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DEFINING THE PORT SERVICE QUALITY MODEL BY USING THE FACTOR ANALYSIS

The methods of choosing the possible attributes affecting the perception of the port service quality are presented in this paper. The purpose of the study is to reduce a great number of the port service quality attributes to a smaller number of attributes, grouped in common factors. Thus, a structural model, much easier to be explained and tested on the concrete example, has been obtained.

The hypothesis is put forward stating that the two dimensions of the port service quality: reliability and competence are best explained by the attributes presented. An optimal selection of attributes has been made by the principal component analysis, while the attribute distribution has been obtained by the exploratory factor analysis. The confirmative factor analysis has been used to define the structural model, adaptable to the results of the questionnaire submitted to the sample of students of the Faculty of Maritime Studies in Rijeka, Croatia.

Key words: *quality attributes, port service, factor analysis, structural model*

1. INTRODUCTION

Globalization trends have accelerated in ports the necessity of adapting to the changed circumstances in the port service market. The ports should replace their basic activity of confronting the land and sea waterways in order to transfer the goods from one transport branch to another by developing and providing the net of logistic services. In this regard, the port authorities must face new challenges, originated from the changes in the port environment, in shipping, in port management and in the logistic industry.

Services are generally present in the modern market circumstances, with the permanent trend of increasing the service trade portion over the portion of

the product market. There are several reasons that can justify the expectations of increasing international service trade, among them the flexibility of supply and demand for services, especially in developed economies that aim at the production and consummation of higher levels of services, as well as the implementation of advanced information and communication technologies in the last decades [16, p. 13.].

The service quality in various service activities has been a frequent topic of a lot of researches. This has improved the relationship between the business success, lowering prices, user's satisfaction and profitability and has additionally motivated scientists and experts in researching the topic. However, despite the obvious accelerating investments and increased service trade, the scientific research and literature in the field of the port service quality are still lacking.

According to the literature, the quality has become an important factor in promoting the port industry and has contributed significantly to the position of the port on the market. The pressure, made on ports by the interest groups, is the additional challenge for realizing a high quality port service on the competitive traffic and logistic market. Therefore, ports must develop and accept the strategy of a permanent advancement and understand the user's demands, thus creating directly the perception on quality of the obtained service.

The concept of the port service quality is a very complex and abstract one due to its principal characteristics (intangibility, heterogeneity, indivisibility of production and consumption.). A great number of attributes expressing the demands of the port service buyer's points out the complexity of the quality.

Hence, the study provides the methodology of reducing a great number of attributes to a smaller number, enabling the optimal set of attributes which defines the port service quality and obtaining a structural model, easier to be explained and tested on a concrete example.

The factor analysis methods used in this paper are as follows: the principal component analysis (PCA), the exploratory factor analysis (EFA), the confirmatory factor analysis (CFA) and the structural equation model (SEM).

2. LITERATURE REVIEW

The early service quality researchers and gurus (Parasuraman, Zeithaml and Berry 1985; Gronroos 1983.) considered the service quality as the relationship between the buyers' expectations upon the service offered to them and the one really delivered. The understanding of the service quality and the complexity of its concept are the reasons for the necessity to define various dimensions and attributes of the service quality and efforts were made by some authors (Parasuraman et al.1985; Schneider, Parkington and Buxton 1980) to identify them.

Based on the interactive approach to the service delivery, Lehtinen and Lehtinen (1985) suggested two- and three-dimensional approach to the service quality. The two-dimensional approach describes the service quality from the buyer's point of view that is through the process quality and the output quality. In this approach the concept of the process quality is based on the fact that the service production and its utilization cannot be observed separately, because the buyer has his contribution in the production process. The process quality level will therefore depend on the way in which both the suppliers and the buyers participate in the delivery, i.e. if their style of participation is complementary, the process quality will probably be higher.

Unlike the former one, the tree-dimensional approach describes the service quality as a physical, interactive and corporative quality. The interactive quality is the result of interaction between the buyer and the interactive elements.

Parasuraman, Berry and Zeithaml (1985) have assessed five dimensions that define the service quality: intangibility, reliability, responsibility, assurance and empathy. Numerous other authors (Cronin and Taylor 1994; Teas, 1994; Buttle 1996.) also considered that, for defining service quality it was important to establish the factors that affect the buyer's perception on the service obtained.

