added for consideration the factor of port management and administration, which was not considered in previous studies. The author found that the factor of port transportation location is the most important.

Some of the studies suggest high practical importance. For example, Lam and Dain (2012) suggested a decision support system for port selection, using AHP methodology from the shipping lines perspective. The authors state that this methodology is advantageous for its users: "AHP addresses the issue of how to structure complex decision-making problem, identify its criteria, measures the interaction among them and finally synthetize all the information to arrive at priorities which depict preferences." Thus, the line managers can use this system for solving complex problem of choosing port by utilizing multi-criteria analysis. The suggested model is web-based and can be used by different decision makers. The system is flexible in the way that users can choose criteria by themselves and set preferences as well, according to the pursued purposes and particular cases. The authors claim that such technological advancements would be beneficial for shipping managers to use because it enhances the service quality of shipping companies.

Table 3. The use of AHP in studies: shipping companies` perspective

Authors	Factors	
	Service	Costs
Park and Min (2011)	• Port's proximity to import/export businesses • Port service quality • Port security • Port management efficiency • Basic infrastructure • Information technology infrastructure • Intermodal link • Feeder service access • Access to major shipping routes • Ship turnaround time • Port security • Carrier bargaining opportunity	• Container handling costs • Terminal contract costs
Guy and Urli (2006)	1. Port infrastructure • Water depth • Quay length • Crane • Inter-modal interface 2. Service _ turn-around time 3. Geographical location • Immediate hinterland • Extended hinterland • Possibility to serve other port within the same service loop	• Total transit costs
Lirn et al. (2004)	1. Port physical and technical infrastructure • Basic infrastructure • condition • Technical infrastructure • Inter-modal links 2. Port geographical location • Proximity to import/ • export areas • Proximity to feeder ports • Proximity to main • navigation routes 3. Port management and administration • Management and • Administration efficiency • Vessel turnaround time • Port security/safety	• Handling cost of containers • Storage cost of containers • Terminal ownership/Exclusive contract policy

Besides AHP model, the MNL model was also used in several studies for predicting a choice of port from shipping lines` perspective.

In the studies from shippers` perspective the generalized discrete choice model was not developed with the port or transportation industry in mind. The missing element of the direct application of the MNL framework to model port choices in these studies is the indispensable element of network. The service network structure, which is a key element of the container port industry, arises from the main business of a port. The main business of a port, defined in Wang and Cullinane (2005) as the facilitation of cargo transportation from point of supply to point of demand, also bestows a critical role upon the port network-connectivity that determines the competitiveness of a port to a large extent[9].

Tang et al. (2008) covered this gap by implementing one specific model, called Network-based Integrated Choice Evaluation (NICE) model. This model unites the network characteristics of the port industry into the multinomial logit preference model (MNL) by the connectivity index. The considered model uses published schedules from liner shipping companies to establish the service network of ports and obtain the associated port connectivity indices. The NICE model also applies factor analysis on observational port attributes (such as port charges, turnaround time, annual operating hours, water depth and so forth) to derive port operating dimensions that are mutually and preferentially independent. The NICE model is empirically determined by expressing the port connectivity index as a conditional MNL function of these mutually and preferentially-independent port operating dimensions that allows for an assessment of the marginal contributions of each dimension separately.[10] Empirical results obtained by applying this model for the process of choice of Asian ports reveal that port efficiency is most important factor in increasing the attractiveness of ports; other attributes which are indispensable for a port to perform in order to be competitive are scale economies and convenience.

Overall, numerous studies dedicate to the perspective of maritime lines in the problem of a port choice. The results vary from one study to another in terms of the order of important factors. However, the main ones remain the same: costs, location, connectivity, efficiency and some other factors. Inside these factors, the sub-factors can be defined, which differ in various studies. Different methods yield different results.

2.4 Port operators` perspective

Besides external customers` perspective there are a few studies, which examine the port service providers' interests in choosing a port. Sanchez et al. (2011) compared the important

9 Cullinane, K., Song, D. W., & Wang, T. (2005). The application of mathematical programming approaches to estimating container port production efficiency. *Journal of Productivity Analysis*, *24*(1), 73-92

10 Tang, L. C., Low, J. M., & Lam, S. W. (2011). Understanding port choice behavior—a network perspective. *Networks and Spatial Economics*, *11*(1), 65-82.

attributes of users and providers for Latin America and Asia region. They pursued the goal of evaluating, whether the perceptions of port operators and shipping lines contradict to each other. They observed that there is a noticeable difference between the perception of port operators about shipping lines` preferences and needs, and the factual shipping lines` needs. The differences are significant in monetary cost, geographical location, and, perhaps most importantly, the speed of ports in responding to the new demands of shipping lines. [11]

The same topic of comparisons of different parties` interests was discussed in the study o f Park and Min who in 2011 proposed a hybrid data envelopment analysis and analytical hierarchy process (AHP) model that allows to identify factors specifically influencing transshipment port selection, evaluates the degree of impact of those factors on a transshipment port selection decision, and then determines the most important ones among various factors. The analysis concerns both carriers of cargo and port service providers. They first identified port selection factors through survey, after they indicated the relative weights (importance) of those factors by implementing AHP model, and after, by using DEA they showed the "contribution" of each factor to port selection. The main distinction from the previous researches of these authors is that this model allows identifying the impact of each factor to the port "attractiveness". They also showed that in this research cost factor remains important, but at the same time non-monetary qualitative attributes such as intermodal links and feeder service access are also significant when identifying port "attractiveness". At the same time, such characteristic as technological infrastructure was not revealed as differentiated one. Moreover, the authors proved again that the importance of different characteristics often depends on the perspective. They demonstrated this fact by considering the shipping line and port operators` points of view, which are different in terms of importance of such attributes as port's proximity to import/export businesses, port service quality, port security, and port management efficiency. The study suggests closer and more proper analysis of maritime carriers` needs and preferences for delivering high-quality service.

1.3 Research gap

Extensive literature review has demonstrated that the problem of port choice was examined in numerous studies, beginning from the 1980th. As port customers differ, the choice process, criteria and outcomes vary according to the perspective from which this process is considered. We considered shippers, freight forwarders, maritime carriers and port operators`

11 Sanchez, R. J., Ng, A. K., & Garcia-Alonso, L. (2011). Port Selection Factors and Attractiveness: The Service Providers' Perspective. *Transportation journal*, *50*(2), 141-161

perspective. However, inside this problem there are different issues that were not fully covered in the existing scientific studies.

In our study we concentrate on freight forwarders and on the choice problem for this specific group of customers. This group nowadays quite often represents a decision-maker while choosing a port, moderately replacing shippers. However, just a few studies reveal the factors that influence decision-making from freight-forwarders` perspective. Furthermore, in comparison to the other considered perspective, for freight forwarders just one study found that would deal with the problem of port choice and result in the choice outcome. Moreover, the review showed the lack of studies that would take into account the relational part of a decision-making process, namely, what role do the shipping companies play in decision-making process, whether they influence the choice? While such groups of factors as costs, infrastructure, hinterland connection and services are explored in various studies, the relational aspects are paid attention only in studies, considering specific sectors of maritime shipping industry, but not for container transportation.

Also, shippers` perspective demonstrated the dispersion in decision-makers preferences when choosing a port. However, there was no attempt to try to classify the preferences of different customers. As soon as shippers` perspective is less relevant, we would like to concentrate on identification of different types of freight forwarders regarding the important factors for choosing a port.

Moreover, the prediction of choice outcome for a decision-maker, according to his system of preferences, exists for shipping companies and shippers, but not for freight forwarders. The scope of models that are implemented for assigning a port for a decision-maker, also lacks objectivity – those methods need to have numerical values for weights of attributes, which, in real life is a hard condition to satisfy. That is why we are going to implement in this study one of the MCDM models, which doesn`t require numeric information about weights of attributes, and is based on aggregated indices randomization method.

Therefore the research questions are the following:

1. What kind of typology can be implemented to differentiate different port customers represented by freight forwarders?
2. How does the process of choosing a port differ from one type of customer to another?
3. How do relational aspects influence the decision-making process?
4. How to rank the alternatives of ports for each type of customer?

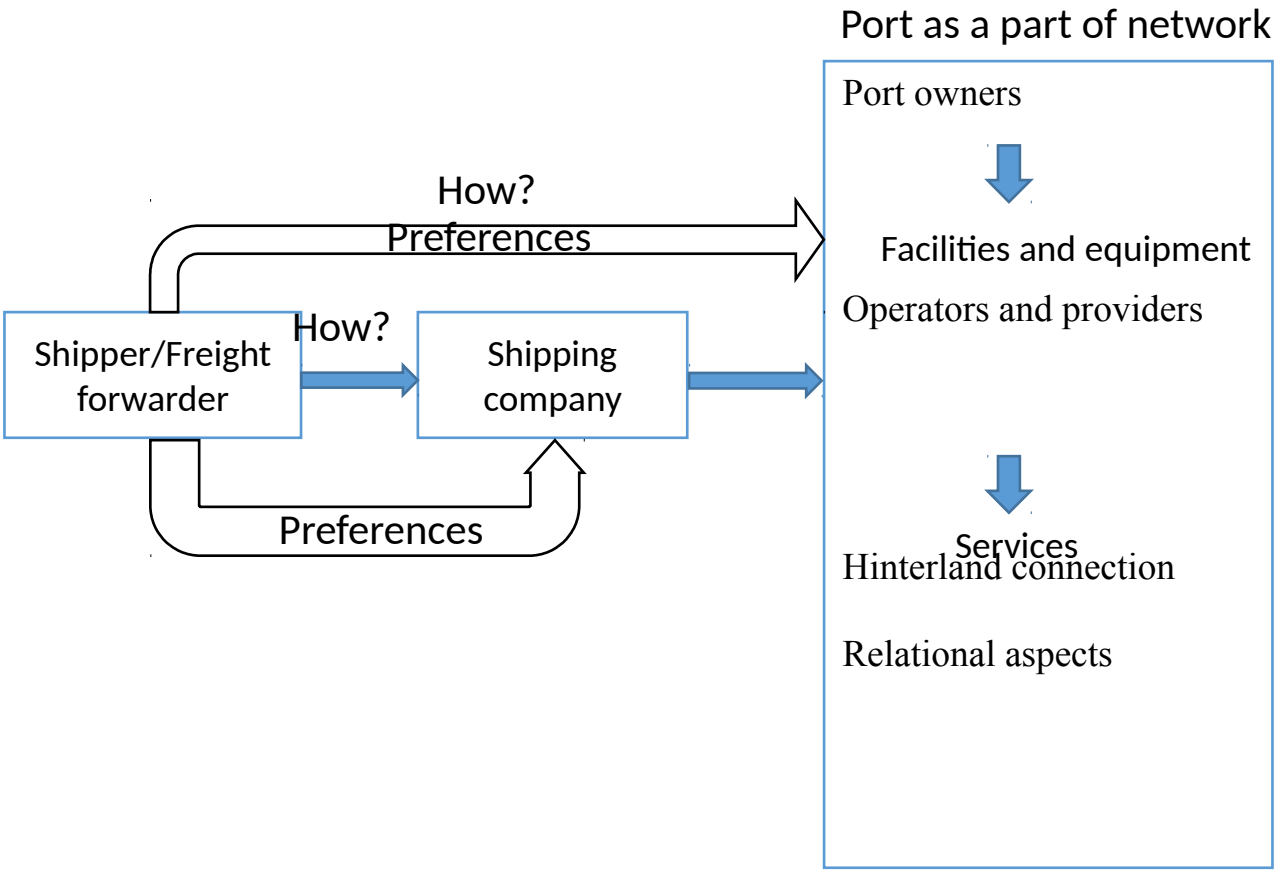
The research questions are designed to find answers that would cover both theoretical and practical issues. In general, there is a lack of information concerning a specific type of customers – freight forwarders, who actually make a decision about port choice. That is why for ports and shipping companies this study is also appealing as a source of customer needs` insights.

