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Development of Modified SERVQUAL–MCDM Model for Quality Determination in Reverse Logistics

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Abstract: To run a business successfully, quality determination and customer relations are very important factors. Therefore, it is necessary to measure quality and identify critical points of business. In this paper, an original integrated model for measuring the service quality of reverse logistics (RL) was developed for the company Komunalac Teslić, which was used as an example. The Delphi and Full Consistency Method (FUCOM) was applied to determine the significance of the quality dimensions, while a modified SERVQUAL (SQ) model was used to measure the service quality of the logistics. An original SQ questionnaire was formed with a total of 21 statements that were arranged in five standard dimensions. Examining the reliability of the questionnaire for quality dimensions using the Cronbach Alpha coefficient, it was found that the measurement scales for dimensions are appropriate in terms of user expectations, while in terms of quality perception there is no measurement scale for the empathy dimension. An extensive statistical analysis was then performed to verify the results. A Signum test was applied to identify the relationship between the responses in terms of expectations and perceptions, i.e., to examine their differences. The findings obtained by this research show that the expectations were higher than the perceived quality of the services and that there was a significant statistical difference for 12 of the SQ statements. For two statements, there was a significant statistical difference in favor of perceived quality compared to expectations. Based on the results obtained, the company must improve its services in order for service quality to be at a satisfactory level.

Keywords: quality; reverse logistics; sustainability; SERVQUAL model; waste management; Signum test; FUCOM

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1. Introduction

The globalization of business together with information technology development has influenced the changes that are happening in the market. The world market is available to all organizations and they can participate in it, which leads to increased competition in the market. Hoping to improve market competitiveness and ensure better long-term development, companies are devoting more and more attention to logistics. Strong, healthy, and well-operated logistics can be an efficient means to reduce costs and increase profit margins [1]. Social pressures, environmental legislation, and economic opportunities have put pressure on companies to increasingly advocate for sustainable development policies [2].

All of this has influenced companies to increasingly address the issue of how they affect the environment. This has motivated companies to establish the concepts of circular and green economies, as well as sustainable and environmentally friendly logistics development, with reverse logistics (RL) emerging as a means of strengthening their competitive position in the market and mitigating their environmental impact [3]. RL includes recycling and the reuse of materials and goods [4]. RL is part of logistics and its main task is to enable the return of products from the customer to the manufacturer in order to fully recycle the product or to separate the components that could be reused. The remanufacturing process is widely used in RL [5]. The main applications of remanufacturing are forecasting problems, production scheduling, capacity planning, production planning, and inventory management [2]. The focus of RL is to maximize the value of end-of-life products through reuse, refabrication, remanufacturing, recycling, and energy recovery of the products [6]. RL represents an important segment of sustainability due to aspects of the recycling process and green supply chain issues [7]. The proper application of RL not only creates a cleaner environment and allows for proper waste management, but it can also have a significant impact on a country's economic development [8].

Adequate waste management, including the implementation of RL, is one of the main challenges facing all countries. It is characteristic of Balkan countries to only recycle a small percentage of waste and to use RL rarely [9]. In addition, there is a generally negative perception of quality among consumers regarding the application of RL, and it is necessary to enhance efforts to raise awareness among consumers in the Balkans [10]. It is necessary to strengthen the citizens' awareness of recycling and introduce RL in Bosnia and Herzegovina (B&H) wherever possible in order to manage waste.

This research aims to determine the quality of services in RL for the utility company Komunalac Teslić by its service users using an original integrated SERVQUAL–MCDM model. The research, conducted at the company Komunalac Teslić, aims to identify and possibly eliminate certain shortcomings. Using the SERVQUAL model and its five dimensions: responsiveness, empathy, assurance, reliability, and tangibles, the service quality of the utility company Komunalac Teslić will be determined. The most important issues, i.e., goals, that this study addresses relate to the following:

Forming an original SERVQUAL questionnaire of 21 statements used for the first time in the literature of reverse logistics.

Forming an integrated model for determining the quality of service, using Delphi and FUCOM methods to identify the significance of dimensions.

Identifying where the biggest gap is in terms of expectations and perceptions of the quality of RL services in this company.

The application of this approach will enable the company Komunalac Teslić to improve the quality of RL services. In this way, the amount of waste in the city of Teslić will be reduced and the environment will be protected. Therefore, it is necessary to obtain feedback from users in order for RL to have better results in waste management.

Apart from the clear motivation and significance of this field of research, in this paper the literature related to RL is reviewed and the use of the SERVQUAL model in measuring the quality of services in logistics as support to create a good model is also reviewed. The main parts of the paper are research methodology, case study, and results. In Section 3, the research process is clarified, while the part related to the case study explains how the survey data were collected using the original SERVQUAL–MCDM model. Section 5 summarizes and explains the research findings with extensive statistical analysis, while the next part of the paper provides a discussion of the results obtained. Moreover, the most important conclusions reached by this research and the limitations and guidelines for future research are presented.

2. Literature Review

Reverse logistics is a term commonly used to describe the management of end-of-life products, and mostly refers to the terms reduce, reuse, remanufacture, and recycle [11].

