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EVALUATION OF THE ON-LINE COMMERCIAL SERVICE QUALITY BASED ON ASSOCIATION RULES

OCENA JAKOŚCI USŁUG HANDLOWYCH *ON-LINE* NA PODSTAWIE ANALIZY REGUŁ ASOCJACYJNYCH

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Summary: The existing approaches to the evaluation of on-line commercial services quality include various quality indicators. The application of multiple attributes for quality evaluation enables and involves specialized analysis techniques to carry it out. This article proposes to utilize association rules in the quality evaluation of the on-line services. The analysis carried out of the discovered association rules has provided interesting dependencies and relationships on the individual characteristics of the on-line commercial service. On the basis of such an analysis, conclusions can be made regarding the general quality of the on-line commercial services. The discovered dependencies and connections can be used in shaping online commercial service quality. Conclusions from the analysis of the association rules can therefore be used to improve the on-line commercial service quality comprehensively which can lead to the higher satisfaction of e-customers.

Keywords: e-commerce, e-quality evaluation, e-customer satisfaction, association rules, data mining.

Streszczenie: Znane podejścia do oceny jakości usług uwzględniają różnorodne wyznaczniki jakości, co w konsekwencji umożliwia ocenę jakości usługi handlowej *on-line* w kilku płaszczyznach. Zastosowanie wielu atrybutów oceny jakości pozwala również na włączenie do jej przeprowadzenia specjalizowanych technik analizy. W pracy zaproponowano, aby do oceny jakości usług wykorzystywać reguły asocjacyjne. Przeprowadzona analiza odkrytych reguł asocjacyjnych wskazała interesujące zależności i związki dotyczące poszczególnych cech usługi handlowej *on-line*. Na tej podstawie można wnioskować na temat ogólnej jakości usług, z drugiej strony odkryte związki i zależności można też wykorzystać do modelowania jakości usługi handlowej świadczonej w Internecie. Wnioski z analizy reguł asocjacyjnych mogą posłużyć zatem do kompleksowego doskonalenia jakości usługi handlowej świadczonej za pośrednictwem Internetu, co może się przełożyć na uzyskanie wyższej satysfakcji e-klientów.

Słowa kluczowe: *e-commerce*, jakość usług handlowych *on-line*, satysfakcja e-klienta, reguły asocjacyjne, *data mining*.

1. Introduction

Today, e-commerce is a common way of making purchases, but this business process cannot be limited only to the act of making a purchase through the website, but also as a complex on-line commercial service. The Internet provides a commercial service via material elements such as the retailer's web page, the stock on its own and suppliers, and additionally non-material elements including the services as part of the transaction, as well as pre-sales and after-sales support.

Nowadays customers, more frequently than before, pay attention to the quality of e-commerce. Therefore the aim of the Internet retailers is to improve such a service as much as possible. Competition is no longer limited to the offer or the price as the source of competitive advantage, it could also be the quality of the commercial service provided when shopping on-line.

To evaluate and then shape the quality of the on-line commercial service, many methods and tools have been developed and presented in the literature on the subject. This paper proposes to include the technique of discovering the association rules regarding the methods of evaluation of quality in e-commerce services. The aim of this paper is to show that through the use of the analysis of the association rules, interesting and valuable patterns of related attributes can be extracted for the improvement of the quality of on-line commercial service. The improvement of quality in terms of the attributes remaining in correlation may contribute to a more comprehensive and effective structure of on-line commercial services quality in contrast to one based merely on the evaluation of the quality resulting from the application of the traditional, multi-attribute evaluation methods.

2. On-line commercial service and its quality

The commercial service generally is defined as the process of sales of goods as the effect of commercial activity, interceding producers of goods with their purchases [Newman, Cullen 2005]. It is also an action aimed at delivering the assortment of products with some value added [Merrilees, Miller 2001]. The definition of a commercial activity delivered through the Internet should only be supplemented with information, that it is (partly or completely) delivered through the IT network.

The on-line commercial service should be perceived from the perspective of the added value that Internet shopping provides the purchaser with the object of the transaction, which vitally influences the satisfaction level of customers [Dobski 2012].

The quality of the commercial services delivered through the Internet may be defined variously and multi-dimensionally. Based on definitions and theories of quality precursors such as P. Crosby, J. Juran, Ch. Grönross and ISO Standards, the quality of on-line commercial services may be understood as the congruence between the on-line commercial service and the customer's demands. It can also be perceived

as the level of satisfaction of the recipient's expectations of that service. Quality comprises all features of the service which form its ability to satisfy clearly described or predictable needs. Finally, the quality of on-line commercial services may be described as the level of preference of a given service against the other or others, in the user's opinion. J. Santos [2003] defined e-service quality as the overall customer assessment and judgment of e-service delivery in the virtual marketplace. E-service quality is a function of how the web facilitates effective shopping, purchasing and delivering of products and services [Zeitham, Parasuraman, Malhorta 2000].