2. Methodology

2.1 Theoretical framework

As the literature review showed, the process of choosing a port varies from one type of customer to another. In this study we concentrate on the customers, who very often make a choice - freight forwarders. They make the final choice of the port, which can be completely their own decision, or, it can be an advice from the managers of a shipping company. It is also possible that customers can "push" the shipping company to sign contracts with new ports that appeal the end customers (shippers and freight forwarders). That is why the end customers` perspective is very important.

Figure 2.1. Theoretical model of a choice process



In order to understand the logic of the methodology used, let us present the general setup of the considered problem, which is depicted on the figure 2.1., and explain the main parts. A customer considers port not as a separate logistic entity, but rather as a part of the whole logistic network. That is why it is necessary to consider not only physical attributes of ports`, but also take into account the services that operators of port provide, the hinterland connection, and

relational aspects. We will elaborate with more detailed description of attributes for each port`s factors in the 3 paragraph.

Customers have certain preferences about the port`s attributes. For some customers only the costs can matter, while for other ones the hinterland connection is of great importance. The best alternatives that correspond to the customers` preferences will differ for each type of such customers` preferences. That is why it is necessary to identify the system of preferences for each type of customers.

We also include in our model relational part. We will try to understand, whether the customers make the decision about port choice rationally, or they are highly influenced by relational (personal) factors. We will include factors that were not previously considered in such type of studies.

Moreover, customer`s choice is influenced not only by the preferences about port attributes, but also by the choosing the shipping company. In most cases a shipper comes to a shipping company, and then, chooses the port among suggested. So, the question arises, how a customer chooses the shipping company? Namely, what attributes are important in this choosing process?

The answers to all these questions we will obtain at the end of the research. In the following paragraphs we will identify the main approaches to data collections that are going to be used in this study, and then present the mathematical model and tool, with the use of which we will obtain the ranking of the alternatives for different customers types.

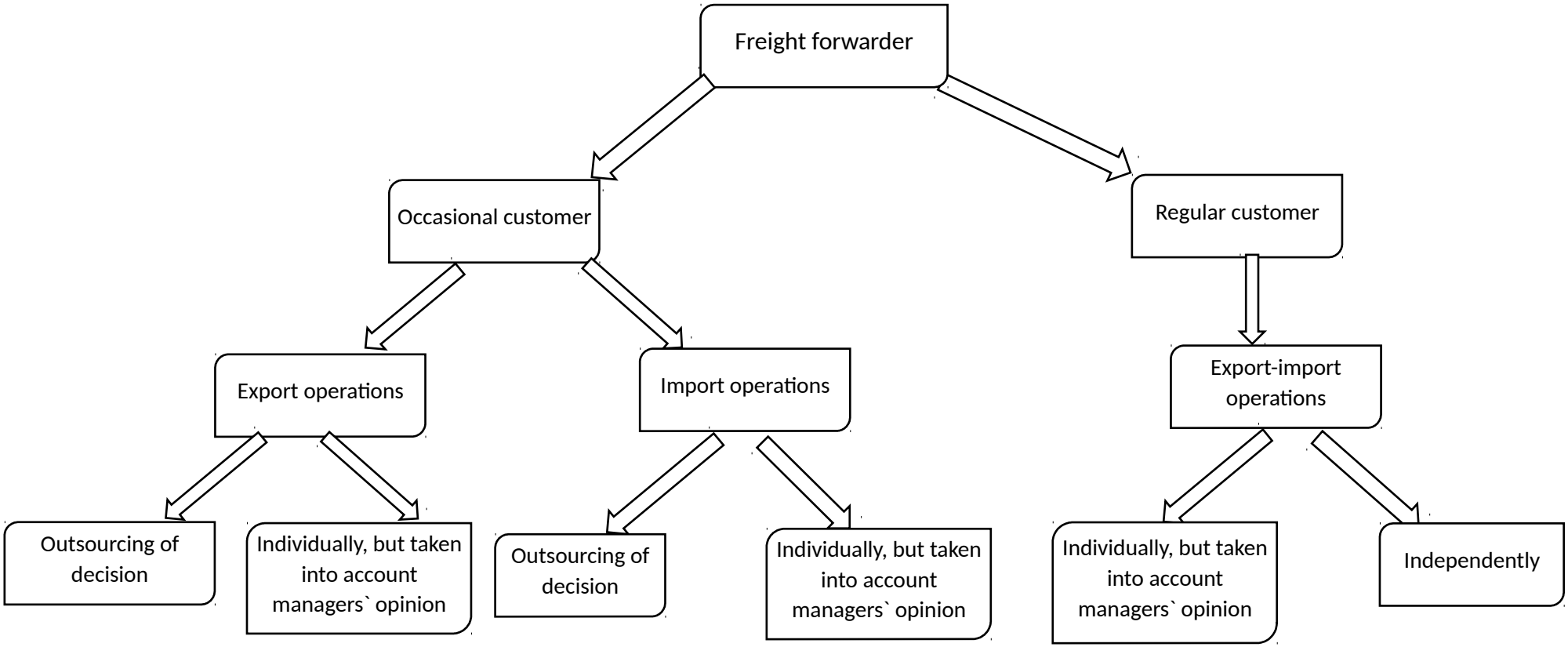
2.2 Hypothetical typology

Literature review and interviews with experts in maritime container shipping allows us to suggest initial framework of customers` typology. The main distinction criteria are the following:

- Type of cargo transportation: export/import/export-import/inland transportation;
- Frequency of contacts: inconstant/constant basis;
- The way of decision-making: independent/outsourcing of a decision to a company/individually, but taken into account the opinion of a company;

We suggest that based on these characteristics several types of customers will be identified, who share the same preferences about the importance of port`s attributes. The scheme is presented in the picture below. It has 3 levels: the first distinguishes between occasional and regular customer, the second – between export/import/export-import operations, and the third – between the independent decision/individual, but taken into account managers` opinion decision/ outsourcing of decision. We expect that these criteria influence the preferences that freight forwarders have, and thus will help to identify different types of customers.

Figure 2.1 Hypothetical scheme of customers` typology



2.3 Identifying the type of research

There is a set of methods that could be applied to the business research. In order to explain, which of them we will be used in this paper, let us consider the following framework of Timm Paul and Farr Rick.

Table 2.1. Types of research

	Basic	Applied
Primary research	Collect data to further general knowledge	Collect data to solve specific problem
Secondary research	Search publications to gain further knowledge	Search publication to solve specific problem

According to this table, the research we will conduct suits the best for the applied primary research. First of all, gathering data from customers implies the existence of primary research, so does the gathering data from the industry expert. As far as in this paper we are going to solve the specific problem, we use the applied research type.

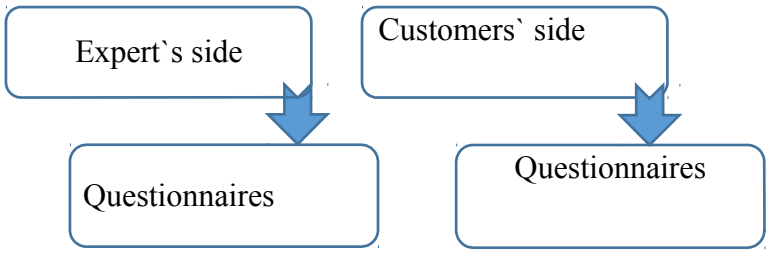
2.4 Data collection approaches:

In this study we are going to use the following empirical study methods:

1) Questionnaire for customers
2) Questionnaire for expert

As was mentioned above, for carrying out the future research it is necessary to obtain some data sets from both expert and customers. In order to do it, it is important to decide which type of gaining data is suitable for each perspective.

Figure 2.2. – Empirical study methods for the obtaining the information



2.4.1 Expert`s perspective

First of all, let us consider expert`s perspective and empirical study methods that are going to be used.

As it was stated in a paragraph above, expert`s estimations are the source of information about the values of the attributes for the container terminals. Some of this information is going to be obtained via interviews. In such interview sessions we pursue two goals – to make sure that in our research we use the same characteristics that are important for the customers and to understand those characteristics that still are not covered in our research, but they exist for the customer when making a decision with which container terminal collaborate to. We initially came up with a set of attributes to apply based on the results of literature review. After, this set was corrected, taking into account the expert`s opinion.

Interviews were conducted in the very beginning with the purpose of understanding, how, in general, the procedure of communication with customers is carried out, how customers, in general, choose port. Basically, interviews were conducted to facilitate further process of research and for forming of general understanding of a problem.

After attributes are identified, we need to obtain its values. The main factors of port choice, attributes of which we explore, are presented below. The experts are asked to evaluate the performance of each port based on different attributes, using the scale from 1 to 5. The questionnaire for expert is based on the same attributes as customers` questionnaire, excluding only those attributes that need to be identified by customers itself, due to individual values of these attributes for every customer. Experts` results are presented in the third chapter of the thesis.

Table 2. 2. Container terminal factors to measure

	Factors of port`s choosing	The scale
1	Physical infrastructure	1…....2…….3…….4…….5
2	Services provided	1…....2…….3…….4…….5
3	Hinterland connection	1…....2…….3…….4…….5
4	Costs	1…....2…….3…….4…….5
5	Relational part	1…....2…….3…….4…….5

2.4.2 Customers` perspective

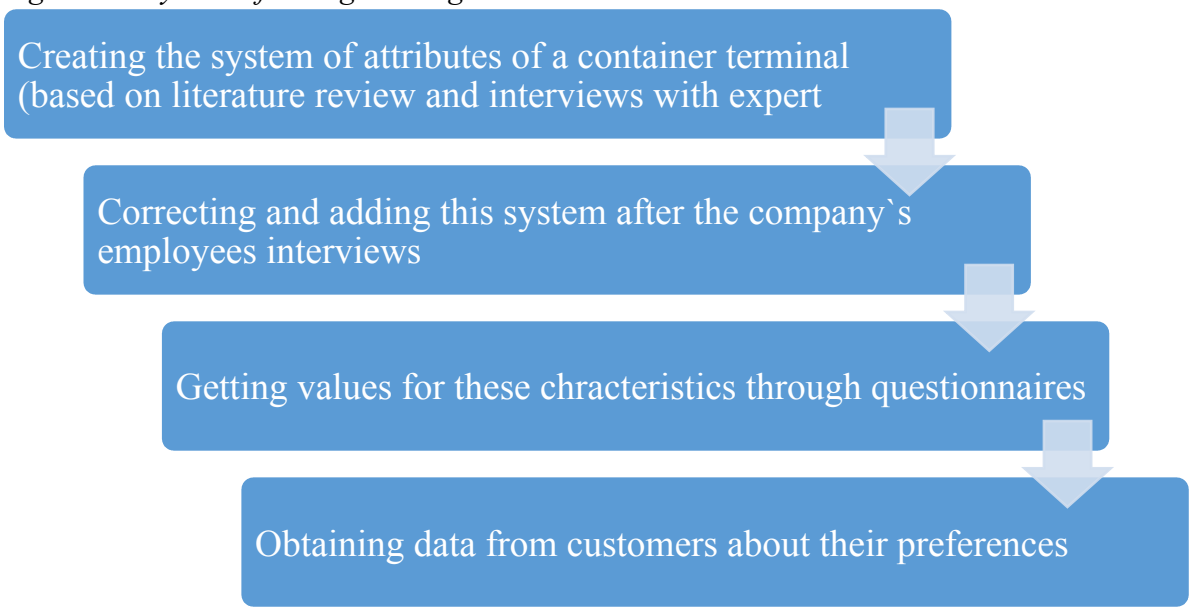
After completing gathering information about characteristics and its values, we proceed to customers` preferences itself. The questionnaire for customers, in our case for freight forwarders, contains the following structure:

- General information about the client. This information is going to be used as a base for identification of customer typology;
- Port choice criteria. In this part client will evaluate, to which extent each attribute is important for him when choosing a port.
- The ranking of the important attributes;
- The ranking of the ports/terminals. Customer can already have certain preferences about the ports/terminals.
- Criteria for the choice of shipping company. Here a customer evaluates different attributes associating with shipping company choice in terms of its importance.