The port service quality assessment is in its initial phase connected with the research made by Foster in 1978. Based on the data obtained from the questionnaires, he determined from the shipper's point of view the service frequency, facilities and closeness to the port to be the most important factors in choosing a port. His study indicated the priority of the service quality related to the cost of the service obtained. The second Foster's research (1979) had the purpose to assess what shippers mostly expected from the port and what their choice depended on. The results of this study were totally different in respect to the previous research. Service cost and charges in the port were the most important factors leading to choose a port, whereas the factors such as vicinity of the port, number of sailings, access to the equipment and service variability, level of obstructions, customs handling quality, amount of free time allowed for cargo, security and reputation were less important. The two researches have a great importance for the further research because they can serve as an example of ambiguity and different comprehension of the same problem within the same group of examinees. The reason for having obtained such results could be different question formulations as well as formulations of different priorities and demands of single groups in choosing a port.

Murphy et al. (1987) used in their study the univariate and multivariate analysis for the identification of the key factors for clients in choosing a port. They found various factors that influenced the choice of a port from the point of view of different participants: port and port authorities, international ocean carriers,

international shipping forwarders, larger US shippers (with more than 5,000 million dollar income) and smaller US shippers (with less than 500 million dollar income). The authors attempted to find the port selection factors across these groups. They pointed out the following factors: access to loading and discharging installations, possibility to settle great amount of cargo, lower cost of shipment handling, less frequency of damage to or loss of cargo, access to facilities, convenient pickup and delivery times, access to information on shipment, assistance in demanding handling, flexibility in satisfying the request for a special handling. These are the factors considered as quality attributes of the port service.

Ugboma et al. (2004) measured in their investigation the port service quality in two Nigerian ports. The findings revealed the difference between the perceived and expected port service quality with the reference to the fact that the examinees considered the quality level of the obtained service lower than expected. Limitations of the research findings could be a relatively small number of examinees and a doubt of adequacy of using the SERVQUAL model for the port service quality measurements.

Ng (2006) made a research showing that, in choosing a port, the users of the Northern-European container ports were mostly influenced by efficiency, geographic position and service quality, rather than by the service cost.

Analysing the findings mentioned above, the different importance of various factors in choosing a port from the point of view of different groups of users is evident. Besides, it can be seen that the choice depends on the qualitative (reliability, accessibility, frequency, security, reputation...) and quantitative indicators, especially on the service cost.

The studies carried out also show certain limitations: a small number of answered questionnaires is a common shortcoming of these investigations and, consequently, the reliability of the data obtained is doubtful; a relatively small number of studies deals with the quality of the port service process and the interest is generally directed to the assessment of factors that determine the choosing of a port (Fleming, 2000; Fleming i Baird, 1999; Notteboom, 1997; Robinson, 1998) [3, p. 168.].

3. METHODS OF THE PORT SERVICE QUALITY ASSESSMENT

An empiric investigation was carried out in 2008, on the sample of students in their third and fourth year of study at the Rijeka Faculty of Maritime Studies, at the end of the courses Traffic Technology and Logistics and Management in Maritime affairs and Maritime Traffic. The sample was representative since the questionnaires were filled in by those students who were present at lessons. It was assumed that the students had acquired a certain level of knowledge and the possibility to become soon the service users in ports working as shippers, freight forwarders, logistics operators etc.

3.1. Data gathering

The data were obtained by analyzing the questionnaire. The questionnaire design was based on literature (Churchill, 1991) and was divided in three phases: 1) to specify what would be the object of the research, 2) to define the attributes contents and formulations, and 3) to establish the forms of evaluation of each attribute.

The questionnaire included 27 attributes of the port service quality, the importance of which was evaluated by the students using a Likert scale ranging from 1 to 5. The scale mark "1" means that the attribute evaluated has no significance, while the mark "5" represents a very important attribute in the perception of the port service quality.

In the formal letter, attached to the questionnaire, the students were asked to fill in the questionnaire very carefully, using the knowledge acquired during their high school education. Out of the total 105 questionnaires distributed, 59 of them (56%) were correctly completed.