In the research of quality in the e-commerce domain, the following quality evaluation methods have been proposed: ServPerf [Zhang, Lin, Ren 2010], Servqual – transformed to e-Servqual [Van Iwaarden et al. 2003; Lee, Lin 2005; Parasuraman, Zeithaml, Malhotra 2005], QFD = Quality Function Deployment [Kuo, Chen 2011], FMEA = Failure Mode and Effect Analysis [Waterworth, Eldridge 2011], SixSigma [Alhyari et al. 2011], Kano [Kuo, Chen 2011], etc. There have been developed various indicators¹ of the on-line commercial services quality and scales of its measurement and evaluation, e.g. Web Assessment tool [Schubert, Selz 1997], SITEQUAL [Yoo, Donthu 2001], WebQual [Barnes, Vidgen 2002], E-S-QUAL [Parasuraman, Zeithaml, Malhotra 2005], E-Rec-Qual [Dolatabadi, Pool, 2013], etc. were all referred to. Therefore it can be concluded that quality evaluation in the e-commerce in the utility aspect is possible based on the number of various, more or less complex methods of assessment and including the broad spectrum of the evaluation criteria.

Based on the literature review on research of the on-line commercial services quality, in this paper a multidimensional model for the quality evaluation of the commercial services has been proposed. The model allows to evaluate the quality of the on-line commercial service in the three following dimensions:

1. Formal – related to the legal requirements which are set out for the vendors selling on the Internet and the requirements which can be acknowledged as obligatory or standard to be followed in commerce.

2. Procedural-functional – related to the attributes of the shopping web page delivering functions (or supporting them) allowing for the realization of the specified elements of the process while providing the on-line commercial service. This approach is determined by the mode of realization of the commercial service and refers to the customer service via the web page and is also related to the functionality and utility of the on-line shop.

3. Technological – regarding the technology and standards used for the needs of Internet service implementation. These attributes refer to the technology used to design the on-line shop website². The technological dimension of assessing the on-

¹ To become familiar with the proposed attributes (beside the ones presenting the measurement scales) please refer to the following works: [Burgess 2004; Ramanathan 2010].

² Indicators of the technological quality result mostly from the recommendations of the Consortium W3C, which deals with preparing the standards concerning the design of the online web pages. More in: [Consortium W3C].

-line commercial services quality may be therefore defined as a website background which determines its characteristics and functionality.

In each dimension the indicators of quality evaluation can be proposed (included in Tab. 1). For the quality attributes (= A) detailed characteristics were defined (= C) of the on-line commercial service.

Table 1. Proposed quality indicators of the on-line commercial service

Formal quality attributes	Individual characteristics
1	2
The method of the information presentation (A1)	Details of the information available on the store's web page and given by the staff and compliance with the actual state, (C1)
	Update of the web page content, (C2)
	Informing on the availability of the goods and services, (C3)
Company's identification (A2)	Posting on the web page all data concerning the seller – the name, address, contact information (phone numbers, e-mail addresses), legal form, identification number of the registration activity, (C7)
Sellers' image (A3)	Allowing the customers to share their opinions and posting them on the web page, (C4)
	Quality certificates, recommendations of the institutions and professionals, distinction of the trademarks of the sold brands, (C5)
Sellers' reliability (A4)	Simplicity, visibility and availability of the rules and regulations of the provided services, (C6)
	Visibility of the pricing policy, (C8)
	Transparency of making complaints and withdrawal from the agreement, (C9)
	Transparency of the range of the given warranty, (C10)
	Lack of irritating advertisements and lack of sending of promotional materials without the consent of the consumer, (C11)
Personal data protection (A5)	Transparency of the privacy policy, (C12)
	Declaration of data encryption, (C13)
	Minimization of the range of data acquired from the customers, (C14)
	Question for the consent on the processing of data, possibility of insight into the data and its modification, (C15)
Technological quality attributes*	Individual characteristics
Availability of the sales portal (A6)	24/7 shop availability, its reliability and efficiency, (C16)
	Presence (perceptibility, visibility) in the search engines results and sponsored links, (C17)
Functional-procedural quality attributes	Individual characteristics

Table 1, cont.