The questionnaire for customers is attached as an appendix.

In general, the system of obtaining data can be presented the following way:

Fig. 2. The system of data gathering



After completing these steps we can proceed further, namely to describe the model, which is going to be used, and the method, which underlies the model.

2.5 Quantitative model

The main questions that we want to answer in this chapter are: what we want to measure and which models and methods can be used for that. After the implementing the methodology described below we want to get the aggregated quantitative indices that would reflect the "attractiveness" of alternatives (in our case -ports). These indices will take into account the

system of preferences of a customer concerning the importance of the characteristics of the terminals.

In order to formulate the considering problem in the right terms and then build proper model let us describe the theoretical model of the problem and its mathematic representation.

2.5.1 Multiple-criteria decision analysis

The model that is used to solve the considered in this thesis problem belongs to the discipline called multiple-criteria decision analysis (MCDA). We were partly considering it in the first chapter. This discipline is a part of operations research which deals with the situation when the decision needs to be made concerning different issues (both for our daily of professional lives) explicitly taking into account multiple criteria. The problem is most likely about making choice between different alternatives. Due to existence of multiple criteria there is no unique optimal solution for such problems; in order to solve it we need to consider the information about preferences of the decision-maker.

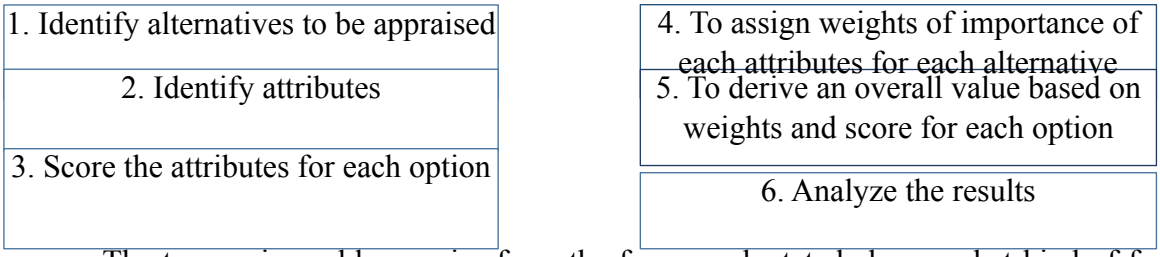
There are different classifications concerning MCDA problems and methods. One of the basic ones is to distinguish multi-criteria evaluation problems from that of multi-criteria design (or multiple objective mathematical programming). The main difference is that the former one has explicit set of alternatives, whereas in the latter ones alternatives are implicitly known. Now let us process towards the multi-criteria evaluation problems, as we relate the problem described above to this class of problems.

2.5.2 Multiple-criteria evaluation problems

For such problems each alternative has a set of performance measures for each attribute. The problem may be defined as finding the best alternative for a decision maker (DM), or finding a set of good alternatives. One may also be interested in "ranking" or "classifying" alternatives.

The general procedure within this multi-criteria evaluation problem for solving can be represented the following way:

Fig.3 The scheme of model building



The two main problems arise from the framework stated above: what kind of function should be used when identifying the overall value based on scores for criteria and weights? What weights should be used for the analysis? The answers for these questions distinguish the sets of methods which are used for solving such kind of problem. The last question is of great importance because in real business or daily life we can hardly indicate the exact values for the weights of the attributes. Instead, we are likely to use the equalities and inequalities for identifying which attribute is more important. We proceed to the next paragraph, concerning the description of model that we are going to use in this study. The method is called aggregated indices randomization method (AIRM).

2.5.3 Aggregated indices randomization method

This methods belongs to a set of aggregated indices methods, but implies different approach towards the choosing the weights for the criteria. Let us now briefly explain the mathematical model of the problem of estimating any complex object, and further to apply this model for our particular problem of container terminal estimation for the customer.

In the considered model a DM estimates the alternatives, using a set of attributes. Thus, those alternatives can be called multi-attributes alternatives.

A numerical value of an attribute for a given alternative determines an estimation of the alternative's preference, this estimation being a numerical function of the attribute's value. Such functions of the attributes' values are named individual preference indices. Any individual preference index can be called an individual criterion of preference. That is why, a set of all individual criteria's values for a particular alternative determines a multi-criteria estimation of the alternative's preference.

The initial assumption of the method used is that each of the constructed individual preference criterion is necessary, and the whole set of them is sufficient for a numerical estimation of any alternative's preference. It means that a numerical estimation of an entire alternative's preference is a numerical function of the set of all single preference criteria. Such numerical function of all single criteria of preference is named aggregated preference index, and is treated as an aggregated criterion of the alternatives' preference. Value of an aggregated

preference index for a given alternative is its preference estimation which takes into account the whole set of single estimations of the alternative's preference. [12]

Additionally it is assumed that an aggregative function (i.e. function which determines a corresponding aggregated index) makes allowance for significance (synonyms: importance, influence, weight, etc.) of different single performance indices for the aggregated preference index. Namely, the aggregative function is supposed to be determined by appropriate non-negative parameters which are named weight-coefficients ("weights"), and which play role of single indices' significance estimations.

Briefly, the mathematical model includes implementation of the following steps:

1) Forming the vector $x=(x_1,\ldots,x_m)$ of the initial characteristics, any of which is necessary, and all together they sufficiently represent the quality of the evaluated objects.

2) Forming the vector $q=(q_1,\ldots,q_m)$ of individual indices which are the functions $q_i=q(x_i;i)$ $i=1,\ldots,m$ of the corresponding initial characteristics which evaluate the observable object with the use of m different characteristics

3) Choosing the form of aggregated function $Q(q)$, which characterizes the quality of the project in integrally. It is assumed that function $Q(q)$ depends on the system of weights $w=(w_1,\ldots,w_m)$ which are non-negative parameters representing the degree of the importance of each individual index for the aggregated index $Q=Q(q)=Q(q;w)$.

4) The defining the system of weights $w=(w_1,\ldots,w_m)$ which shows the "weight" of every individual index $q_1,\ldots,q_m$ in $Q(q)$. The additional clause of normalization $w_1+\ldots+w_m=1$ allows to define w_i as an estimate of the relative weight of the individual index q_i, $i=1,\ldots,m$.

Each alternative A_i can be evaluated according to the described above methodology.

Further description of the method has to be connected to the special software that allows to solve two main important issues concerning the forming of the single preference vector and choice of weights based on non-numerical, non-exact, non-complete information.

Let us present further this methodology adopted for our problem of choosing.

12 Hovanov, N., Kornikov, V., & Seregin, I. (1997, June). Qualitative information processing in DSS ASPID-3W for complex objects estimation under uncertainty. In *Proceedings of the International Conference" Informatics and Control". St. Petersburg (Russia)* (pp. 808-816)

2.5.4 Problem formulation in methodological terms

The first step of the methodology presented above is to define $x=(x_1,\ldots,x_m)$ of initial characteristics. For our problem, x stands for the attributes of container terminals which were stated in the third paragraph, such as road access, the cost of cargo transshipment and so on.

After, the forming of individual indices needs to be provided. In order to use the software DSS APIS we need the information obtained through the questionnaires from the company about the values of the attributes of container terminals. This information is downloaded into the software with the appropriate normalizing function choice.

The type of the normalizing function is defined according to the following rule: if after increase of the value of the attribute the attractiveness of an alternative increases, then the type of the function is increasing. In the opposite case, the type is decreasing. For example, the higher the costs of transportation are, the less an alternative is attractive. In our case only one attribute has a decreasing function.

After that all information from clients, concerning their preferences about the importance of different terminals` attributes, needs to be numerically estimated. For this purpose in the software it is possible to get certain weights based on this non-numeric, non-exact information for each customer.

The last step is to get the aggregated indicator of overall attractiveness of the object (container terminal) for the customer according to his preferences (which are already transformed into numerical weights). After obtaining all aggregated indicators those alternatives of container terminal can be ranked in descending order for each client.

Moreover, customers can be grouped in different segments according to the type of shipment, regularity of relationships with shipping company, and preferences. For each type of the customers the best alternative can be identified. In this case the information about the values of the attributes should be taken from the experts` interviews.

2.6 Decision support system APIS

For the realization of the method described above, the computer software is used. It is called DSS (decision support system) APIS (Aggregated Preference Indices System) which is used for estimation of complex multi-attribute objects of different nature under uncertainty.

Let us list the main advantages of this software for solving our problem:

1) It allows avoiding the problem associated with different scales of the initial attributes by forming normalizing function of the individual indices.

More precisely, 2 cases of relationships between the initial attributes and individual indices of preference are possible:

- The degree of preference q_j is increasing when value of attribute a_j is increasing on interval $[MIN_j, MAX_j]$
- The degree of preference q_j is decreasing when value of attribute a_j is increasing on interval $[MIN_j, MAX_j]$

After formation of monotone normalization functions $qj=qj(aj), j=1,\ldots,m$, values of all individual preference indices for all alternatives can be calculated.

2) It takes into account the absence of exact weights and transform ordinal information into exact weights with the use of formulas.

DSS APIS differs from the other decision-support systems by allowing to use the following types of information:

Non-numeric information – non-numeric information (ordinal information) on weight-coefficients values. It can be represented by a system $OI(w)=\{w_r=w_s; w_u>w_v; \ldots\}$ of equalities and inequalities for weight-coefficients.

Non-exact information – non-exact information (interval information) is defined by a system $II(w)=\{a_j<=w_j<=b_j; \ldots\}$ of inequalities and equalities (when $a_j=b_j$) for weight-coefficients.

NNN-information on weights – ordinal (non-numeric), interval (non-exact), and non-complete (incomplete) information on weights is a combination $I(w)$ of non-exact information (interval information) $II(w)$ on weights and non-numeric information (ordinal information) $OI(w)$ on weights.

At the end, values of an aggregated preference index $Q(q;w)$ for alternative A(i) calculated These values are elements of set of all possible values of aggregated preference index for alternative $A(i), (i = 1,\ldots,k)$.

Alternatives can be ranked according to its aggregated preference index, which is average aggregated preference estimations. Moreover, APIS allows to get the standard deviations of the estimations. As a result, APIS provides the graphical representation of the result, which shows the ranking of all the alternatives for the decision-maker.

Summary

In this chapter we suggested the methodology to be used in our research. First of all, the type of research is identified – in this study we conduct primary and applied research. The main source of the data needed is questionnaire – for expert and chosen group of customers – freight forwarders.

In the very beginning of this chapter we presented the hypothetical model of customers` typology. It is based on 3 main criteria: the frequency of calling to shipping company, the nature of decision-making in terms of independency, the type of cargo transporting. It is supposed that

each type will have some distinctive types of preferences and thus, different solutions of port selection need to be provided.

For solving the problem of port selection we use the method called AIRM and the computer-based program APIS. This program takes into account customers` preferences about the importance of different port`s attributes, the values of those attributes and the preferences about alternatives itself (if there are any). The values of the port`s attributes are obtained from expert. The program allows to aggregate the data into one index that characterizes the overall attractiveness of the port for a customer. After that it provides the benchmarking of ports for the considered customer.