Reduce is a term that refers to waste reduction in manufacturing and the packaging of products. The term reuse refers to the return of an unused product to the manufacturer in order to put the product back into use. The term remanufacture refers to a process of repairing, restoring, or overhauling products to extend their lifespan. Recycle refers to a process in which any component of a product that contains a certain value is returned to the manufacturer. RL should be designed outside the company and should not be limited by waste collection and recycling actions [12], but other activities should also be included to preserve the value and usefulness of materials for the longest possible period, which would make significant gains for the company's value chain [13]. Implementing RL helps reduce production waste and helps companies make a profit [14].

There are many reasons why business professionals and scientists turn their attention to RL, including the following: growing concern for the environment, competitive advantage, financial potential, legal reasons, and social responsibility [15]. RL is closely related to the elements of sustainability within supply chains [7]. Creating a sustainable supply chain and sustainability in business itself are the main conditions for competing in the global world market [16]. RL plays a significant role in many traditional efforts related to the sustainability of enterprises [17]. However, RL is not always required for a supply chain to be sustainable or environmentally friendly, but it is linked to the environmental awareness of enterprises [7]. Therefore, it is necessary to observe RL separately from a sustainable supply chain, since it is not an element of sustainability but plays a significant role in reducing the negative effects that a company has on ecology and the environment.

In contrast to the supply chain, i.e., logistics, RL starts from the final destination (customers) and ends at the place of origin (suppliers) [18]. Based on that, it can be stated that the user is a key participant in RL. Therefore, it is necessary to develop RL based on user expectations or increase existing customer satisfaction [19]. Increasing customer satisfaction is achieved by improving services. The improvement of RL services is achieved by improving the system of quality in companies. Quality management does not directly affect competitiveness, but it does affect certain dimensions, such as increasing customer satisfaction, attracting new customers, improving the image of companies and various other factors that lead to an improved competitiveness within companies and their market survival in times of crisis [20]. Quality management seeks not only to meet or exceed customer expectations but also to meet the expectations of other interested parties important to the company, e.g., the public, regulatory bodies, and suppliers [21].

In order to manage quality in RL, it is necessary to examine customer satisfaction, as this is key to RL. To achieve this, different models are used, and the most prominent is SERVQUAL. Wang et al. [22] showed that the SERVQUAL model was used the most and cited by researchers, and thanks to that the model significantly contributed to service quality research. Apart from that, many organizations have improved their quality after the application of the SERVQUAL model after obtaining poor results in the initial stage. In addition, SERVQUAL is a very useful tool for recognizing customer requirements [23]. The SERVQUAL model was known as the Gap Model, and it is used to measure quality in relation to expectations and the evaluation of performance [24]. The difference between expectations and the evaluation of performance is quality. If expectations are higher than the evaluation of performance, then the level of quality is low and vice versa.

Meidutė-Kavaliauskienė et al. [25] have proved that the SERVQUAL method is suitable for identifying sectoral value gaps in logistics and its application ensures competitive advantages. Prentkovskis et al. [26] proved the applicability of the SQ model in combination with a MCDM method using the example of a logistics service in an express post company. In their research applying SERVQUAL, Kilibarda et al. [27] proved that the quality of logistics services was not at a satisfactory level in Serbia. Using SERVQUAL, Knop [28] showed that the quality of the service provided by transport and logistics operators in the pharmaceutical industry was such that the expectations regarding the quality of services provided by these operators were higher than the actual quality level obtained for all dimensions of the service quality being evaluated. Limbourg et al. [29] examined the

quality of logistics services using SERVQUAL on a sample of 200 logistics service users in the city of Da Nang and showed that the customer support programs needed to be improved. Using the SERVQUAL model, Memić et al. [30] showed that the users were not satisfied with the logistics services of a passenger transport company since all the dimensions had negative values regarding the difference between the observations and the expectations. Czajkowska and Stasiak-Betlejewska [31] used the SERVQUAL method to measure the expectations and the perceptions of the quality of logistics services in companies operating in Eastern Europe and showed that the quality of the services in the areas of "Empathy" and "Materiality" should be improved. Roslan et al. [32] proposed a SERVQUAL-based model to measure the differences between customer satisfaction and desire in terms of the quality of logistics services provided by manufacturers in Iskandar, Malaysia. Parmata et al. [33] used SERVQUAL to measure the quality of the service of three major pharmaceutical distributors in India and to show how service quality affects service satisfaction. These studies have shown the effectiveness of the SERVQUAL model in testing the quality of services in logistics. Therefore, in this research, it was decided to use the SERVQUAL model to measure the quality of RL services using the example of the company Komunalac Teslić.

3. Methodology

In order to determine the service quality of Komunalac Teslić in terms of the application of RL, a methodology consisting of three phases (Table 1) was used. Phase 1 of this research was data collection. When measuring the quality of RL at the company Komunalac Teslić, the users of these services were surveyed. First, the SERVQUAL questionnaire was adapted to measure the quality of RL. Then, this questionnaire was set up online using a template of Google forms. After the survey was completed, the data were further processed and prepared for analysis.

Table 1. Research methodology.