1	2
Support from the web page and its complexity (A7)	Availability of the help system explaining the procedure of making an order, (C18)
	Availability of the suggestion system for filling in the forms and indicating in the forms the fields filled incorrectly, (C19)
	Possibility of realizing all the desired service activities exclusively via the web page (gathering information on the offer, seller, conditions of purchase, contact, ordered post-sales service), (C20)
Utility of the web page (A8)	Ease of navigation on the web page, simplicity and transparency of the menu, (C21)
	Speed in reaching the interesting information and availability of the internal search engines making it easier to find the searched product or information, (C22)
	Transparency and readability of the information included on the web site, (C23)
	Availability of the web page in other language versions and adaptation of the web site for the needs of the disabled, (C24)
Visualization of the offer (A9)	Use of high quality multimedia for the presentation of the offer (photos with the zoom option, presentations, movies), (C25)
Cart functionality (A10)	Presence in the shop of the virtual shopping cart, (C26)
	Allowing the choice of making a purchase with registration and without it, (C27)
	Allowing to return to the previous stages of the order to modify them, (C28)
	Allowing for the automatic recalculation and actualization of the cart contents, (C29)
	Allowing for the display of the summary of the made order, (C30)
Communication (A11)	Variety of the forms of contact, (C31)
	Level of engagement of the personnel in solving the customer's problem, (C32)
	Speed of giving an answer to a question, (C33)
	Confirmation of the realization of the stages of the order via mail, (C34)
Customer's participation (A12)	Availability of the offer configurators or forms for expression of wishes, special needs concerning the delivery, (C35)
	Option of registration and having a member account, (C36)
	Availability of choice from among many forms of payment, many forms of delivery and delivery date, (C37)
	Possibility of price negotiation, (C38)
	Fulfillment by the sales portal of the function of the conductor of the promotion-advertisement campaign, (C41)
Post sales service (A13)	Availability of the forms for filing complaints, returns or withdrawal from the agreement, (C39)
	Possibility to check history of orders (C40)

* In the proposed catalogue of technological quality attributes, there were included only those attributes which were possible to evaluate by respondents who were consumers of the on-line shops.

Source: own work.

The indicators presented above allow performing a multidimensional evaluation of the quality of the on-line commercial services. E. Cristobal et al. [2007] noticed that the most of the e-commerce quality studies are guided mainly in three different areas: on-line sales service quality, quality of Internet shop's website design and on-line service quality. The proposed evaluation model, therefore consolidates the current fields of quality studies of the on-line commercial services which allows for their more complex evaluation.

3. Association rules and their use in commercial e-services

Discovering the association rules is one of the techniques of *data mining*. The aim of data mining is to extract the useful information from large portions of data. The origins of discovering the association rules date back to the problems considered in context of the market basket analysis (MBA), which by definition involve searching for the co-existing shopping patterns in the data pool concerning the transaction. On this basis, the rules concerning association, the relations between the elements of the databases and their sequencing can be created. Analysis of the associations is considered as a valuable expansion of the reporting tools as it gives a new perspective on the accumulated data [Shmueli, Patel, Bruce 2010].

Association rules provide information in the form of the statement: "if A then B", where A and B are attributes. Attribute 'A' in a rule is an antecedent, 'B' – is a consequent. Contrary to the rule of logic, an association rule has probabilistic characteristics. The quality of the rule is dictated by two indicators:

- *Support* – this indicator corresponds with the percentage of observations including both characteristics being an antecedent and a consequent. A measure is calculated according to the formula:

$$\text{support}\{A \rightarrow B\} = \frac{N_{A \rightarrow B}}{N}.$$

- *Confidence* – this indicator is measured by the share of observations including characteristics being an antecedent and consequent among the transactions including only an antecedent. An indicator is calculated as follows:

$$\text{confidence}\{A \rightarrow B\} = \frac{N_{A \rightarrow B}}{N_A} = \frac{\frac{N_{A \rightarrow B}}{N}}{\frac{N_A}{N}} = \frac{\text{support}\{A \rightarrow B\}}{\text{support}\{A\}}.$$

Support factor is a probability that a transaction randomly chosen from the database includes both an antecedent and a consequent; a confidence factor, on the other hand, is a conditional probability that a transaction randomly chosen from the database will include all those predetermined of the consequent relative to the antecedent (more in: [Agrawal, Imielinski, Swami 1993; Agrawal, Srikant 1994; Olson, Shi 2006; Rajamaram, Ulmann 2012]).

One of the most popular and widely used approaches for determining the association rules is one based on the Apriori algorithm. The approach is based on counting the transactions to find frequent item sets (all combinations of items whose support is greater than minimum support) and then derive association rules from the obtained frequent item sets (more in: [Kumar, Verma 2016; Goswami, Chaturvedi, Raghuvanshi 2010]).

Discovering the association rules can have a broad application, for example in commerce [Ahmed 2004]. Discovering the association rules technique allows to determine, e.g. the shopping preferences of the clients. This method is also used in planning promotions, corrections of the selling prices and marketing actions [Kamakura 2012]. A retailer can use this information in planning the store layout and put products that co-occur together close to one another to improve the customer's shopping experience.

The analysis of the association rules is also being used in e-commerce – e.g. while searching for the connection between the purchases made in a particular period of time, searching for the preferences of the customers concerning the on-line advertisements in order to improve the efficiency of the marketing campaigns, searching for the relations between answers given by the respondents or customers' comments about unspoken needs and requirements [Natarajan, Shekar 2005; Kohavi, Provost 2001; Liao, Chen, Lin 2012; Karimi-Majd, Mahootchi 2015]. The results of the association rules analysis may be used to drive recommendation engines and to build recommendation systems [Hemalatha 2012; Liao, Chen, Lin 2011] implemented discovered association rules to increase the on-line shopping and home delivery business model for hypermarkets' sales services. Due to that model, they expected to attract more customers.