The advantage of this model is that it doesn`t require exact numeric information about the weights of attributes. It generates it itself after obtaining interval and ordinal information about attributes. Thus, at the end we have the benchmarking of alternatives (ports in our case) according to the aggregated indices, and also the weights of the attributes, reflecting, to which extent different attributes are important for the customer.

3. Empirical part

3.1 Data collection

In this study we investigate the customers of ports and shipping companies in Saint-Petersburg, and the way, how they choose a port for cargo transportation. For this purpose we addressed to Maersk Line`s clients, which are mainly represented by freight forwarders and represent the huge part of all shipping companies and ports` clients. Let us now briefly describe terminals and ports, which we consider to be alternatives for selection in Saint-Petersburg:

1) First Container Terminal (FCT). This one is the leader in the field of handling with containers in Europe. It cooperates with a lot of shipping lines and appears to be one of the most important transportation point on the route of cargo.

2) Petrolesport. Petrolesport is a modern technically advanced port complex, which includes container terminal and ferry terminal. Petrolesport performs all necessary activities for the container handling: the loading/unloading, storage, forwarding, and handling of various cargo types, as well as all customs related activities, and other operations. It provides the port services for all kinds of cargo: refrigerated, ferry, timber, general cargoes, and is one of the leading ports in the Northwestern Federal District of Russian Federation.

3) Moby Dick. This port is situated near St. Petersburg, in Krondshtat. It is comparatively less than above-mentioned ones, but also important because there is always demand for this port from the customer side.

4) Sea fish port. This port exists since 1956 and mainly deals with cargo handling and storage. The port consists of 3 terminals, one of which is constructed for container handling. The port is situated on the south of Saint-Petersburg not far from high-way

5) ULCT. (Ust-Lugsky Container Terminal) This container port in one of the largest in Russia and Eastern Europe with highly technological equipment. It is situated 100 km far from St. Petersburg, in the Gulf of Finland.

3.2. Expert`s estimations

Maersk Line collaborated with these terminals and ports for a long time. Let us now present the expert opinion about the values of port attributes that were identified in our questionnaire.

Initially the questionnaire was compiled in such a way so as to completely reflect the main port`s attributes, which were first identified through literature review, and then verified by expert. The questionnaire accounted for 19 attributes that need to be evaluated. However, some of them were excluded due to the equal values for all 5 container terminals. The employed model, APIS, does not allow to proceed with the equal values for attributes because it means that the alternatives are indistinguishable for a customer regarding this particular attribute. Due to this reason we excluded the following attributes: cargo safety, port safety, the absence of drug cases in a port. Moreover, we could not include those characteristics that have different values for different customers, for example, existence of personal relations, the proximity to business (which includes two attributes). These attributes are important for the customers, even if the alternatives are indistinguishable according to these factors. At the end we obtained 13 attributes for which we got numerical values from the experts. You can see these values in the Table 3.1.

Table 3.1. Experts` evaluations of ports` attributes (on to scale from 1 to 5)

№	Attributes	Petrolesport	First Container Terminal	Ust-Lugsky Container Terminal	Moby Dick	Sea Fish port
1	Technical infrastructure	4	3	2	3	2
2	Special equipment	5	4	2	4	2
3	Availability of storage services	3	3	4	4	4
4	Timeliness of loading/unloading of containers	4	4	4	3	4
5	Custom clearing procedure	4	4	4	3	3
6	Qualified personel	3	4	4	3	2
7	Delivery of containers in and out	5	4	4	4	3
8	Developed transportation network around a port	5	4	2	4	4
9	Opportunity to choose the time of cargo taking out	4	4	5	4	3
10	The conditions of cargo storage in port	3	3	5	5	4
11	Port reputation	4	5	4	4	3
12	Recommendation to the clients	5	5	5	5	4
13	Total costs	3	3	5	4	3

In general, each of the port has certain advantages and disadvantages. That is why the choice of a port depends to a large extent to the customer preferences and specific needs. Moreover, the difference in choice could be a result of initial customer differences, such as regularity of applying to shipping line`s services or, type of cargo transportation (export/import), or some other specification. This would result in identifying customer typology.

As for the data from customers, we got 5 different types of answers on questionnaire designed for customers. The results of these answers we will discuss further in the section "customer typology".

3.3. Findings and the results of empirical study

As the results of empirical study we obtained the estimations of attributes of maritime terminals from the industry expert and the results of survey for the users of these terminals – freight forwarders. First of all, we provide the analysis of expert estimations in order to understand, how ranking would look from their perspective. After that we suggest the ranking of ports for freight forwarders, using APIS. We will see further, whether there are types of customers, for which the rankings coincide.

3.3.1 Estimation of alternatives from company`s perspective

Having received the values of the attributes from industry expert, we evaluate the attractiveness of each port from the expert`s perspective, without taking into account the preferences of customers. We obtain the ranked alternatives, based on the estimations of the industry expert.

In order to evaluate the alternatives we look first at the sum of values of attributes from the Table 3.1., and then at the elements of this sum according to the grades (from 2 to 5). We can see this analysis in the table below.

Table 3.2. Estimation of alternatives from the expert

Marks	Petrolesport	First Container Terminal	Ust-Lugsky Container Terminal	Moby Dick	Sea Fish port
Sum	**52**	**50**	**50**	**50**	**41**
"5"	20	10	20	10	0
"4"	20	28	24	28	20
"3"	12	12	0	12	15
"2"	0	0	6	0	6
Rank	1	2	2	2	3

The table demonstrates that Petrolesport has the highest rank, which is equal to 52, followed by FCT, ULCT and Moby Dick that share the same place because they have the equal points. Sea Fish port has only 41 points and due to this fact it is places on the lowest position. It should be noticed that even if ULCT is ranked the 2nd, it has some very low estimations of the attributes ("2"), but FCT and Moby Dick doesn't have it. Sea Fish port doesn't have any highest-graded attributes ("5"). The distributions of values of the FCT and Moby Dick are the same (10 for the "5" grade, 28 for "4" grade and 12 for "3" grade).

So we can conclude that from expert perspective Petrolesport is the most attractive port to choose, followed by FCT, ULKT and Moby Dick, which share the same positions, and at last, Sea Fish port. As we have conducted this analysis of the alternatives` attractiveness from expert`s perspective, we can look at the customers` perspective and compare the results.

3.3.2 Customers` typology

We identified 5 types of the customers` preferences based on the importance of different attributes that customers have. We used the answers on questionnaire about the importance of different characteristics. Respondents had to estimate the importance of ports` attributes and also gave their preferences about the ports itself (if they have any). Customers can not give their preferences about all the characteristics, they just choose those, which are the most important for them, indicating also others, which are less important. After we look at the attributes that matter the most for the customers – these attributes form the basis of the typology. Let us present this typology in the next paragraph.

For further convenience we denote the port`s attributes as follows:

Table 3.2. Denotation of attributes

№	Attributes
X1	Technical infrastructure
X2	Special equipment
X3	Availability of storage services
X4	Timeliness of loading/unloading of containers
X5	Customs clearing procedure
X6	Qualified personel
X7	Delivery of containers in and out
X8	Developed transportation network around a port
X9	Opportunity to choose the time of cargo taking out
X10	The conditions of cargo storage in port
X11	Port reputation
X12	Recommendation to the clients

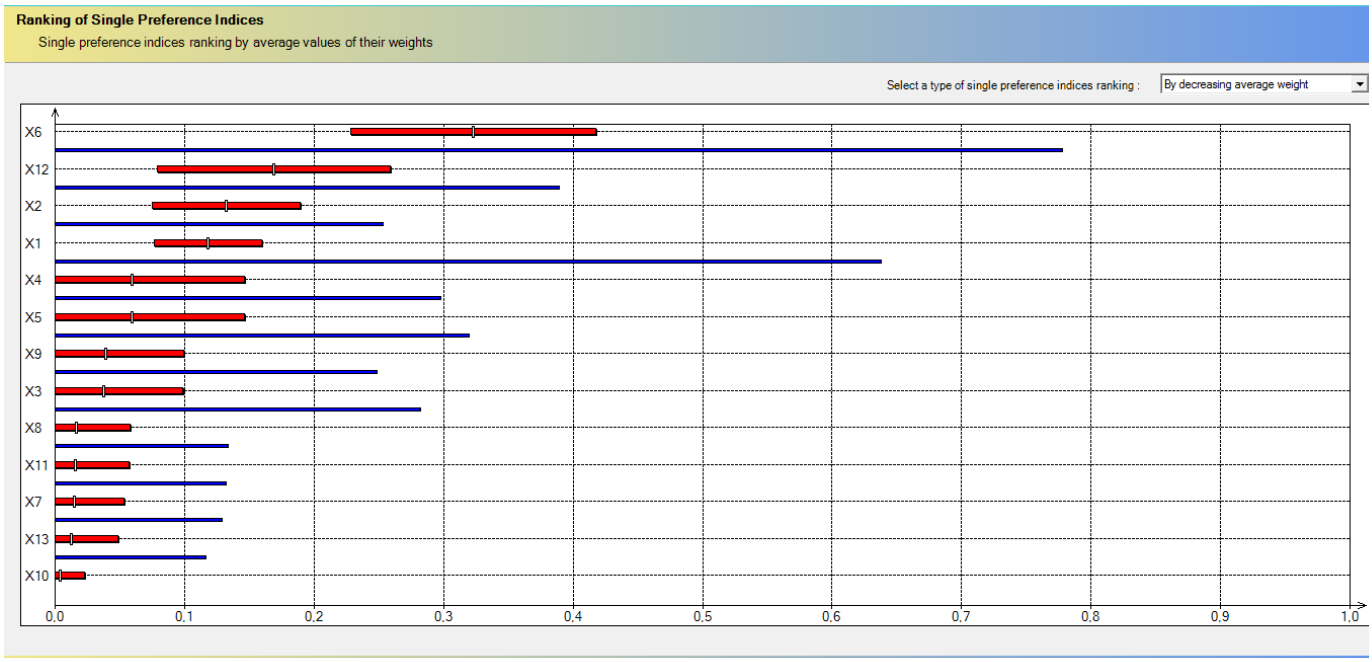
X13	Total costs

The 1st type of customers` preferences

The first type of customer put on the first places the factors connected to the service and physical conditions of a port, namely technical infrastructure (X1), special equipment (X2), and qualified personnel (X6). Moreover, for this type of the customers the recommendations from the company are important (X12).

After we put into the APIS the preferences of such type, we got the diagram, which represents the ranked attributes from the most important to the least important. The dash crossing the red horizontal line indicates the average importance of this attribute for the customer. For example, for considered type the highest importance (weight) is given for the "qualified personnel" attribute (X6), and it accounts for 0,32. The sum of all attributes` average weights equals to unity. We can see that the first 4 positions are taken by 4 attributes mentioned above. For this type of customer such characteristics as costs, conditions of cargo storage, port reputation are of the least importance. They care the most about the facilities of a port and employees, who these facilities support. Such kind of customers transport unordinary cargo, which require existence of special equipment for loading/unloading of containers.