Phase	Steps
Phase 1. Data collection	Forming an original SERVQUAL questionnaire Sending the SERVQUAL questionnaire to users Data processing and preparation for analysis
Phase 2. Determining dimension weights	Surveying users about the dimension importance percentages they have for them Synthesis of dimension weight ratings obtained by users Implementing the Delphi method Collecting data from decision-makers Calculating the weights of quality dimensions using the FUCOM method
Phase 3. Research results	Descriptive analysis of results Comparison of expectations and perceptions in respondents' answers Determining insignificant and significant differences in expectations and quality perception Conducting a Signum test
Phase 4. Discussion of results	Analysis of the results obtained Comparison of results in terms of expectations and quality perception Proposed guidelines for quality improvement

Phase 2 of the research was applied by determining the weights of the quality dimensions. This weight determination was performed in two ways. The first way collected users' opinions about the importance that a certain dimension had for them, by applying the Delphi method [34]. The second way applied the FUCOM method [35–37], where five decision-makers were selected for the evaluation of the quality dimensions.

Phase 3 included the results of the research. After the data were processed and prepared for analysis, the distribution of the obtained results was presented. Then, the obtained results were compared in terms of the service users' expectations and perceptions, thus comparing their agreement or disagreement with the given statements in terms of

expected and perceived quality. After that, the insignificant and significant differences were determined, first for the users' expectations, and then for the users' quality perception. The last part of the analysis of the research results was the implementation of a Signum test where the significance between responses for expectations and perceptions were determined. Because the collected results had non-parametric characteristics that deviated from expected binomial distributions, a Signum test was used [23].

Phase 4 of the research involved conducting a discussion of the results obtained. First, an analysis of the obtained results was completed, and it was determined where there was the biggest difference, i.e., for which statements the expectations were higher than the perceptions and vice versa. Based on the comparison of the results, it was identified why such results were obtained. Then, the guidelines on how the company Komunalac Teslić will improve the quality in the implementation of RL were provided.

4. Case Study

At the very beginning of its business, the enterprise for utility services consisted of a utility company and a water supply system in the municipality of Teslić, and it was not until 2001 that these two businesses separated. Since 2001, the utility company has been operating independently under the name Komunalac Teslić. So far, the company has about 7000 registered users; 6500 are natural persons and 500 are legal entities. In the beginning, waste collection and transport were only undertaken in urban and suburban areas, while in the last few years the business has changed and expanded into the rural areas of the municipality of Teslić, thus increasing the number of users. Waste collection charges are fixed and are taken on a monthly basis. The basic function of the utility company Komunalac Teslić is waste management in the territory of the municipality of Teslić. Waste collection in the urban zone is carried out twice a day, except on weekends when waste collection is carried out once a day. Waste collection in rural areas is carried out once a week. Each rural settlement has a particular day when waste is collected. In this case, waste management includes waste collection and its disposal at a landfill under the supervision of the utility company. In the last few years, the company Komunalac Teslić has initiated activities to open a recycling center. In 2020, the company started collecting waste that will be recycled. The company Komunalac Teslić decided to set up containers for sorting waste intended for recycling. The containers are at accessible locations, so that users can dispose of waste in a very easy and fast way. The number of containers and their volume at a location depends on the number of users in that area. Service users have been informed by the media about the provision of a new service to collect waste that will be recycled. The aim of this company is to increase the percentage of waste for recycling. In order to improve the quality of this service, users were surveyed about their expectations before setting up the containers, and their quality perceptions after setting up the containers. In this way, the company Komunalac Teslić will receive the necessary information on how to improve its RL services through waste recycling.

Users were surveyed through the application of the SERVQUAL model. The customized questionnaire consisted of 21 questions related to expectations and 21 questions related to quality perception. The questions in the questionnaire were divided into five dimensions: reliability, assurance, empathy, responsiveness, and tangibles (Table 2). Users were offered answers for the rating of expectations and quality perceptions in the form of linguistic values, which ranged from "I completely disagree with this statement" assigned grade one, and "I completely agree with it" assigned grade five. A Likert scale of five levels of disagreement or agreement with given statements was used. At the end of the questionnaire, users had to rate each quality dimension in the form of percentages and thus needed to determine which of the dimensions was the most important to them. The total sum of the evaluated dimensions should be 100%. During the evaluation, the users were guided by which of the given dimensions they thought had the greatest impact on the quality of the provided service of the utility company. The questionnaire was posted online using Google forms. The questionnaire was active from March to May 2020. The links

were forwarded by social networks and the e-mail services of the company Komunalac Teslić. The questionnaire was accessed by 170 service users, and it was correctly filled in by 112 users.

Table 2. SERVQUAL questionnaire.

Dimensions		Statements	Grades				
Reliability	Q1	Services will be provided at the expected time	1	2	3	4	5
	Q2	Waste will be collected regularly	1	2	3	4	5
	Q3	Waste collection will be performed without difficulties	1	2	3	4	5
Assurance	Q4	Workers will be careful when performing work tasks	1	2	3	4	5
	Q5	The user will be informed in a timely manner	1	2	3	4	5
	Q6	The cost of the waste collection service will be fixed	1	2	3	4	5
Tangibles	Q7	The cost of the service will be acceptable	1	2	3	4	5
	Q8	No noise will be generated during waste collection	1	2	3	4	5
	Q9	Invoices will be clear and delivered to home addresses	1	2	3	4	5
	Q10	The streets will be clean and tidy	1	2	3	4	5
	Q11	The containers will be placed close to the household	1	2	3	4	5
	Q12	There will be no unpleasant odors at waste disposal sites	1	2	3	4	5
	Q13	Waste collection vehicles will be modern	1	2	3	4	5
Empathy	Q14	Services will be flexible and customized	1	2	3	4	5
	Q15	The time of waste collection and transport will be appropriate	1	2	3	4	5
	Q16	When charging, population categories will be taken into account	1	2	3	4	5
Responsiveness	Q17	Workers will be professional during the waste collection process	1	2	3	4	5
	Q18	Novelties will be accepted quickly	1	2	3	4	5
	Q19	Users' needs will be adequately responded to	1	2	3	4	5
	Q20	Waste collection will be fast and adequate	1	2	3	4	5
	Q21	Traffic will not be disturbed	1	2	3	4	5