On-line retailers can use association rules in planning the placement of content items on their websites, or the location of products in their catalogue. In addition, the results of association analysis can be used in targeted email marketing [*Market Basket Analysis...*].

The method of discovering the association rules is applicable successfully in the analysis of the behavior of the on-line portals users, including commercial ones [Mobasher 2005; Fu, Budzik, Hammord 2000; Vijaylakshmi, Mohan, Suresh Raja 2010].

A new example of the analysis of the association rules application can be an evaluation or the shaping of the quality services and business processes. The association rules were used by Carmona et al. [2012] for establishing crucial factors important from the point of view of designing of websites.

In this paper it is proposed to use an approach based on discovering the association rules for the evaluation of the quality of the on-line services, then formulating proposals for modeling appropriate quality services.

4. The methodology of the study

The following article is linked to the broader research concerning the evaluation of the quality of the on-line commercial services in the maritime e-commerce domain (that is the segment of the e-commerce market of which the object of the transactions are retail goods and services connected to the maritime economy).

It was assumed in the research that the quality indicators of the commercial services are the characteristics presented in Section 2 of this work (Tab. 1). The respondents, customers of the maritime internet shops, in the on-line survey were supposed to assess the degree of satisfaction of expectations towards each of the characteristics of the formal, technological and functional-procedural dimensions. The following grading scale of customer expectation satisfaction has been assumed with respect to the individual characteristics of the maritime e-commerce commercial service:

1 = customer expectations were not met at all (on-line commercial service quality very low),

2 = customer expectations were not met in most cases (low quality of the on-line commercial service),

3 = customer expectations were met in a moderate amount (average quality of the online commercial service),

4 = expectations were met in most cases (high quality of the on-line commercial service),

5 = customer expectations were met in full or were exceeded (very high quality of the on-line commercial service).

The survey questionnaire was divided into two parts. In the first part the respondents were assessing the quality of the maritime e-commerce commercial service in the formal and technological aspects, in the other part of the questionnaire – in the functional-procedural aspect. The results of the research will be presented while maintaining this division.

Based on the results of the research it was possible to make conclusions regarding the degree in which the expectations of the customers towards the particular characteristics of the commercial service are met in the maritime e-commerce and the size of the quality gap, which, however, is not a subject of this work. Whereas the cognitive questions in the following work were constructed as follows:

- Was the degree of evaluation of customer expectations satisfaction in the case of some characteristics related to the evaluation of the expectations satisfaction in connection with other characteristics?
- What are the relations between the characteristics which were assessed poorly due to the degree of fulfillment of the expectations of the respondents with other characteristics?

For this purpose the data obtained from the survey research was used in discovering the association rules. The analysis was carried out in the R environment (Rattle)³.

³ R for Windows v. 3.2.2. – available under the address <https://cran.r-project.org/bin/windows/base/>. Instruction manual included.

To reveal the association rules in the ways of evaluation of the individual characteristics it was necessary to establish the minimal levels' indicators referring to *support* and *confidence*. The arbitrarily adopted levels of the indicators in the individual groups of evaluation, along with the acquired number of the association rules, are presented in Tab. 2. Thresholds were set which guarantee obtaining of so-called strong rules.

Table 2. Minimal levels of the support and confidence indicators in the individual parts of the analysis

Databases	Indicators levels and no of rules
Evaluations concerning formal and technological quality	Support: 25% Confidence: 70% no of rules: 857
Evaluations concerning functional-procedural quality	Support: 40%* Confidence: 70% no of rules: 608

* Original minimal level of the indicator was intended to be 25%, however the number of the acquired associations was too high for the software to display them in detail. The minimal level of the indicator was raised to 40% acquiring a still numerous set of valuable rules.

Source: own work.

The discovered association rules were used to formulate conclusions concerning the general evaluation of the on-line commercial service. Furthermore, attention was focused on the associations of the characteristics which did not satisfy the customers; this was treated as guidelines for formulating the range of activities improving the quality of the on-line commercial service.

5. The results of research and analysis

5.1. Evaluation of formal and technological quality of the on-line commercial service based on association analysis

It results from the analysis carried out of the association rules that maritime on-line shops, in terms of the realization of the formal and technological characteristics, have a rather consistent and well prepared strategy. In most of the rules, if the characteristic which was an antecedent was assessed as mostly satisfying the expectations of the customers, then satisfaction in reference to the occurrence of the other characteristic being consequent was perceived as equally satisfying by the respondents.

In the discovered association rules some identified features were characterized by the high frequency of occurrence⁴ (for example: C3, C7, C11, C12, C13, C14, C15, C17). Therefore it can be concluded that the researched maritime on-line

⁴ Extractions of characteristics were made based on the charts of Relative Frequency.

shops, due to the care about the formal quality in their on-line commercial services, have made an effort to act under the provisions of the current law. Fulfillment of the obligations imposed by the law in terms of disclosure of the privacy policy, acquiring the customers' consent for the processing of their data, ensuring the possibility of viewing the data and its modification, additionally supported by the realization of such characteristics like the minimization of the range of data which the customer has left behind and the declaration of the encryption of such data, which customers assess as positive and are satisfied in this field. The occurrence of the listed characteristics in various combinations proves that maritime on-line shops, which in the opinion of the customers took care of their personal data security, simultaneously were making efforts to be reliable entities (identified), which did not use irritating advertisements and which updated information on the shop's offer on their web page.