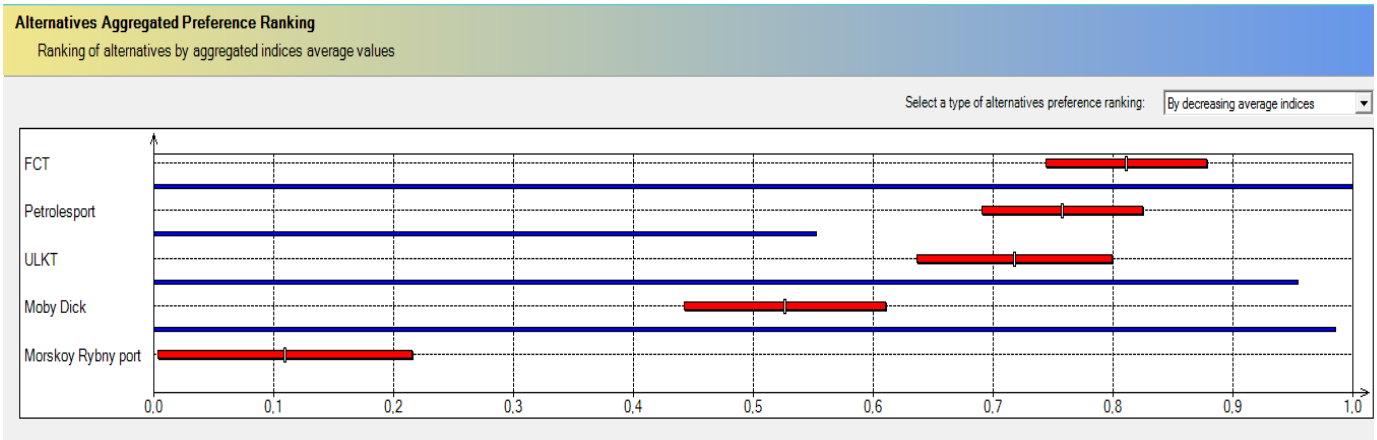
Diagram 3.1. Ranking of attributes for type 1



Besides the information about the distribution of weights for attributes we also obtain the ranking of ports, according to the customers` preferences. The Diagram 3.2 shows us the results. We can see that First Container Terminal is the most preferable and attractive for this

customer (it has 0,81 out of 1 score), followed by Petrolesport (0,75 out of 1), ULKT (0,71 out of 1), Moby Dick (0,52 out of 1), and the most non-preferred is Sea Fish port (0,11 out of 1). "The winner" dominates the second-placed alternative with 100% probability, while Petrolesport does it with just 55% probability (the blue line indicates it). Sea Fish port has significantly lower aggregate index, than the rest of ports.

Diagram 3.2. Ranking of alternatives for the type 1



Customer itself in questionnaire chose the following ranking of alternatives: first – FCT, then Petrolesport, and third, Moby Dick. The obtained from the APIS results coincide with the preferences from the questionnaire to large extent. However, the diagram shows that instead of putting Moby Dick on the third place, this customer should rather consider ULKT. In comparison to expert opinion, Petrolesport doesn`t look like a perfect alternative for this type.

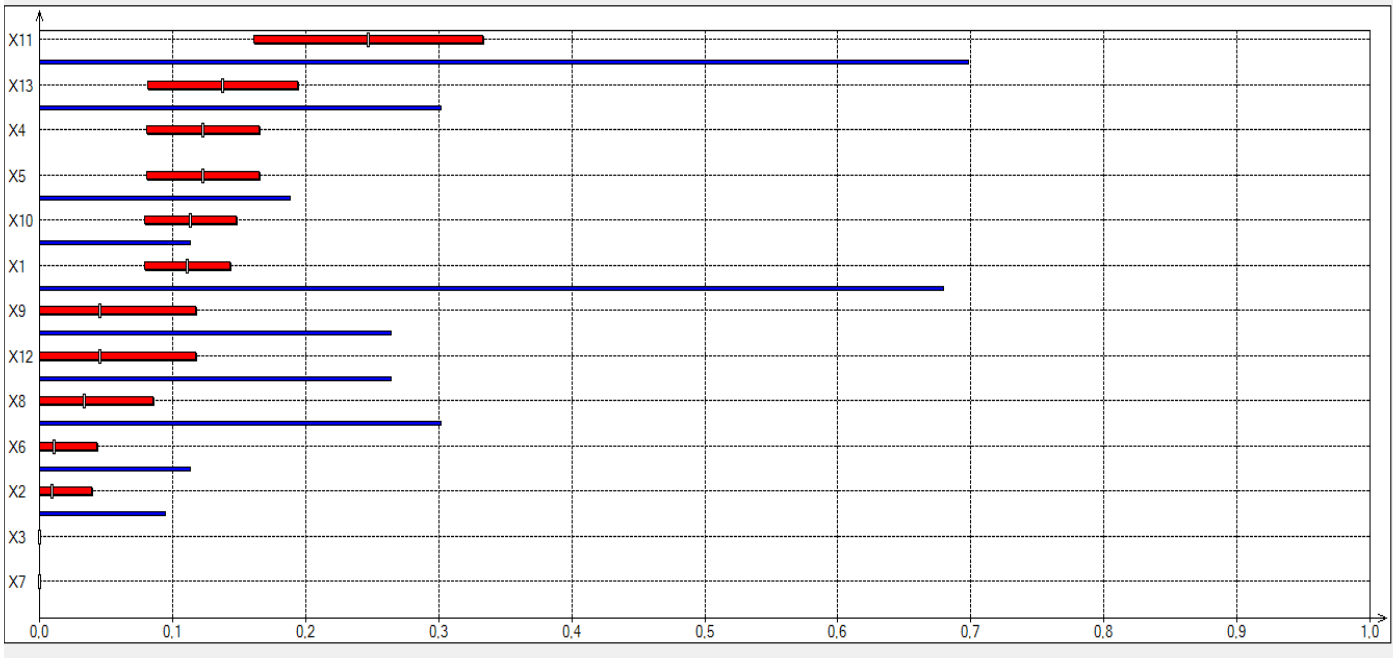
The 2nd type of customers` preferences

In comparison to the first type of customers, the second one doesn`t seek for the technical infrastructure of a port. For this type costs and port reputation are the most important, followed by the customer clearing procedure and timeliness of operations.

In the diagram below the single preference indices ranking is shown, by average values of their weights. It indicates that the most important criteria is port reputation (X11), followed by expenses (X13), timeliness of operations (X4) and customer clearing procedure (X5). While port reputation has the weight equals to 0,25, the following 3 attributes have approximately the same weight around 0,13, as Diagram 3.3 indicates.

Such type of the customers is indifferent to technical characteristics, but care about simplicity, speed and costs of shipment. He carries technically simple cargo, non-perishable. What is also interesting is that for this type the existence of personal relations is important to the large extent. It is not reflected in the table below due to the limitations of the used model.

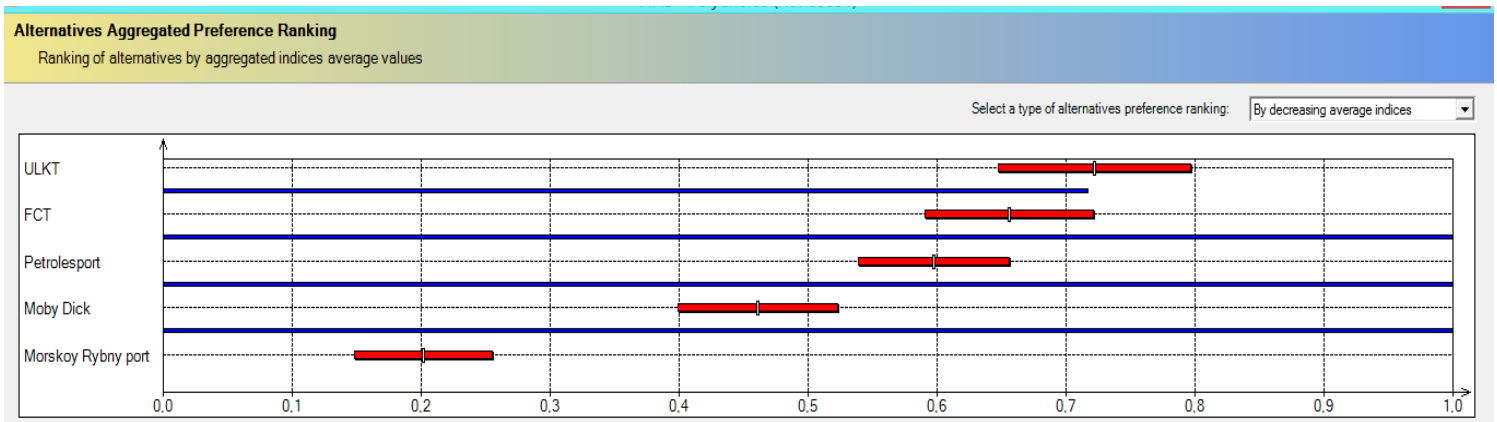
Diagram 3.3 Ranking of attributes for type 2



The results in the form of ranked alternatives are shown in the Diagram 3.4. It indicates that the most attractive alternative for such type of the customers is ULKT, which dominates the next alternative with the 71% probability. The rest of alternatives are arranged in the following order: second – FCT, with the aggregate index equals to 0,65; third – Petrolesport, with the aggregate index 0,6; the forth position is occupied by Moby Dick, and the fifth by Sea Fish port with the lowest index 0,2. Such results partly coincide with those, indicated in questionnaire – ULKT is again not taken into account, while this is the most preferred alternative. The order after ULKT is indeed chosen by the customers. If to speak about the similarities between this type and the expert opinion, there is a little similarity, as with 71% probability ULKT is better than FCT, which is, in turn, better, than Petrolesport with 100% probability.

As this type appraises the most port reputation and costs, ULKT alternative needs to be chosen. However, customers either are not offered this port or they for some unrevealed reasons prefer other ports. The attribute of distance for this type is not important, meaning that some other reasons for not choosing this port can exist.

Diagram 3.4. Ranking of alternatives for the type 2

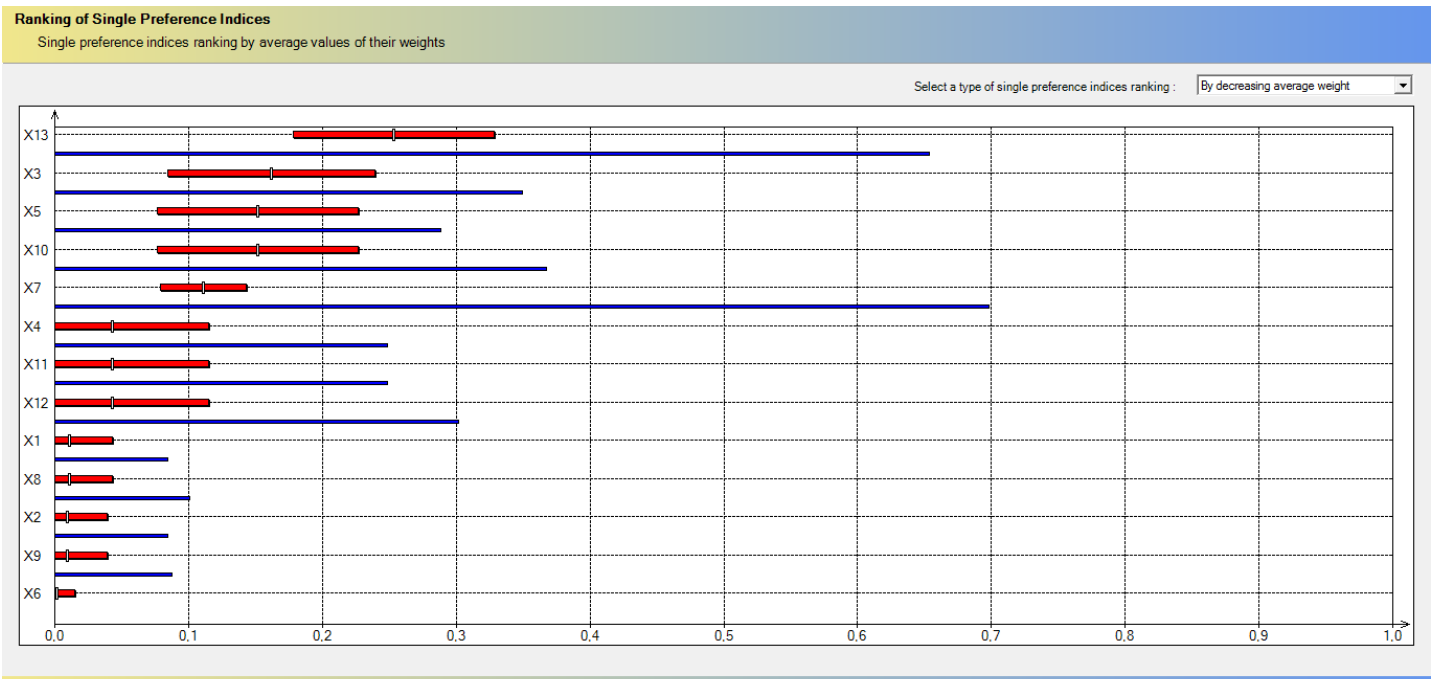


The 3rd type of customers` preferences

The following type of customers is characterized by strong position about storage services (X3 and X10), customs clearing procedure (X5), and the costs (X13), which represent the result of efficient storage and customs services. Such type of the customers most often deals with the import cargo, implying high-quality storage services and efficient custom procedure. He doesn't pay much attention to the technical facilities and professionalism of employees. Such type of customers could transport perishable items.