As we mentioned in the introduction, the original SERVQUAL questionnaire contained 21 statements that were used for the first time in the literature. The questionnaire was formed based on the experiences of managers from the field of reverse logistics and the need of the utility company Komunalac Teslić, for which this research was performed. It is important to note that this questionnaire contained statements mostly related to waste collection management. Bosnia and Herzegovina is a very poor country from the aspect of the full application of reverse logistics (reduce, reuse, recycle), so we were forced to only consider waste disposal as one of the channels of reverse logistics.

In addition to user surveys, the FUCOM method was applied to determine the weights of the quality dimensions by decision-makers. Five decision-makers who are regional experts in the field were selected. They are informed on a daily basis and they make decisions related to waste management activities in reverse logistics. Decision-makers based their preferences on the results of the Delphi method, i.e., the initial ranking for the FUCOM method.

5. Results

Before showing the results collected from the users in terms of expectations and quality perceptions, the findings related to the weights of the quality dimensions are presented first. At the end of the questionnaire, each service user evaluated individual quality dimensions with a percentage of how important a certain dimension was to them. Each dimension was summed up and divided by the total rating, i.e., the sum of the percentage values of one dimension was divided by the sum of the percentage values for all dimensions. In this way, the results of the weights of the quality dimensions were obtained (Table 3). Based on the results obtained, it can be concluded that the most important dimension for users was responsiveness (w = 0.216), followed by the reliability dimension (w = 0.204) which was slightly smaller than the responsiveness dimension. The assurance dimension

(w = 0.199) and the tangibles dimension (0.191) had approximately the same results, while the empathy dimension (0.190) was in the last position.

Table 3. The weight values of the quality dimensions obtained by users applying the Delphi method.

Weight Coefficients	Values
Reliability	0.204
Assurance	0.199
Tangibles	0.191
Empathy	0.190
Responsiveness	0.216
Total	1.000

Final weight values were determined using the FUCOM method by five decision-makers. Based on the ranking defined by users applying the Delphi method, the decision-makers compared the criteria. After applying the other steps of the FUCOM method, their final values were calculated by the Lingo 17 software, as shown in Table 4. The same procedure was applied for all decision-makers and the weights were calculated for each decision-maker. The final weight values, related to the decision-makers' opinions, were obtained by applying the average value for the quality dimensions. The highest value was given to the responsiveness dimension (w = 0.231), followed by the reliability dimension (w = 0.211), assurance (w = 0.197), tangibles (w = 0.189), while the empathy dimension gained the least weight (w = 0.172).

Table 4. Final weight values of the quality dimensions obtained by the decision-makers using the FUCOM method.

	Reliability	Assurance	Tangibles	Empathy	Responsiveness
DM1	0.203	0.203	0.194	0.167	0.233
DM2	0.214	0.196	0.181	0.174	0.235
DM3	0.214	0.195	0.195	0.172	0.224
DM4	0.217	0.198	0.192	0.175	0.217
DM5	0.207	0.194	0.182	0.172	0.244
Wj	0.211	0.197	0.189	0.172	0.231

After the final weights of the quality dimensions were determined by users and decision-makers, descriptive statistics of the data received from the users were performed (Table 5). The highest value for user expectations was given to the assurance dimension (mean = 3.915), while the lowest value was given to the empathy dimension (mean = 3.342). When observing the results obtained for quality perception, the highest value was given to the reliability dimension (mean = 3.783), while the lowest evaluated dimension was empathy (mean = 3.247). When determining the dispersion of the service users' responses, it was identified that the tangibles dimension (ST = 1.348) had the largest dispersion in responses in terms of user expectations, while the reliability dimension had the lowest dispersion (ST = 1.230).

When observing the results for quality perception, the dimension tangibles (ST = 1.321) had the largest dispersion in users' responses, while the dimension reliability (ST = 1.189) had the smallest dispersion. The internal consistency of the measurement scales was measured using the Cronbach Alpha (CA) coefficient. The results obtained using the CA coefficient are such that there was an internal consistency in the dimensions for measuring user expectations, as all CA values are higher than 0.6 [38]. However, in the responses related to perception in the empathy dimension there was no consistency of the measurement scales, and certain segments of the SQ questionnaire have been deleted.

Table 5. Descriptive analysis of quality dimensions, Cranbanch alpha indicator and quality identified.