The analysis of the obtained association rules has been carried out only for the cases with the highest support ratio. Table 3 presents the selected rules, with the highest mentioned ratio.

Table 3. Selected association rules with a high support ratio concerning the evaluation of the expectations satisfaction of customers of the maritime on-line shops in relation to the formal and technological characteristics of the on-line commercial services

Rule no.	If (antecedent)	then (consequent)	Support	Confidence
1	C12 = (3,4]	C14 = (3,4]	0.4705882	0.8275862
2	C1 = (3,4]	C2 = (3,4]	0.4705882	0.7741935
3	C6 = (3,4]	C8 = (3,4]	0.4509804	0.8214286
4	C17 = (3,4]	C8 = (3,4]	0.4509804	0.7931034
5	C15 = (3,4]	C14 = (3,4]	0.4509804	0.7666667
6	C7 = (3,4]	C14 = (3,4]	0.4313725	0.8461538
7	C16 = (3,4]	C8 = (3,4]	0.4313725	0.8148148
8	C2 = (3,4]	C8 = (3,4]	0.4313725	0.7096774

Source: research results of the R for Windows.

These rules can be interpreted in the following way (based on the example of rule 1) – if fulfillment of characteristic no 12 'transparency of the privacy policy' was well assessed by the respondents (expectations mostly satisfied) then fulfillment of characteristic no 14 'minimizations of the range of data acquired from the customers' was also well assessed. In 47% of the surveys, satisfaction of the expectations in regard to the characteristics no 12 and 14, the respondents assessed as on the good level. 82 % of persons who assessed satisfaction of the expectations in regard to characteristic no 12 on the level 4 (on the 5 point scale), assessed the satisfaction of the expectations regarding to the characteristic no 14 identically.

Based on the rules above it can be concluded that:

- On one hand maritime on-line shops therefore fulfilled their obligations established by law in terms of personal data protection of the customers. On the other hand, they themselves did not need the excess amount of data from the customers (see rule 1, 5 and 6). This can be viewed as a sign of attention to quality – the necessary data is collected, the number of mistakes is minimized during its input, it is easier to gather them and analyze, providing them is customer friendly and does not constitute for the eventual resignation from the finalization of the on-line commercial service, if such data needs to be submitted. Furthermore, although the shops minimized the range of the gathered data, they left such a range of information useful for identification which was satisfactory to the customers.
- If the maritime e-shop had simple, clear and easily accessible rules and regulations of the services and the content of the web page was updated, then the price policy of the shop was also clear to the customers – see rules 3 and 8. This proves that all terms and conditions of buying in the maritime on-line shops were transparent to the customers.
- Online shops giving funds for the positioning and optimization of the Internet portals (or doing so on their own), in order to get ahead of the competition and to be more visible (higher) in the search results as well as making sure that their sales portal always works without any interference, made sure that after the customer has entered the web page, his/her trust has not failed and that the shop displays the price terms of the transaction precisely (see rules 4 and 7).
- The effort was made so that the customer was best informed about the offer (see rule 2). Posting of the detailed information on the web page is not enough – the customer needs to be sure that the information given to him/her by the web page or the personnel is true, reliable but most importantly updated. A well-informed customer who is assured of the collected information very often does not look for additional contact – this favors the faster realization of the on-line commercial service and makes higher customer satisfaction more possible.

However, particularly noteworthy, due to the shaping of the quality of the on-line commercial services, are rules in which both formal and technological characteristics occurred which were unsatisfactory to the customers. These rules were contained in the table below.

Based on the above rules, characteristics can be extracted which should be particularly noteworthy to the maritime Internet retailers. Improvement of the quality should mainly concern such aspects as:

- Transparency of the range of warranties provided by the seller – despite the updates of the web pages, transparent price policy and visibility of the web pages in the search results, and despite the perceived transparency of the privacy policy, customers of the maritime on-line shop had restrictions towards the transparency of the range of the provided warranties i.e. they had trouble with acquiring information on this matter (see rules 9, 10 and 12).

Table 4. Listing of the association rules indicating the low evaluation of the quality of the on-line commercial service – formal and technological

Rule no.	If (antecedent)	Then (consequent)	Support	Confidence
9	C2 = (3,4], C8 = (3,4], C17 = (3,4]	C10 = (2,3]	0.2549020	0.7647059
10	C12 = (3,4], C17 = (3,4]	C10 = (2,3]	0.2941176	0.7500000
11	C4 = (2,3]	C10 = (2,3]	0.2549020	0.7222222
12	C8 = (3,4], C12 = (3,4], C17 = (3,4]	C10 = (2,3]	0.2549020	0.8125000
13	C4 = (2,3]	C9 = (2,3]	0.2549020	0.7222222
14	C5 = (2,3]	C8 = (3,4]	0.2941176	0.7894737
15	C9 = (2,3]	C8 = (3,4]	0.2941176	0.7894737

Source: research results of the R for Windows.