3.2. Principal features of the methodological approach

The researches have indicated a large number of dimensions¹ by which the service quality is defined. Berry, Zeithaml & Parasuraman have identified ten service quality dimensions:

- reliability – consistency of the performances, no errors, no delay
- accessibility – readiness to provide service by employees
- competence – knowledge and ability of the contact personnel
- access – accessibility and simplicity in contacts
- courtesy – decency, companionship, gentleness, respectability
- communicability – informing and listening to customers
- credibility (support) – trustworthiness, honesty
- safeness – absence of danger and risk
- understanding the user's needs
- appearance – the service user's perception of the service, equipment and staff.

Numerous definitions of the terms "service" and "service quality", found in Croatian and foreign literature [14, p. 219.], as well as the port complexity in terms of service providing, point out the different perceptions of the port service quality. With regard to the fact mentioned above, it can be concluded that there is not any unique concept of dimensions and attributes that could serve as the port service quality measurement. Dimensions of the port service quality should cover the entire process of the service production and delivery towards

¹ Dimensions are the most prominent parameters of the service quality, measured by the set of attributes.

customers, where the following dimensions could be sorted out: reliability, adequacy, flexibility, competence and accessibility [14, p. 220].

According to the authors' evaluation, the research comprised 27 port service quality attributes, generally defined by two dimensions: reliability and competence. The dimension *reliability* was defined by 13 attributes, while the *competence* was defined by 14 attributes (Table 1).

Table 1. Port service quality attributes

Mark	Attributes
Re1	Delay in ship/train arrival/departure
Re2	Time waiting for ship loading/discharging
Re3	Average time for ship loading/discharging
Re4	Time waiting for truck/train loading/discharging at the terminal area
Re5	Time for transshipment truck/train – time interval from the truck arrival to its departure
Re6	Error-free documents
Re7	Complete documentation
Re8	Complete, timely and correct cargo information
Re9	Statistical data of the delivery performed
Re10	Minimizing unexpected deviations in the service providing
Re11	Cargo monitoring
Re12	Ability in consistent service providing
Re13	Delivering in time - no delay
Co1	Value-added services
Co2	Value-for-money insurance
Co3	Understanding the user's needs
Co4	Continuous service enhancing
Co5	Emphasising the importance of satisfied customers
Co6	Advanced management
Co7	Adapting to special demands
Co8	Communicating with customers
Co9	Immediate customer's objection acceptance
Co10	Fondness and benefits for constant shippers
Co11	Simplicity in administration (customs duty)
Co12	Efficiency in solving the customer's complaints
Co13	Trusting
Co14	Ability/knowledge of employees

The data collected were processed by the multivariate analysis using MA-TLAB for Windows 7.01 and LISREL 8.80, realized through several steps. The factor analysis was used as follows: the principal component analysis (PCA),

exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and the structural equation model (SEM). The correlation matrix of the original attributes was examined [15, p. 96.] and the adequacy of the factor analysis application was ascertained.

The research has been performed in four steps, presented on Scheme 1.

In the first phase of the research, by using the principal component analysis^{2*} (PCA) method as one of the exploratory factor analysis (EFA) methods, the reduction of the original (observed) attributes has been obtained.

The principal idea of the factor analysis, as well as the analysis of the principal components, is that a set of p variables (attributes) and n examinees may be defined by a smaller number of attributes. That is why it is used as the reduction method. The factor analysis is the approach based on the correlation matrix or covariance and enables the grouping of similar (according to the correlation factor) attributes. Analysing the content of the grouped attributes, the common group features are determined, representing new non-measured *latent* attributes – common **factors**. The measured attributes with certain loading (factor loading – simple correlations between any original attribute and factor, whereby the nature of the very factor is explained) load every factor, i.e. the measured attributes are the *indicators* of the (latent) factors. For the purpose of a simpler interpretation of the factor analysis [23, p. 12.] the VARIMAX rotation has been used.