Dimension	Expectations			Perception			SQ Gap
	AV	ST	CA	AV	ST	CA	
Reliability	3.848	1.230	0.845	3.783	1.189	0.813	−0.014
Assurance	3.915	1.234	0.746	3.385	1.269	0.600	−0.009
Tangibles	3.712	1.348	0.822	3.655	1.321	0.618	−0.017
Empathy	3.342	1.281	0.942	3.247	1.229	0.338	−0.018
Responsiveness	3.833	1.287	0.810	3.699	1.242	0.600	−0.029
SERVQUAL	3.730	1.276	0.833	3.554	1.250	0.600	−0.017

When filling out the questionnaire, the respondents filled in their expectations and perceptions regarding the RL service quality of the company Komunalac Teslić. The distribution of ratings in terms of expectations and quality perception are shown in Table 6. These results show that the highest expectations of service users were related to statement Q9 (Invoices will be clear and delivered to home addresses) where there is the highest rating by all users (mean = 4.1786), while the lowest expectations were for statement Q12 (There will be no unpleasant odors at waste disposal sites), which received the lowest rating by users (mean = 3.3750). The ratings of RL service quality perception are such that the highest rating was given to statement Q5 (The user is informed in a timely manner) (mean = 3.9107), while the lowest rating was given to statement Q16 (When charging, population categories are taken into account) (mean = 3.2411).

Table 6. Distribution of ratings in terms of expectations and perceptions.

Ordinals	Expectation Ratings					Mean	Perception Ratings					Mean
	E(1)	E(2)	E(3)	E(4)	E(5)		P(1)	P(2)	P(3)	P(4)	P(5)	
Q1	11	11	9	36	45	3.8304	11	15	7	43	36	3.6964
Q2	10	12	10	40	40	3.7857	7	17	7	40	41	3.8125
Q3	6	9	13	43	41	3.9286	5	15	12	41	39	3.8393
Q4	7	15	8	39	43	3.8571	8	16	6	43	39	3.7946
Q5	5	14	10	33	50	3.9732	5	12	12	42	41	3.9107
Q6	6	13	12	32	49	3.9375	11	11	11	44	35	3.7232
Q7	6	18	8	38	42	3.8214	7	12	9	45	39	3.8661
Q8	9	13	10	41	39	3.7857	9	15	17	39	32	3.6250
Q9	6	5	15	23	63	4.1786	13	13	8	40	38	3.6875
Q10	14	14	9	35	40	3.6518	9	20	12	35	36	3.6161
Q11	9	14	9	40	40	3.7857	18	13	15	29	37	3.4821
Q12	21	16	8	34	33	3.3750	9	18	12	40	33	3.6250
Q13	15	24	11	27	35	3.3839	11	14	27	33	27	3.4554
Q14	9	16	18	42	27	3.5536	5	16	12	39	40	3.8304
Q15	10	12	15	30	45	3.7857	11	14	27	33	27	3.4554
Q16	8	15	4	38	47	3.9107	18	23	15	26	30	3.2411
Q17	11	13	11	34	43	3.7589	8	13	13	45	33	3.7321
Q18	6	14	10	46	36	3.8214	12	14	24	33	29	3.4732
Q19	6	16	21	38	31	3.6429	5	14	30	34	29	3.6071
Q20	10	13	14	31	44	3.7679	6	20	12	46	28	3.6250
Q21	4	14	11	35	48	3.9732	7	19	9	38	39	3.7411
sum	189	291	236	755	881		195	324	297	808	728	

Considering the rating of expectations and quality perceptions, it is obvious that the number of ratings received increased: for grade one, from 189 to 195 (+6); for grade two, from 291 to 324 (+33); for grade three from 236 to 297 (+61); and for grade four, from 755 to 808 (+53), while the number of grades five given by the users in terms of quality perception decreased from 881 to 728 (−153). In this way, it was shown that expectations were higher than the perceived RL quality.

This fluctuation in ratings indicates the exclusive disappointment of the respondents who had the highest expectations (Figure 1). However, the presentation of expectations and perceptions of 112 respondents (Figure 2) by expectation and perception indicates uncharacteristic fluctuations. This fluctuation has a dominant tendency to decrease ratings for user perceptions, but in some cases, it also has a tendency to increase ratings for user perceptions. Therefore, it is necessary to consider this relationship through a linear correlation between the same ratings of expectations and perceptions.