- Enabling the customers to post their opinions and making them public on the web page – the transparency of the range of warranties shared by the seller also raised objections if the maritime on-line shop did not enable the customers to post their opinions and did not make them public on the web page – see rule 11. Therefore in the range of both characteristics, improvement actions are necessary.
- Transparency of making a complaint and withdrawal from the agreement as well as allowing the customers to share their opinions on the quality of the provided services and making them public on the web page – if the maritime on-line shop did not allow the posting of opinions for the customers in a sufficient way and did not publish them on the web page, then the customers were not satisfied in terms of transparency of the procedure of making a complaint and withdrawal from the agreement (see rule 13). Customers assessed the satisfaction of their expectations as barely average in terms of the above mentioned characteristics of the on-line commercial service, which proves the necessity of improvement of the quality in that aspect. However, in the maritime e-shops in which insufficient procedure of making a complaint and withdrawal from the agreement were displayed, customers were satisfied with the transparency of the privacy policy after all – see rule 15.
- Publishing on the web page of the quality certificates, institution and professionals' recommendations and display of the trademarks of the brands sold in the shops – in maritime e-shops in which the customers were satisfied with the transparency of the privacy policy, the above mentioned certificates of the seller's image were disclosed in a sufficient way – see rule 14.

The aspects of the commercial service non-satisfactory to the clients prove that despite the seemingly consistent strategy of realization of the on-line commercial service, in terms of characteristics, especially formal ones, deficiencies can be observed. What is interesting is that if the above characteristics were not realized properly then usually the on-line shops did not allow in a sufficient way to post

opinions on them and their commercial services quality. Conceivably the lack of possibility to post opinions by the customers is related with the deficiencies in the maritime e-retailer's dealings concerning the withdrawal from the agreement, complaints and returns and provided warranties, which would be viewed as especially unfavorable from the viewpoint of the on-line commercial services. It was also proved that customers appreciate the maritime on-line shops for respecting their privacy and the data provided, but expect from the on-line retailer to publish (apart from the data used for identification) the data which would certify the retailer's image and would be a guarantee of quality of the realized on-line commercial services. It is therefore recommended to publish information on the certifications of the sales activity, recommendations on building a positive image with the use of well-known brands.

5.2. Evaluation of functional-procedural quality of the on-line commercial service based on association analysis

In the identified association rules, good evaluations predominated as to the satisfaction of the customers' expectations in terms of the individual functional-procedural characteristic (assessment of 4 on a 5 point scale). If the expectation towards the antecedent characteristic were mostly satisfied then the satisfaction of the expectations towards the consequent-characteristic was assessed on the same level.

A group of characteristics of high frequency of occurrence can also be detected. In the rules, in various configurations, from 2 to 3 from the below mentioned functional-procedural characteristics were occurring frequently the characteristics: C22, C23, C26, C27, C28, C29, C37. Taking into account the characteristics occurring numerously in the association rules of a high degree of certainty, it can be concluded that the combined occurring of the characteristics was especially related to such attributes of the on-line commercial service as the web page's utility, cart's functions and participation of the customer. Transparency and readability of the information contained on the page was often positively assessed by the customers, especially in connection to the speed of reaching the necessary information thanks to, among others, the availability of the internal search engines on the shop's web page, as well as individual functions of the shopping cart – from the fact of its functioning on the maritime shop's web, through its automatization and availability of functions related to making choices by the buyer resulting in the co-decision on the final shape of the on-line commercial service. Especially the functions of the shopping cart show a well developed, consistent and complex strategy concerning the functional-procedural attributes. Buyers appreciated the fact that the shopping cart included elements such as the possibility to make a choice of purchase with or without registration (a simplified cart), returning to the previous stages of the order to modify and automatically recalculate and update its contents.

The rules chosen for the further application among the ones occurring in the significant percentage of the questionnaires were the ones with the highest support indicator – above 50% (see the table below).

Table 5. Chosen association rules with a high support indicator concerning evaluation of the satisfaction of the maritime on-line shops customer's expectations in relation to the functional-procedural characteristics of the on-line commercial service

Rule no.	If (antecedent)	Then (consequent)	Support	Confidence
16	C22 = (3,4]	C23 = (3,4]	0.6037736	0.8888889
17	C36 = (3,4]	C27 = (3,4]	0.5849057	0.8157895
18	C23 = (3,4]	C19 = (3,4]	0.5849057	0.8157895
19	C27 = (3,4]	C18 = (3,4]	0.5849057	0.8157895
20	C18 = (3,4]	C19 = (3,4]	0.5849057	0.7948718
21	C27 = (3,4]	C19 = (3,4]	0.5660377	0.7894737
22	C19 = (3,4]	C20 = (3,4]	0.5660377	0.7894737
23	C21 = (3,4]	C23 = (3,4]	0.5471698	0.8787879
24	C40 = (3,4]	C36 = (3,4]	0.5471698	0.8787879
25	C37 = (3,4]	C27 = (3,4]	0.5471698	0.8055556
26	C22 = (3,4]	C36 = (3,4]	0.5471698	0.8055556
27	C23 = (3,4]	C18 = (3,4]	0.5471698	0.7631579
28	C27 = (3,4]	C20 = (3,4]	0.5471698	0.7631579
29	C18 = (3,4]	C20 = (3,4]	0.5471698	0.7435897

Source: research results of the R for Windows.