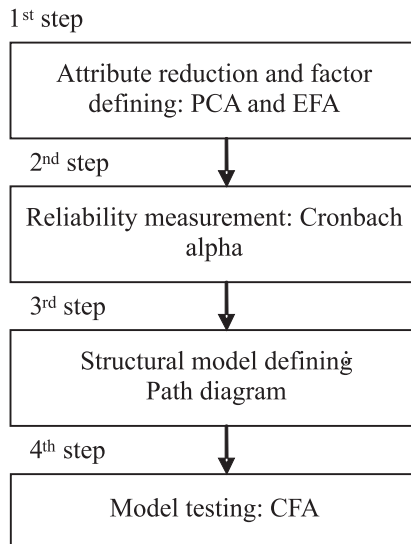
In the second phase, the Cronbach alpha coefficient values, that measure the reliability of the reduced attributes grouping in common factors, have been determined.

In the third phase, by using the path diagram from the LISREL 8.80 programme package, the structural model has been defined.

In the fourth phase, by using the CFA method, the reliability of separated factors and the dimensionality have been determined. Additionally, the convergent and discriminatory validity to examine the adaptability of the model to the data obtained has been tested.

² PCA is the specific mode of FA (factor analysis). In some statistical packages (SPSS, STATISTICA), PCA is the option of FA.

Scheme 1. Research framework of the service quality assessment



The results obtained from the research framework mentioned above are presented in the following section of the paper.

4. RESULTS OF THE EMPIRIC PORT SERVICE QUALITY RESEARCH

For a simpler and clearer interpretation of the results, the information data from the original set of attributes, using the exploratory factor analysis, have been appropriately reduced, leading to the reduction of the number of attributes. The correlation matrix of the original attributes revealed that every attribute had at least one correlation coefficient with the absolute value higher than 0.3 [15, p. 11.], a reason that justified the use of factor analysis.

Since the factor number and the structure were not known in advance, the exploratory factor analysis was used. In determining the factors, their attributive values were taken into consideration. In the factor analysis the attributive factor value equals to the sum of the squared factor loadings of all the attributes. For the fact that there is not any single accepted method for choosing the factor number, the most frequent “root of greater than one” criterion, according to which the factors having the attributive value higher than one are maintained (Kaiser’s criterion), has been chosen. According to this criterion, two factors have been extracted.

The first determined factor is general and almost every attribute in it has a high loading. Every next factor explains a smaller part of the variance. That is why it is convenient to make the rotation of the factors for the disposal of the variance. By using the VARIMAX rotation, the factors have been transformed and the possibility for the attribute to appear in both the factors has been removed, thus leading to a simpler, more understandable structure and unaltered variance.

The grouping of attributes in factors entirely depends on the loading value. Loading factor greater than 0.5 are statistically significant [10, p. 385.] and every attribute with the greatest absolute value in the row is grouped exactly in that factor (Table 2). The results of the factor analysis (present factor structure) have suggested that the obtained factors have *convergence property* (inhering attributes have high loading factor on one factor) and *discriminatory validities* (inhering attributes have low loading factor on the other factor). Attributes Po4 and Ko11 do not satisfy the mentioned properties (low loading values in the first factor and small differences in loadings of these attributes in the first and second factor) and for that reason they have been omitted in the further research.

Table 2. Factor structure after the VARIMAX rotation

Attributes	Factors	
	1.	2.
Re1	-0.0646	0.1094
Re2	0.1804	0.4350
Re 3	0.3905	0.4817
Re4	0.5079	0.4177
Re5	0.5778	0.1863
Re6	0.6152	0.1226
Re7	0.5076	0.2507
Re8	0.6806	0.1405
Re9	0.6606	-0.1426
Re10	0.7367	0.1751
Re11	0.6144	0.1231
Re12	0.4915	0.2121
Re13	<u>0.3763</u>	<u>0.1219</u>
Co1	0.5308	0.4325
Co2	0.5930	0.1442
Co3	0.1654	0.5969
Co4	0.0818	0.8301
Co5	0.0585	0.6183

Attributes	Factors	
	1.	2.
Co6	0.4357	0.5365
Co7	0.3548	0.4155
Co8	0.1588	0.1263
Co9	0.2783	0.2496
Co10	0.2816	0.5126
Co11	0.5006	0.4950
Co12	0.6106	0.4348
Co13	0.3449	0.1601
Co 14	0.3786	0.0907

Reliability, as a dimension of the service quality, is very significant in the cargo transport development. The service considered reliable is the one obtained in time and entirely following and satisfying the contract conditions, with necessary information available to the user. Competence, on the other hand, can be viewed through the satisfying level of communication in the case when prompt answers to some problem are needed, when the importance of the users being satisfied is always emphasized and when the management continuously improve their services.