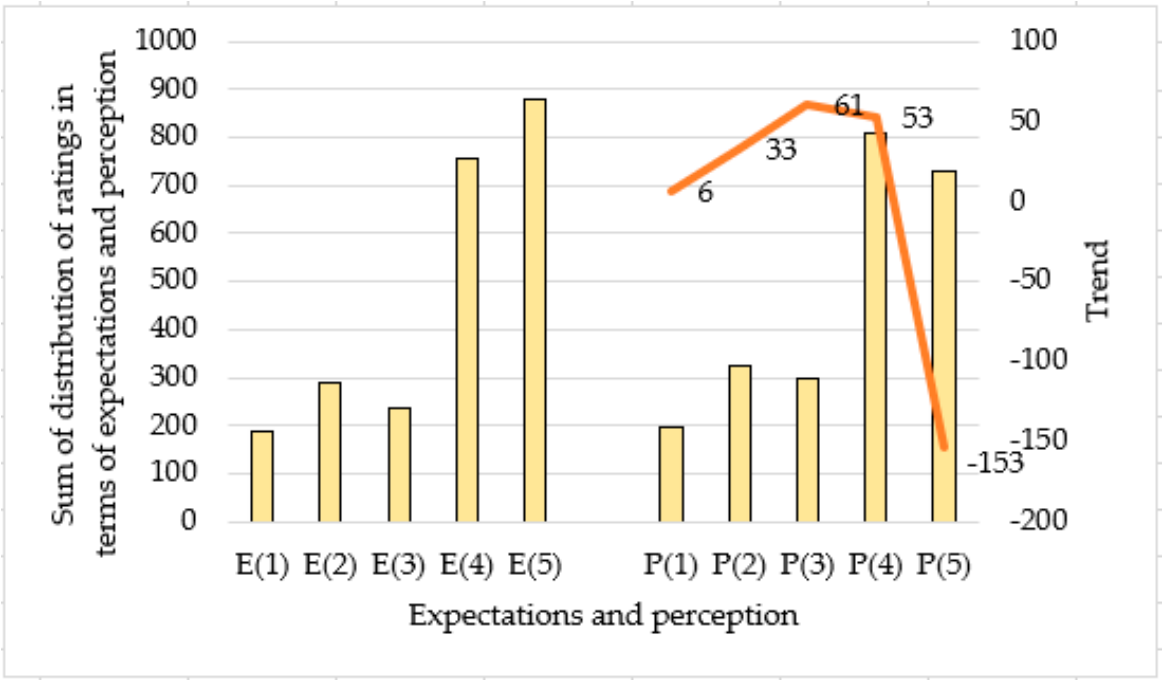

Figure 1. The difference in the sum of distribution in terms of expectation and perception and their trend.

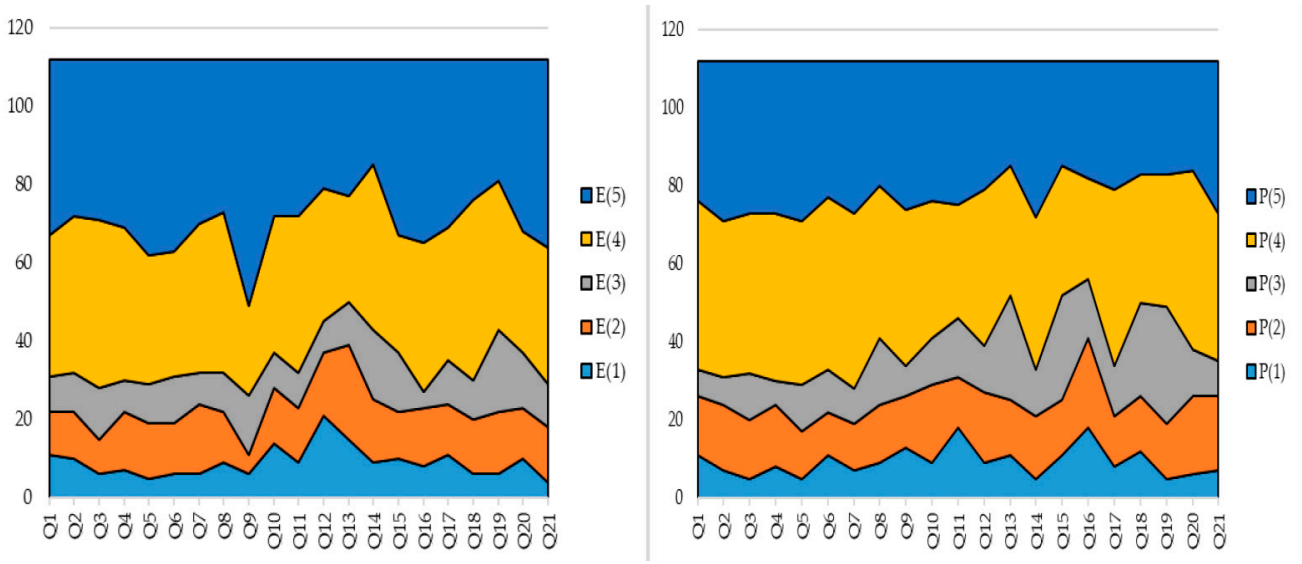

Figure 2. Stacked plots of all variables of expectations and perception.

The results of the correlation coefficient show that there is a small correlation between the ratings observed (Table 7). Only observing the same ratings shows that a small number of respondents in their perception rating repeated their rating from expectations. At grade four, there was a negative correlation between these responses ($r = -0.149$). However, the

weak correlation between the ratings does not allow a relevant conclusion to be drawn about the relation between expectations and responses, but at the same time they point to analytical dynamics resulting from the obvious consistent cooperation and interest of users in participating in the survey.

Table 7. Results of a linear correlation between the ratings of expectations and perception.

	E(1)	E(2)	E(3)	E(4)	E(5)
P(1)	**+0.109**	+0.293	+0.090	−0.075	−0.318
P(2)	−0.056	**+0.051**	+0.404	−0.237	−0.307
P(3)	−0.465	−0.296	**+0.396**	+0.102	−0.138
P(4)	−0.119	+0.110	−0.014	**−0.149**	+0.214
P(5)	+0.284	−0.109	−0.421	+0.207	**+0.223**

Research into the nonparametric characteristics of the distribution of expectations in responses has not established a specific type of distribution in any case. Binomial distribution, established in some previous research [23] was potentially the closest, but did not meet the verification requirements with a given significance threshold of $p > 0.05$ in the case of expectation and perception. Therefore, the basis for further analysis is a nonparametric Signum test.

In accordance with the Signum test results, insignificant and significant differences in the values of each of the expectations $E_m(n)$ n∈[1,21], m∈[1,112] are given in Table A1, while the Signum test results of insignificant and significant differences in the values of each of the answers $P_m(n)$ n∈[1,21], m∈[1,112] are given in Table A2.