The conclusions from the analysis of the above rules are as follows:

- The designers made an effort for the maritime on-line shops to be readable, transparent, comprehensive and easy to use for the buyers, not only in terms of the navigation on the web page and help system but also in terms of the individual stages of the on-line commercial service operations (see rules 16, 18, 23, 27).
- The on-line commercial service was possible to realize quickly without unnecessary formalities (therefore suggestions were included in the forms), and so the rules of sales were easily accessible and comprehensive to each customer (see rules 19 and 21). Freedom of making purchases without formalities was also appreciated by the customers who in addition highly assessed on-line shops for their possibility of registration and having a member account which is, in a way, some sort of commitment of the parties (shop and the customer) in regard to sustaining their further relations (see rule 17).
- Simplicity of making a purchase is accompanied by the complexity of the commercial service – minimization of the formalities does not exclude the broad range of the customer service via the web page nor the large selection of options in terms of realization of the individual stages of the on-line commercial service (see rules 25 and 28).
- Complexity of the range of the on-line commercial service possible for realization through the maritime on-line shop web page could mean that for the occa-

sional on-line buyer making an order is a complicated action. Meeting the needs of such customers, designers of the maritime on-line shops made effort to post all instructions and suggestions to possibly simplify this process. Such actions also contribute to the complete and satisfactory fulfillment of the needs of all customers, also the new ones (see rules 20, 22 and 29).

- The customers eager to make lasting relations with the seller, reaching beyond the utility of the web page (especially in the context of possibly fast reaching the necessary information) point also to the possibility of the after sales service. Insight of the customer to the history of orders may greatly accelerate repetitive purchases (see rules 24 and 26).

From the above analyzed rules it can be concluded that maritime on-line shops have web sites equipped with various functionalities thanks to which the customer may, in the fastest possible way, make a self-service purchase. Therefore it can be further assumed that in terms of the functional-procedural dimension of the on-line commercial service, designers of the maritime on-line shops realize the well-thought-out strategy. This is however, partly due to the fact that, among other features, many on-line shops are designed based on the ready-made frameworks dedicated to the e-commerce, with which it is enough to activate (turn on) the chosen functions. High evaluation of the quality in this aspect therefore does not have to be merited only to the designers or the web page administrators, but can be a derivative of the use of the ready-made solutions of e-commerce.

In the identified association rules an attempt has been made to find particularly those ones in which some of the characteristics were evaluated lower than the others. Similarly, as in the case of the formal and technological characteristics, the lowest evaluation which occurred in the association rules corresponded with the satisfaction of the expectations of the respondents in relation to the characteristics on the average level (level 3 in the 5 point scale). The rules indicating the low evaluations of the quality of the on-line commercial service in the functional-procedural aspects are included in the table below.

Table 6. Listing of the association rules indicating the low evaluations of the quality of the on-line commercial service – functional-procedural characteristics

Rule no.	If (antecedent)	Then (consequent)	Support	Confidence
30	C20 = (3,4], C39 = (2,3]	C19 = (3,4]	0.3207547	1.0000000
31	C29 = (3,4], C41 = (2,3]	C28 = (3,4]	0.3396226	1.0000000
32	C39 = (2,3], C41 = (2,3]	C19 = (3,4]	0.2641509	1.0000000
33	C29 = (3,4], C39 = (2,3]	C28 = (3,4]	0.2641509	1.0000000
34	C22 = (3,4], C35 = (2,3]	C23 = (3,4]	0.2641509	1.0000000
35	C26 = (3,4], C41 = (2,3]	C23 = (3,4]	0.2641509	1.0000000

Source: research results of the R for Windows.