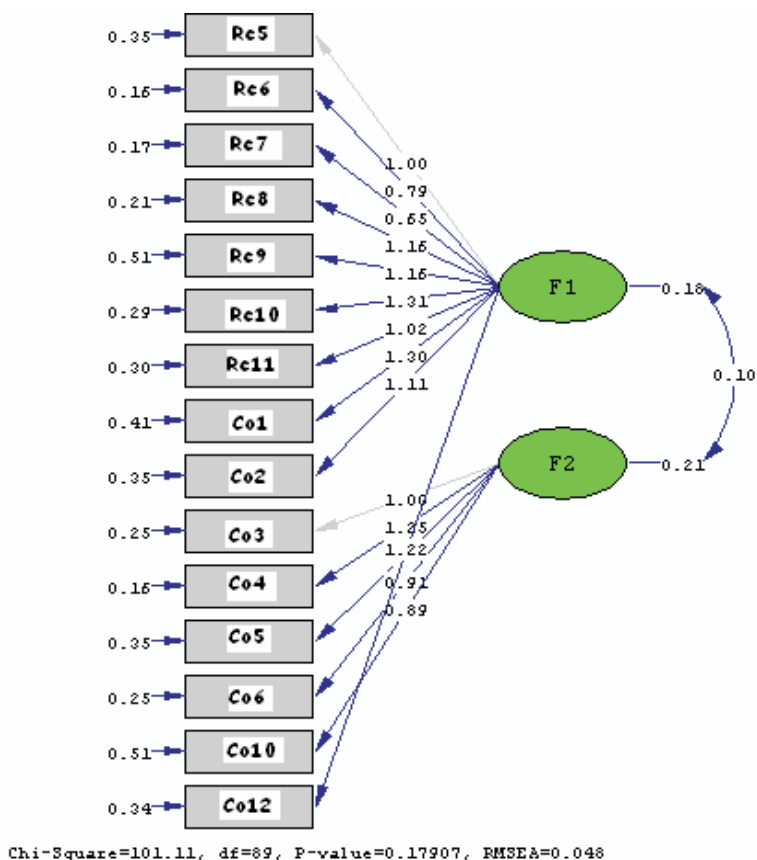
Interpretation of factors is based on the factor structure presented and on the identification of the attributes that have loadings on the same factor. It is evident from Table 2 that the first factor indicates respectively the attributes Re5, Re6, Re7, Re8, Re9, Re10, Re11, Co1, Co2, Co12, and the second factor Co3, Co4, Co5, Co6, and Co10. So, it can be concluded that the attributes of the first factor best explain the reliability of the port service delivering and therefore the first factor has been named *reliability*, while the attributes of the second factor best explain the service provider competence and, consequently, the second factor has been named *competence*. Besides, it is also evident that after the factor analysis has been performed, seven attributes that, according to the authors, best explain reliability, and three attributes that, according to the authors, best explain competence have been included in the first factor, whereas in the second factor five attributes that, according to the authors, best explain competence have been included and no one that explains reliability were. Thus, the hypothesis that the assumed attributes define two structurally different dimensions - reliability and competence, appears to be valid.

Cronbach α coefficient has been determined for both the factors. It is evident from Table 3 it is that the attributes within every factor have a satisfying level of correlation, proving the reliability of this research (Cronbach α coefficient > 0.70 represents the satisfying level of reliability in the research (Nunnally, 1978; Churchill, 1991).

Table 3. Cronbach α coefficient computed for both the factors

Factor	Cronbach α coefficient
1. Reliability	0.8680
2. Competence	0.7818
TOTAL	0.9057

The convergent and discriminatory validity of the factors have been additionally tested by using the confirmatory factor analysis. Analysing the dimensionality of the factors, the mono-dimensionality has been assessed because in the structural model every attribute loads only one latent variable (factor) [24, p. 351.] that is evident from the path diagram showing a structural model tested by the confirmatory factor analysis (Scheme 2).