We can conclude that the tests of expectations are dominantly different from each other and that they represent a reference basis for the estimation of expectations. Expectation E12 had the strongest logical differentiation, and expectation E18 had the weakest logical differentiation. In accordance with the Signum test results, it should be noted that expectations E01 were absolutely in compliance with E07 ($p = 1.0000$) and that expectations E01 were absolutely in compliance with E18 ($p = 1.0000$). The relationship between expectations E07 and E18 is significantly consistent, but not absolute ($p = 0.7728$). Moreover, we can conclude that the results of the response tests are mostly different from each other and that they represent a reference basis for estimating expectations.

Perception P16 to expectation E16 had the strongest logical differentiation, and perception P09 to expectation E09 had the weakest logical differentiation. In accordance with the Signum test results, P10 had the highest number of four absolute compliances with the following: P08, P12, P19, and P20. It should be emphasized that expectations E10 and E19 were absolutely in compliance. The coefficients of linear correlation between these expectations and answers are as follows:

- Between E10 and E19 r = +0.792
- Between P10 and P19 r = +0.654
- Between E10 and P10 r = +0.945
- Between E19 and P19 r = +0.915

The high compliance of the rating distribution of expectations between E10 and E19 was based on two subgroups of respondents that were not in compliance and therefore the results were such that there was a moderate correlation (r = 0.7921), and their compliance differentiation was also expressed in perceptions P10 and P19 (r = 0.6538). However, the consistency of the relationship between their expectations and responses was evident in the correlations for E10 and P10 (r = 0.9450) and E19 with P19 (r = 0.9145), so we conclude that there are no significant quantitative differences between E10/E19 expectations and P10/P19 perceptions, but there are significant qualitative differences in the relationship between E10/P10 and E19/P19 expectations due to the inversion of the groups with opposite attitudes to expectations and perceptions.

In accordance with the Signum test results, absolute compliance was also established between the following perceptions: P01/P09, P03/P14, P06/P17, P11/P18, P13/P15, and P17/P21. The specific determination of differences between individual expectations and responses is given in Table A3, and based on the results it can be noted that:

- A total of 12 responses had significantly lower ratings than expected, such as: E01/P01, E03/P03, E04/P04, E06/P06, E08/P08, E09/P09, E11/P11, E15/P15, E16/P16, E18/P18, E20/P20, E21/P21;
- A total of 7 responses remained at the level of expectations: E02/P02, E05/P05, E07/P07, E10/P10, E13/P13, E17/P17, E19/P19;
- A total of 2 responses had significantly higher ratings than expected: E12/P12, E14/P14.

The largest drop in ratings was found for expectation E16 to perception P16, which is extremely significant (p = 0.0000) and in absolute value is $\Delta(16) = -0.6696$, and in relative terms it represents a loss of 17.12% of the expectation. The E16/P16 relation is specific because the perception is absolutely heterogeneous (there is no compliance by the Signum test with another perception). The second drop in the ratings value was found for expectation E09 to perceptions P09, which is also absolutely significant (p = 0.0000) and in absolute value is $\Delta(09) = -0.4910$, and in relative terms it represents a loss of 11.75% of the expectation.

6. Discussion

When assessing the quality of RL services at the company Komunalac Teslić, the original SERVQUAL–MCDM model was used. Using this model, users' opinions about the quality of services were examined. A total of 21 statements were used and were divided into five dimensions: reliability, assurance, empathy, responsiveness, and tangibles. RL is specific because the initiation of activities is by the customer, ending them at the supplier [18], which distinguishes it from classical logistics.

The questionnaire containing these statements was completed by 170 users, and 112 of them completed it correctly. First, the correlation between ratings for expectations and perceptions was examined. The results have shown that there is a weak correlation between the ratings, which has proved that the collected results have non-parametric characteristics that deviate from the expected binomial distributions.

By comparing the results obtained by measuring expectations and perceptions, it was shown that user expectations differ significantly from the perception of quality in 14 statements. The results obtained using this model showed that in statements Q16 (When charging, population categories will be taken into account) and Q9 (Invoices will be clear and delivered to home addresses) there is the highest degree of discrepancy between expectations and perceptions by users. As can be seen, both of these statements are not related to RL services but to invoices and charging. The company Komunalac Teslić should first work on improving the service of distributing invoices, and when charging, take into account the categories of the population and adjust the cost of services to the categories. However, the results showed that there was also a significant statistical difference in responses for the other 12 statements. Based on that, the company Komunalac Teslić must first introduce novelties in its business, then harmonize the time of waste collection and transport with the requirements of households and set up containers close to the households. This is only a part of the service that the company Komunalac Teslić must improve in order to improve the quality of RL services. The reason for this is that the service users had high expectations regarding the introduction of the new RL service.

What is particularly significant for the results obtained is that there is a higher rating of quality perception than user expectation for two statements, and those statements are Q12 and Q14. There is also a significant statistical difference between these statements. Based on that, it can be concluded that the company Komunalac Teslić has additionally adjusted its services to the users' needs, improving flexibility and reducing unpleasant odors at waste disposal sites. In addition, there is a higher rating of perceived quality for

three other statements than of expected quality, and those statements are Q2, Q7 and Q13. However, there is no significant statistical difference between expectations and perceptions of quality for these statements.