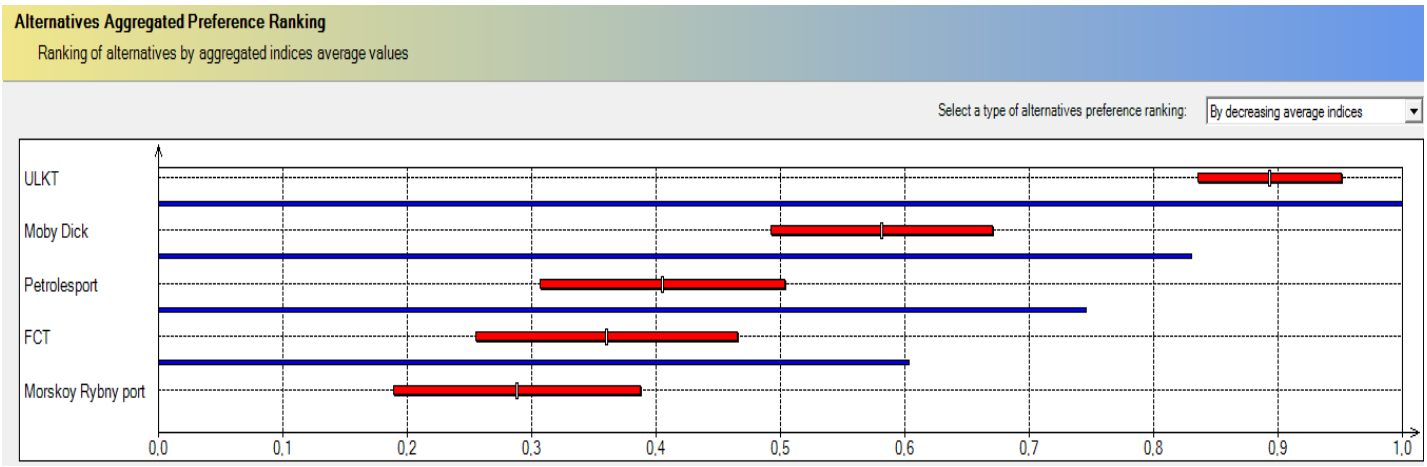
The order of attributes according to its weights is presented below. The attribute of costs is put on the first place with the average weight of 0,2, followed by "availability of storage service", "customs clearing procedure" and the conditions of cargo storage in port" with approximately the same weights, around 0,15, as the Diagram 3.5 shows.

Diagram 3.5 Ranking of attributes for the type 3



As for the ranking of all ports for such type of the customers, the results are shown in the Diagram 3.6. ULKT dominates with 100% probability over Moby Dick, which is put on the second place. The gap between them is quite prominent – ULKT has 0,89 aggregate index, while that for Moby Dick is 0,58. The third place is given to Petrolesport, with 0,4 index, followed by FCT and Sea Fish port. Sea Fish port again the most undesirable alternative, and ULKT the most preferable one.

Diagram 3.6. Ranking of alternatives for the type 3



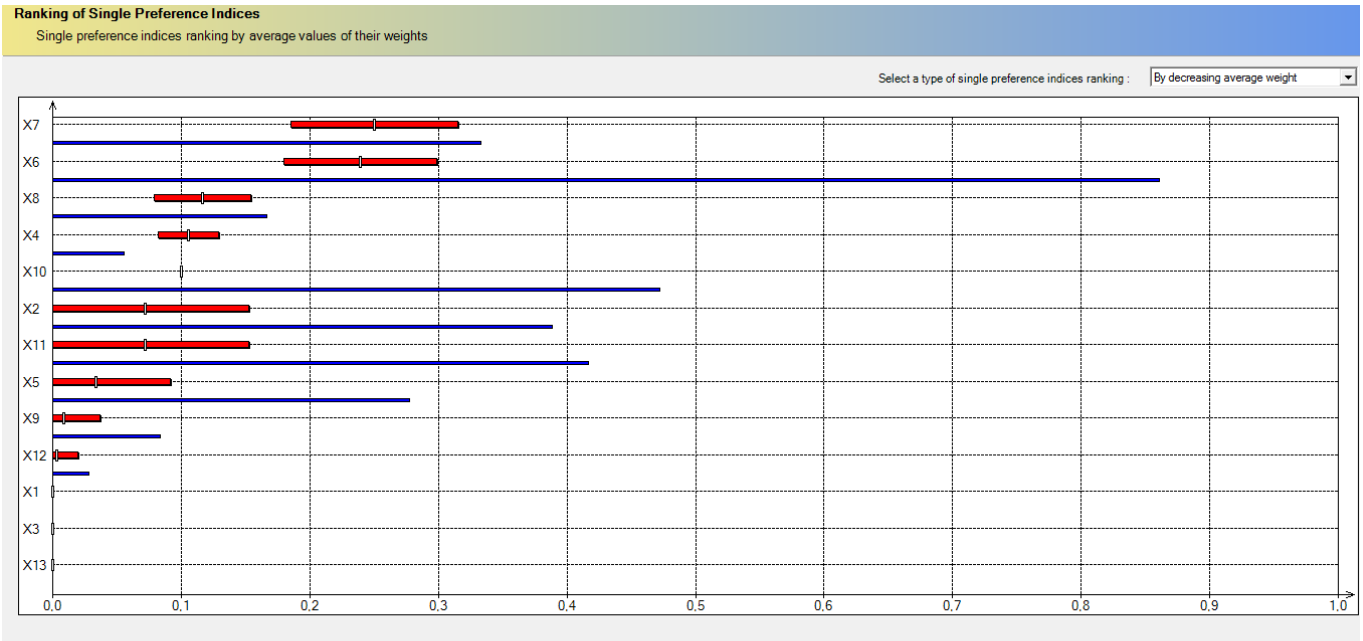
For this type the results from APIS do not coincide with those obtained from the expert. ULKT prevails over Moby Dick with 100% probability meaning that for all of the attributes this alternative is more preferable for this type of customers, than the rest.

The 4th type of customers` preferences

The forth type of the customers care the most about before- and after- transportation service, highly appraising such attributes as convenience of delivery of containers in and out(X7), qualified personnel (X6), developed transportation network (X8) and timeliness of handling the containers (X4). Attributes X7 and X6 have the highest position in terms of importance, and are designated the same weight, equals to 0,25. Developed transportation network is also important for this type of the customers, in the same extent as timeliness of services. All the attributes are ranked and depicted in the Diagram 3.7.

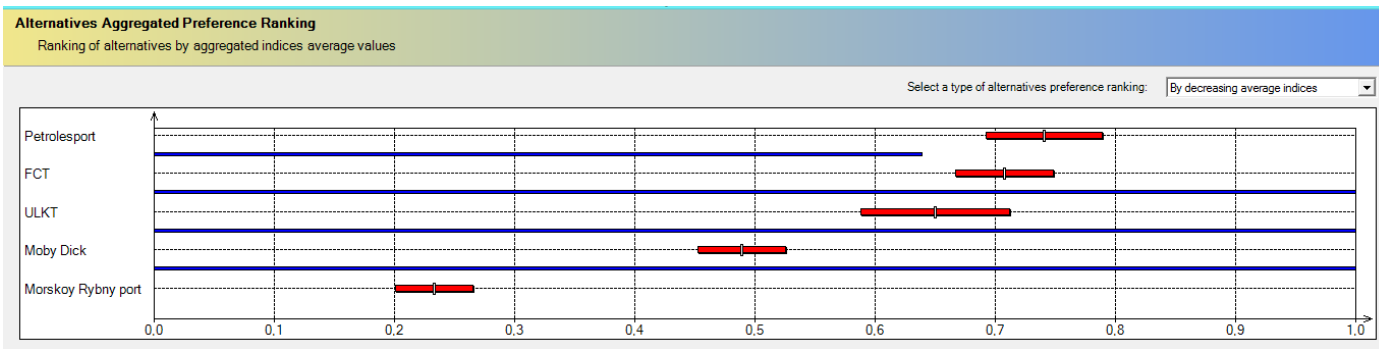
Such type of customers concerns the logistical role of a port, which is in our case represented by the attributes of developed transportation network and easiness of delivery of containers. Moreover, he cares about the speed of services provided in a port, pointing that timeliness and qualified personnel are also significant. Such type of customers is constant user of port services, who has to go there quite often, and because of it he cares about the process of delivery the cargo.

Diagram 3.7 Ranking of attributes for the type 4



In this case the ranked order of alternatives differs from the previously considered. The Diagram 3.8 indicates it. Petrolesprt is the leader for such type, which is given the aggregate index of 0,75, and it dominates the next alternative with 64% probability. FCT follows Petrolesport, lagging not too much. ULKT is also quite close to the FCT, and has 0,65 index of attractiveness. Sea Fish port is again the outsider with 0,24 index. It should be noticed that besides Petrolesport, each alternative dominates the next one with 100% probability.