In all of the identified rules the low evaluation of the satisfaction of the customers' expectations occurred in relation to only three functional-procedural characteristics belonging to the attributes of the on-line commercial service related to the post sales service and participation of the consumer. Actions improving the quality of the on-line commercial service in the function-procedural aspect should be taken in particular in terms of the following characteristics:

- Sharing the forms for filing the complaints, returns or withdrawal from the agreement – this characteristic was not properly realized, though maritime on-line shops gained the approval of the consumers for enabling the realization exclusively through the web site of all the desirable service activities (from searching for the information on the offer through the post sales service) – see rule 30. Other forms (e.g. the contact form) on the web pages were accessible as the customers appreciated, at the same, time on-line shops for using the suggestion system in filling in the forms and indicating incorrectly filled fields in them (see rules 30 and 32). Consumers who were satisfied with the automation, recalculation and updating of the shopping cart are, at the same time, pleased with the possibility of returning to the previous stages of the order to make modifications, would also expect availability on the page of such forms (see rule 33). From the above mentioned rules it can be concluded that even though shops generally serve the consumers comprehensively via the website, there are still deficiencies in terms of the post-sale service. Shops on the individual stages of the on-line commercial service frequently share various forms, their filling in is made easier through the system of suggestions and validation. However, in the opinion of the consumers, there are shortages of such forms for filing complaints, returns or withdrawal from the agreement. Consumers expect a composite, provided in a comprehensive way on-line commercial service – from the pre-sales service, during making a transaction, as well as after it. Transparent procedures in terms of the post-sales service and sharing the tools necessary for its realization on the web page can elevate consumer satisfaction and cause the return of the customer in the future despite the unsuccessful purchase. Lack of suitable forms concerning the returns, complaints or the withdrawal from the agreement enhances customer dissonance, as in order to solve the problem with the unsuccessful purchase it makes it necessary to make him/her search for additional information which is perceived as the waste of his/her time.
- Promotion-advertisement campaign functions executed via the sales portal – customers appreciated maritime on-line shops for the existence of the shopping cart, its automatization, recalculation, updating the contents and the possibility to return and modify the earlier stages of the order, but at the same time were dissatisfied with the portal serving as the promotion-advertisement campaign channel, which can mean that the customers expect that the shopping cart will include the benefits resulting from the promotion campaigns or there will be the possibility of modifications in this scope (see rules 31 and 35). The evident lack

of this characteristic in the on-line commercial service was also acknowledged by the respondents who viewed the shop web pages as transparent, readable, informative, and helpful to the customer, especially in the context of the existence of the suggestion system on the form filling (see rules 32 and 35). It can be therefore concluded that customers would expect to be well informed in terms of current promotions via the sales web page and would expect the possibility of the benefits resulting from them on the shopping cart level – the existence of this characteristic is therefore related to the functionality of the cart and the utility of the web page from the customer's point of view.

- Availability of the offer configurators or forms for expressing wishes, special needs concerning the order – customers of the maritime on-line shops, especially those who appreciate the web pages of the shops for their transparency and readability of the information and speed in reaching the interesting information thanks to the internal search engines, are dissatisfied in terms of the availability of the offer of configurators and ready-made forms for expressing their wishes or needs (see rule 34). On-line customers probably appreciate the on-line shopping for its speed, time saving, but also for the fact that in the virtual space they can find a lot of information on the subject of an interesting offer. However, the complexity and richness of the offer may cause trouble in the choice of the most satisfying offer. Therefore, expectations towards the availability in the on-line commercial service of such tools and solutions which can make that choice easier are expressed. It turns out that in this respect, the available search engines and transparency of the offer are not sufficient. The expected offer configurators would contribute to an even faster and convenient ordering, but could also positively influence the satisfaction of the consumer, both with reference to the process of providing the online commercial service as well as to the choice of merchandise which best suits their needs.

6. Conclusions

The on-line commercial service provided by maritime e-commerce shops seems to be consistent, well developed and corresponding to most of the demands of the customers in each dimension of quality evaluation (formal, functional-procedural and those technological ones which respondents could verify). The analysis indicated that aspects which need to be improved are the ones which give the statement of good image and the seller's reliability. Customers also expect an improvement of the utility of the on-line shops web page, increasing the functionality of the shopping cart and raising the range of participation of the customer in the process of providing the on-line commercial service.

The use of the association rules for the research of quality of the on-line commercial service seems to be fully justified. The data mining technique allows for using data acquired from the survey research in another, different way. Data

concerning the level of satisfaction of the customers' expectations towards the on-line commercial service, also has to be interpreted in a straightforward way, which means to recognize the size of a quality gap which needs to be eliminated. The recognition of correlations in the evaluation of particular characteristics may contribute to a more effective quality development, as it then allows for improving all of the characteristics which are related. Improvement of quality in only one of the characteristics could not fully satisfy the customers. Therefore the application of the association rules analysis allows not only for reaching the conclusions concerning the quality of the on-line commercial service, but also fostering its comprehensive improvement.

Further research related to the on-line commercial service will be focused on the broader use of the analysis of the association rules. The possibility of the association rules application is interesting from the aspect of determining the causes of abandoning the shopping cart by the e-customers. Another aspect of the research is the one identifying the correlation between the satisfaction of the customers from the commercial service and further purchases in the same on-line shop. Also it would be interesting to use other data mining methods (for example decision trees) producing rules which could be implemented as rules for indicating the proper areas important from the point of view of the acceptable usability of the websites. Of course the analysis could be also carried out in other domains of e-commerce to obtain more generalized conclusions. The technique of discovering the association rules has therefore a huge potential for the research related to the quality of the services provided on the Internet.

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