Scheme 2. Path diagram – structural model

By testing the structural equation model (SEM) it has been determined to what degree is the model adapted to the results of the questionnaire. The structural equation model is merely the approximation. By using it, it is not possible to answer the question: "Is the model ideally adapted?" but rather: "Is the model satisfyingly adapted in order to be used as approximation?" [28]. The indices of the structural model adaptability to the questionnaire results are presented in Table 4.

Table 4. Indices of the structural model adaptability to the questionnaire results

Index	Index value
Goodness of Fit Index (GFI)	0.81
Adjusted Goodness of Fit Index (AGFI)	0.75
Normed Fit Indeks (NFI)	0.86
Non-Normed Fit Index (NNFI)	0.97
Comparative Fit Index (CFI)	0.97
Chi-Square/df	1.13
Root Mean Square Error of Approximation (RMSEA)	0.048

According to the shown indices one can conclude that the structural model is marginally adapted to the questionnaire results since the size of some indices suggests that they have a satisfying level of adaptability (NNFI, CFI, Chi-Square/df, RMSEA), while the GFI, AGFI and NFI indices with values less than 0.9 [11, p. 45.] demonstrate the unsatisfying level of adaptability and consequently the necessity to modify the model.

5. CONCLUSION

Defining principal quality attributes as universal and, at the same time, specific feature of the delivered port service aims at understanding the port user's needs and demands. In the present research, based on the collected data and by using the factor analysis, an attempt has been made to reduce the originally large number of attributes to a smaller number with some common features. Based on the factor structure after VARIMAX rotation, 15 attributes, indicating two non-measured groups associated in common factors, have been set out. One can conclude that the attributes of the first factor explain best the reliability of the port service delivery and, therefore, the first factor has been named *reliability*. The attributes of the second factor explain best the competence of the service delivery hence the second factor has been named *compe-*

tence. Thus, the hypothesis, put forward at the beginning of the research that the two dimensions of the port service quality - reliability and competence are best explained by the original attributes, has been verified.

The obtained results will be used in further researches aiming at measuring the quality and thus at contributing to develop as well as to encourage competitiveness on the port service market. Despite the authors' opinion that the results of this research are scientifically founded and applicable, still the research has some limitations. The first limiting factor is the sample size and the doubt whether the students, attending the final courses of the Rijeka Faculty of Maritime Studies, are really competent to judge the importance of the various attributes in the perception of the port service quality. In the present research the questionnaire method has been used, so the fact that other methods (interview, for instance) have not been adopted could be considered as a limitation, too. For this study only two dimensions of the service quality have been chosen and this could be regarded as another limiting factor.

Further researches should overcome these shortcomings enlarging the sample size, conducting the survey or interview on the port service users (shippers and freight forwarders) and taking into consideration all the attributes that reflect the user's demands and needs.

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Sažetak

DEFINIRANJE MODELA KVALITETE LUČKE USLUGE METODOM FAKTORSKE ANALIZE

U ovom je radu prikazana metodologija izbora mogućih atributa koji utječu na percepciju kvalitete lučke usluge. Svrha istraživanja je sažimanje velikog broja atributa kvalitete lučke usluge na manji broj atributa koji se mogu grupirati u zajedničke faktore, što je rezultiralo strukturnim modelom kojeg se jednostavnije može protumačiti i testirati na konkretnom primjeru.

Autori su postavili hipotezu da prikazani atributi najbolje objašnjavaju dvije dimenzije kvalitete lučke usluge: pouzdanost i kompetentnost. Metodom glavnih komponenata napravljen je optimalan izbor atributa, a eksploratornom faktorskom analizom distribucija atributa po faktorima. Primjenom konfirmativne faktorske analize definiran je strukturni model za koji je utvrđena prilagodljivost rezultatima provedene ankete na uzorku studenata Pomorskog fakulteta u Rijeci.

Ključne riječi: *atributi kvalitete, lučka usluga, faktorska analiza, strukturni model*

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