Diagram 3.8. Ranking of alternatives for the type 4



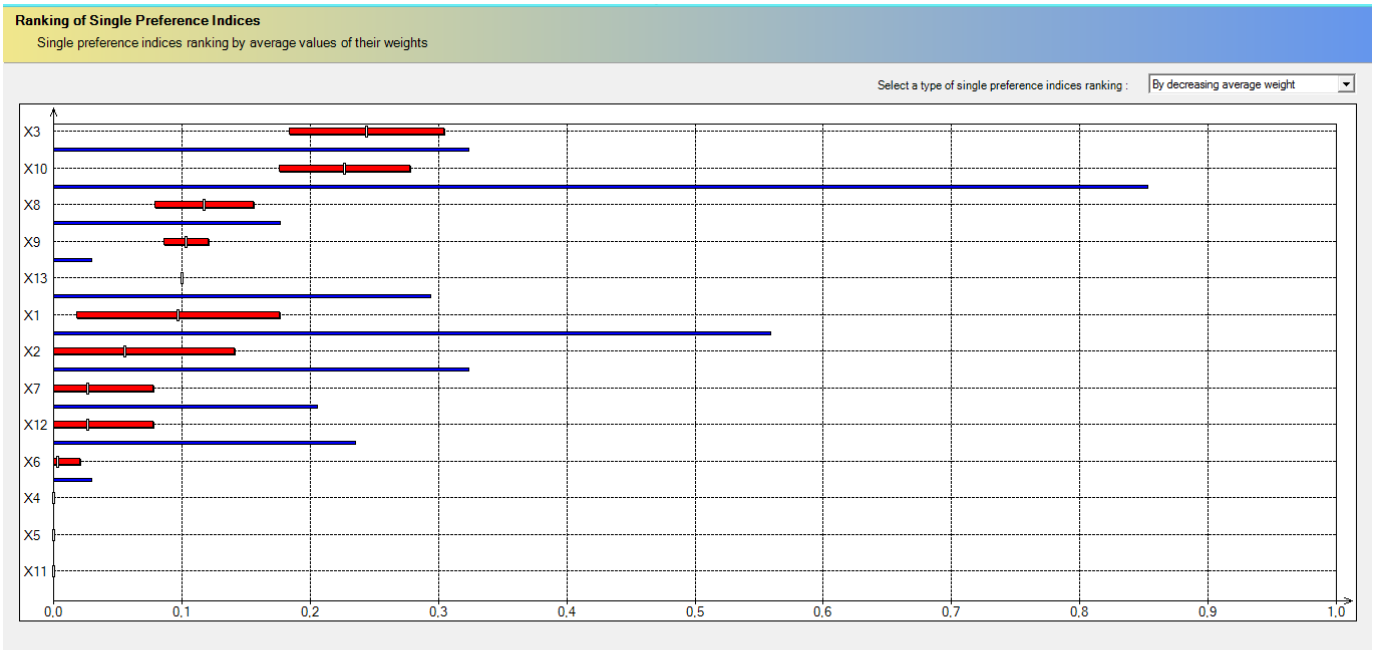
These results correspond to those from the customer questionnaire to some extent: Petrolesport is chosen indeed most often, followed by FCT. However, ULKT is chosen by the customers only in the fourth place, while out results show it has the third rank. Sea Fish port is again ranked to be the leas preferred. If we compare it with the expert results, we can see that this is the only case, when the results completely coincide. The ranking from expert is 100% the same, which APIS provides for such type of preferences.

The 5th type of customers` preferences

This type of the customers is also concerned with storage conditions, as the third type, but also he needs developed transportation network along with the opportunity to choose the time for taking the cargo. Such type of customers cares about the integrity of port into the whole logistics network. The problem of choosing the port for such type of the customers is connected to the problem of logistics optimization, in terms of both costs and location. As storage factors are important, this type of customers deals with import cargo transportation quite often. He also might transport special cargo, which needs existence of special condition in storage terminals. The importance of developed transportation routes might indicate that cargo will further transported to the distant locations.

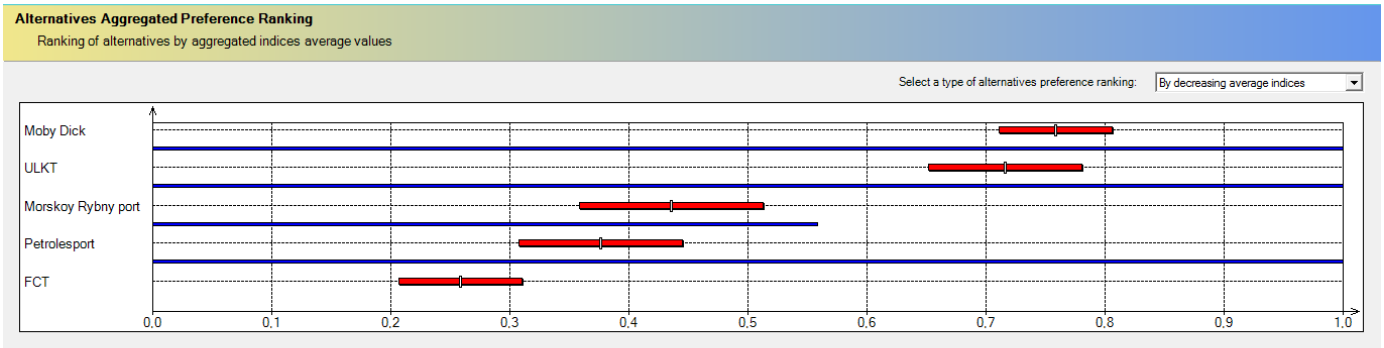
The factors of storage services (X3 and X10) are placed foremost and together account for around 0,5 weight. Developed transportation factor (X8) is also important, but in less extent, as it has the third position. The opportunity to choose the time for cargo taking out comes after X8 and has almost the same weight for this type. The attributes and values are depicted in the Diagram 3.9.

Diagram 3.9 Ranking of attributes for the type 5



The alternatives are ranked in the way as the Diagram 3.10 indicates below. Moby Dick has become the most attractive alternative for such type of the preferences. It has 0,75 aggregate index, followed by ULKT, which has 0,71 index of attractiveness. After ULKT the large gap takes place, and Sea Fish port comes the third with the index of 0,43. Petrolesport and FCT are ranked the last as the most non-attractive for this type of customers.

Diagram 3.10. Ranking of alternatives for the type 5



The results do not coincide with those, obtained from the questionnaire. They indicated the preferences of Petrolesport and Sea Fish port over Moby Dick. The reason might be that this type of customers in the questionnaire indicated that they do not follow any scheme about the estimating the ports when choosing it. They do not coincide either with those, obtained from the expert point of view.

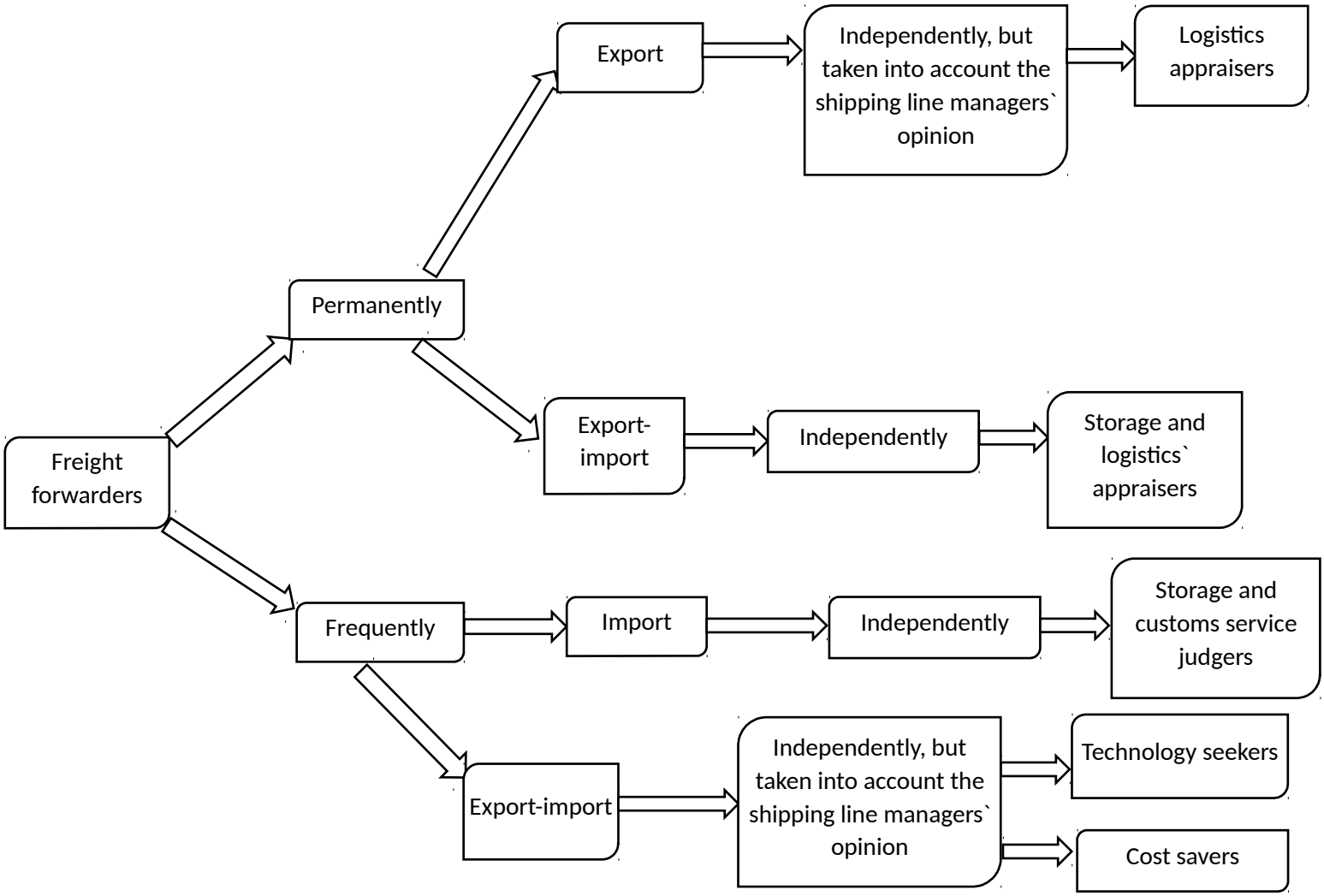
Such typology of preferences reflects the difference between existing customers` preferences. In the second chapter we presented the hypothetical scheme that could be implemented in order to differentiate customers` preferences. After conducting the survey we

identified 5 types of customers` preferences, and now we would like to see, whether the suggested scheme corresponds to the reality or not, and whether the identified types could be distinguished according to the considered criteria (the type of cargo transportation, frequency of appealing to the maritime company`s services, and the independence of decision-making).

3.3.3 Scheme of customers` typology

The factual results indicate that customers indeed differ based on the suggested criteria. However, the observed typology is different from the suggested scheme. It also has 3 levels, but with less complicated structure. The real scheme, identified with the use of questionnaire, is presented below.

Figure 3.1 Scheme of customers` typology



The Figure 3.1 above depicts, how the typology of customers is connected to the general information about customers. In contrast to the suggested in the Chapter 2 scheme, this one eliminates the occasional customers, who called the service once, seldom, or from time to time, leaving only the category of regular customers. They include frequent and constant ones. All 3 types of transportation exist, however, not for every category. For example, the constant customers usually do either export operations or export-import ones. Frequent customers also can perform export-import operations, but they also can transport import cargo. Neither of categories demonstrate the outsourcing of decision about port choice to the managers of the chipping companies, but two other options take place: customer either make a decision just by themselves, independently, either they listen to the opinion of the shipping line`s managers, but make final decision independently. We match up the identified types of customers` preferences with the abovementioned criteria. For example, the storage services appraisers perform either pure import or export-import operations: this type of customers` needs excellent storage services in order to keep the import cargo for some time. However, in order to build more proper scheme of customers` typology, more customers need to be surveyed.

If to speak about the relational part in the decision-making process, one type of the customers indicated the importance of existence of personal relations for decision-making, while the rest finds it unimportant. However, even for that type, which indicated the importance of personal relations, this factor is not the only one, influencing the decision. Even if some types indicate that they make the decision, taking into account the recommendations from the shipping company, only one has denoted the high importance of this factor for decision-making. As for the order of decision-making, 4 types of customers agree with the statement that they first choose shipping company, and after a port. But one type has the opposite preferences – port is chosen first, and the shipping company second. This is the type that seeks for the excellent storage and customs service.

3.4. Managerial implications

The results of the empirical study indicated that there is a difference in the way, how freight forwarders choose a port. The difference exists in preferences, concerning attributes of ports, along with the difference in the process of choosing.

Both for shipping companies and ports the results of this study provide the insight on how their customers choose a port, what kind of preferences they have, what are their needs. As shipping companies offer complex solution, including the services of ports, the impression from port`s services affects overall impression from the shipping company`s services. That is why this

is not only ports that are interested in the results of this study, but shipping companies as well. Moreover, our survey revealed some preferences about the important characteristics for shipping companies as well. We found that such attributes as ability to track moving of containers, speed of service delivery, qualification of employees and price affordability are the most important factors for freight forwarders when choosing a shipping company. It means that freight forwarders concern not only with the financial issue of the transportation, but the quality of service delivered as well. Even though in crisis times shipping companies incur cost-cutting measures, these measure should not be connected to the factors listed above because they are crucial for customers.

From the ports` perspective, this study gives an insight on how the decision-makers choose ports. The understanding of factors influencing customers` behavior is essential to deliver the right services. Our study revealed that not for every type of the customers costs play the major role. They do, for two of them, but together with other attributes that are not less important. More and more attention is paid for the quality of service provided, for the storage services, for the convenience of using a port, and port`s connectivity. That is why ports should develop not only internal services and facilities, but also do not forget about the importance of obtaining the access to the main road and rail routes. The port is often not the final point of destination, and cargo moves further, using different modes of transportation. That is why port plays important role for overall logistics, and for customers it is of great importance to choose an optimal port for further cargo transportation.

Delivered in port cargo is left for some time in the storage zone, especially the import cargo. Some cargo needs special conditions for storage, some cargo are stored for a long time and because of this customers want to be sure that cargo will be safe. They are also interested in keeping the costs of storage down because storage costs usually account for large sum of spending for the container shippers. That is why ports, which offer storage service should further develop it towards better customer satisfaction. Moreover, such attributes as cargo safety and port safety turned out to be also important for customers. It means that ports should not forget about keeping these characteristics on the high level.

Ports should deeply understand the main types of its customers and their needs so as to suggest better offering for them. As long as the whole industry is turning toward more technologically developed, ports should also keep up with this trend. Our study revealed that there is a type of freight forwarders, which seeks for technologically developed services. In previous studies such findings did not appear. It means that new type of customers started to appear – those who seek for technological integration of the port. It is not a surprise – more and

more freight forwarders itself offer technically integrated solutions to its customers (shippers), and they expect such type of services from its providers.

From the perspective of freight forwarders, this study suggests the framework to benchmark the ports, according to the preferences. Using this model, they can choose the most suitable for them solution, while having an opportunity to look at the overall rank of alternatives to choose. If customer seeks more the technological services of ports, they should choose FCT. For the type of customers, which values simplicity and is cost-concerned, the best option is to choose ULKT. The same alternative is the best for those forwarders, who seek for quality of storage customs services. Other type of preferences tells about importance of the integration of port in overall logistics and about the speed of services provided. For customers with such system of preferences the best alternative is Petrolesport. At last, customers, who care about storage and logistics state of a port, should choose Moby Dick. A customer with any other preferences can also get the ranked alternatives, in conformity with system of preferences about port`s attributes. For implemented model no exact values for weights of attributes are needed, just the preferences about the importance of different characteristics.

As our study revealed, customers do not use any formal evaluation of ports when choosing it. However, they have some preferences and needs, which they can rank in terms of importance for them. They can`t do it for each of the attributes. But they can outline those, which they appraise the most. Our model helps to identify the most attractive alternative for freight forwarders, which have only understanding of what they expect from port and the services it provides.

The considered problem exists not only in the field of maritime transportation, but also in any other logistics field. In our study we consider services provided by container terminals and ports. Our methodology can be implemented for other industries, like rail transportation, for example, for assessing the rail container terminals. The methodology can be extended, but this study provide the basis for the assessing the terminals from customers` perspective.

3.5 Limitations and restrictions

The goal of this study is to develop customer-oriented benchmarking model to choose container terminal. The sense of customer-orientation is that we suggest several types of customers` preferences, which differentiate customers, and present ranked container terminals.

Due to the limited amount of received questionnaires, this study presents a few types of customers. With higher response rate we could elaborate more proper and thorough typology. It

is also possible for future research to see the distribution of customers` preferences in order to understand, what kind of customers represents the hugest part and the smallest one.

Another limitation and the opportunity for future research is to increase the scale of estimation of attributes` importance. In this study we used the scale from 1 to 5, which did not allow us to choose higher precision for estimation of weights in APIS. It is possible to get more precise estimations of weights, if the scale would be from 1 to 7, or from 1 to 10. However, it also leads to some difficulties, concerning the way, how respondents could differentiate between these marks.

Moreover, we could not include such attributes and distances and existence of personal relations in our model because the respondents did not provide the personal evaluation of these attributes towards container terminals. In such case, it would be more individual solution, not for the type of the customers, but more for an individual customer.

In general, the problems of how freight forwarders choose a port/terminals and what solution can be suggested are underexplored. Different mathematical models can be implemented for solving a problem of assigning the best alternative to a customer.

Conclusions

Shippers and freight forwarders face the problem of selecting a port when they need to deliver a cargo using the maritime mode of transportation. This decision plays a strategic role – the right choice of a port could shorten the lead time, reduce costs, increase speed, and overall, enhance the effectiveness of logistic chain. Thus, it is of great importance to make a right decision choosing a port that would the best satisfy the specific needs.

In this study we considered the freight forwarders` perspective, as the main group of a port`s customers. After reviewing relevant literature we found that little attention is paid to this specific group of customers, whereas in real life a decision on selecting a port is often taken by them. When considering shippers` perspective, we found that preferences determined on a set of meaningful to the customer port attributes vary within this group of customers, thus resulting in different solutions to the problem of port selection. Therefore, it was suggested that preferences of freight forwarders are also different and, thus, a port selection would vary with regard to the type of the preferences determined over the port`s attributes.

In order to provide the best solution for each type of customers` preferences we developed the benchmarking model to choose a container terminal. On the basis of the literature review and an interview with industry expert, a set of attributes that customers could consider important for a port to possess was identified. After that we conducted a survey aimed at revealing the customers` preferences on the importance of port`s attributes and the ports. The next step was to benchmark ports for each of specified preferences that were detected through the questionnaire. For this purpose we implemented the AIRM methodology and based on it computer program APIS.

In this study we identified 5 types of customers, and for each, we provide the solution:

- The first type is characterized by the strong need in high-quality infrastructure, sound port facilities and qualified personnel to manage these facilities. Moreover, the customer of this type relies on recommendations form shipping company employees while making his decision choosing the port. For such type of preferences the best alternatives are: FCT and Petrolesport.
- The second type of the customers seeks for costs optimization and good port reputation and high speed of delivering services. For such type the best option is to choose ULKT.

- The same alternative is suggested for the customers, who expect high-quality storage services and appropriate custom clearing procedure along with optimal costs.
- For freight forwarders, who care the most about the logistics costs and overall convenience of delivery, the best alternative is to choose Petrolesport.
- The five type of the customers, which looks for both excellent storage services and logistics, the best option - Moby Dick.

Customers` preferences concerning ports not always coincide with those, provided by APIS. This means that customers do not always follow the rational procedure of port`s estimation. Moreover, one type of customers pointed out the importance of personal relations, which can be the determinant of the choice.

All in all, the results correspond to the existing market conditions of Saint-Petersburg ports, ULKT is known more for dealing with simple and "cheap" cargo, while Petrolesport and FCT concentrate more on delivering complex services. [13]

If to speak about the relational part, we found that there are types, for which existence of personal relations matter, and for which recommendations from shipping companies are important. However, this is not the case for every type. Moreover, we found that in some cases the choice of a port is made taken into account the opinion of the managers of a shipping company. It means that ports should pay attention not only to the relationships with its final customers, but also with shipping companies.

Overall, customers concern not only about the price, but also about the service and logistics. The suggested model would allow to a customer with certain preferences to obtain the solution of a best-suited port. For shipping companies, this study gives an insight on what customers seek for when choosing a port and shipping company. The understanding of customers` needs is necessary for suggesting the best transportation solution. For ports itself, this study provides the typology of customers` preferences. Ports, thus, can evaluate, which criteria are needed for improvement in order to satisfy customers` needs. They also can adjust services for each type of the customers.

The problem of terminal selection appears in different logistics field. Provided in this thesis methodology of port benchmarking for different types of customers can serve as a base for the problem of terminal selection in railway industry, for example.

13 http://www.rbc.ru/spb_sz/17/05/2016/573acbc39a79475d19f2225c?from=main

To conclude, we achieved the set goal, and answered the research questions. The customer-oriented benchmarking model is suggested so as to give the best port alternative for each type of the customers.

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Appendix

This survey is conducted in order to identify customer preferences in choosing a port / container terminal and a shipping company (line) for cargo shipping. Please, answer the questions listed below. Filling out the questionnaire will not take a lot of time, you will need approximately 5-7 minutes. Thank you!

№	Question	Answer
General information about a client		
1	Evaluate the frequency of calling on the Maersk Line services	1. Once 2. Seldom 3. From time to time 4. Frequently (on a monthly basis) 5. Very often (on a weekly basis)
2	The reason for calling on mainly concerns:	1. Export of cargo 2. Import of cargo 3. Both export and import 3. Transportation inside company
3	Who makes a choice of a port?	1. Independently 2. Shipping line`s managers 3. Individually, but taken into account the recommendations from shipping line`s managers 4. Other_____
4	Evaluate, please, to which extent you agree with listed below statements: where 1 –completely disagree, 5 –completely agree): • In first turn, I choose shipping line, and only then a port/ terminal of calling • In first turn, I choose a port/terminal, only then a shipping line • The choice of a port/terminal is made by using a scheme that allows me to evaluate every particular terminal	1.....2.....3.....4.....5 1.....2.....3.....4.....5 1.....2.....3.....4.....5
Часть 1. Choice criteria		
1. Please mark the importance of each of the following criteria for you when choosing a port / container terminal (where 1 – unimportant at all, 5 - very important). If there are other criteria which in some degree is important to you, but not listed below, select them, please, at the end of the table in the line "Other".		

№	Criteria	
1	Technical infrastructure	1.....2.....3.....4.....5
2	Special equipment	1.....2.....3.....4.....5
3	Availability of storage services	1.....2.....3.....4.....5
4	Timeliness of loading/unloading of containers	1.....2.....3.....4.....5
5	Cargo safety	1.....2.....3.....4.....5
6	Custom clearing procedure	1.....2.....3.....4.....5
7	Qualified personnel	1.....2.....3.....4.....5
8	Delivery in and out of containers	1.....2.....3.....4.....5
9	Port safety	1.....2.....3.....4.....5
10	Distance from departure point to port	1.....2.....3.....4.....5
11	Distance from destination point to port	1.....2.....3.....4.....5
12	Developed transportation network around port	1.....2.....3.....4.....5
13	Opportunity to choose the time of cargo taking out	1.....2.....3.....4.....5
14	The conditions of cargo storage in port	1.....2.....3.....4.....5
15	Port reputation	1.....2.....3.....4.....5
16	The absence of drugs cases in port	1.....2.....3.....4.....5
17	Recommendations from shipping company	1.....2.....3.....4.....5
18	Existence of personal relations in port	1.....2.....3.....4.....5
19	Total expenses	1.....2.....3.....4.....5
Other:		
20		1.....2.....3.....4.....5
21		1.....2.....3.....4.....5
22		1.....2.....3.....4.....5

Please indicate the numbers of 5 the most important criteria for you from those listed above, placing them in order of importance.	

If you have certain preferences regarding container terminals, indicate them, please below, having ranked alternatives from 1 to 5.	
Petrolesport	
First Container Terminal	
Moby Dick	
ULKT	
Sea Fish Port	
Other	

Part 2. Please mark the following criteria for selection of a maritime shipping company line, according to the degree of importance for you (where 1 - not important, 5 - very important).		
1	Opportunity to track the location of a container	1.....2.....3.....4.....5
2	Simplicity of order making	1.....2.....3.....4.....5
3	Rapidness of service provision	1.....2.....3.....4.....5
4	Availability of managers	1.....2.....3.....4.....5
5	Qualifications of managers	1.....2.....3.....4.....5
6	Acceptable price for transportation	1.....2.....3.....4.....5
7	Individual approach	1.....2.....3.....4.....5