In order for Komunalac Teslić to advance its RL services, it is necessary to improve the services aiming to improve the perceived quality of services. This needs to be carried out particularly for those services where there is a significant statistical difference between user expectations and their perception. It is necessary to re-examine the perception of users after a certain time in order to determine whether the quality has improved. Only in this way is it possible to constantly improve the quality of the services since there is feedback from service users.

7. Conclusions

Every company strives to improve the quality of its services and products in order to be more competitive in the market. When a new service is introduced, it is necessary to determine how the service has been accepted by users. In this paper, the quality of RL services was examined using the example of the company Komunalac Teslić, using the original SERVQUAL–MCDM model for measuring the quality of services. It was used to measure the expectations and the perceptions of the quality of the user services when introducing RL services. The research findings have shown that there are higher user expectations than quality perceptions for most of the statements. This especially refers to statements Q9 and Q16. However, the results have shown that there is a significant statistical difference between the perception of quality and user expectations for statements Q12 and Q14. In order to improve the quality of its services, the company Komunalac Teslić must continuously examine the user perception of the quality of the services. Only in this way will timely information will be obtained.

The main disadvantage of this research can be seen through the fact that many users of the services of the company Komunalac Teslić were not included. However, not all customers use RL services because they are not familiar with the importance of RL for preserving the environment. Therefore, it is necessary to increase people's awareness of the importance of RL in order for more of them to use these services. The research methodology has shown great flexibility in work and can be used in measurement and other services that occur in logistics.

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Appendix A. Statistical Analysis

Table A1. Signum test results of insignificant and significant differences in the values of statements in expectations.

	E01	E02	E03	E04	E05	E06	E07	E08	E09	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20	E21
E01		0.131	0.022	0.450	0.000	0.002	**1.000**	0.182	0.000	0.000	0.182	0.000	0.000	0.000	0.131	0.008	0.013	**1.000**	0.000	0.046	0.000
E02	0.131		0.000	0.013	0.000	0.000	0.289	0.480	0.000	0.000	0.480	0.000	0.000	0.000	0.752	0.001	0.505	0.387	0.002	0.752	0.000
E03	0.022	0.000		0.043	0.302	**1.000**	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.803	0.000	0.002	0.000	0.001	0.267
E04	0.450	0.013	0.043		0.001	0.016	0.221	0.013	0.000	0.000	0.013	0.000	0.000	0.000	0.043	0.077	0.003	0.343	0.000	0.009	0.001
E05	0.000	0.000	0.302	0.001		0.134	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.000	0.000	0.617
E06	0.002	0.000	**1.000**	0.016	0.134		0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.547	0.000	0.002	0.000	0.000	0.221
E07	**1.000**	0.289	0.003	0.221	0.000	0.001		0.289	0.000	0.000	0.221	0.000	0.000	0.000	0.421	0.016	0.046	0.773	0.000	0.145	0.000
E08	0.182	0.480	0.000	0.013	0.000	0.000	0.289		0.000	0.001	0.480	0.000	0.000	0.000	0.773	0.001	0.547	0.343	0.001	0.773	0.000
E09	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
E10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000		0.000	0.000	0.000	0.054	0.000	0.000	0.002	0.001	**1.000**	0.001	0.000
E11	0.182	0.480	0.000	0.013	0.000	0.000	0.221	0.480	0.000	0.000		0.000	0.000	0.000	0.773	0.001	0.505	0.387	0.002	0.752	0.000
E12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		**1.000**	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
E13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.000**		0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
E14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.054	0.000	0.001	0.002		0.000	0.000	0.000	0.000	0.004	0.000	0.000
E15	0.131	0.752	0.002	0.043	0.000	0.000	0.423	0.773	0.000	0.000	0.773	0.000	0.000	0.000		0.001	0.450	0.522	0.002	0.480	0.000
E16	0.008	0.001	0.803	0.077	0.070	0.547	0.016	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.001		0.000	0.034	0.000	0.000	0.070
E17	0.013	0.505	0.000	0.003	0.000	0.000	0.046	0.547	0.000	0.002	0.505	0.000	0.000	0.000	0.450	0.000		0.190	0.021	**1.000**	0.000
E18	**1.000**	0.387	0.002	0.343	0.000	0.002	0.773	0.343	0.000	0.001	0.387	0.000	0.000	0.000	0.522	0.034	0.190		0.000	0.286	0.000
E19	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000	**1.000**	0.002	0.000	0.000	0.004	0.002	0.000	0.021	0.000		0.008	0.000
E20	0.046	0.752	0.001	0.009	0.000	0.000	0.149	0.773	0.000	0.001	0.752	0.000	0.000	0.000	0.480	0.000	**1.000**	0.286	0.008		0.000
E21	0.000	0.000	0.267	0.001	0.617	0.221	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.000	0.000	

Table A2. Signum test results of insignificant and significant differences in the values of statements in perception.

	P01	**P02**	**P03**	**P04**	**P05**	**P06**	**P07**	**P08**	**P09**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**P16**	**P17**	**P18**	**P19**	**P20**	**P21**
P01		0.001	0.000	0.003	0.000	0.371	0.000	0.080	**1.000**	0.027	0.000	0.043	0.000	0.000	0.000	0.000	0.387	0.000	0.134	0.099	0.182
P02	0.001		0.505	0.617	0.003	0.016	0.114	0.000	0.001	0.000	0.000	0.000	0.000	0.724	0.000	0.000	0.039	0.000	0.000	0.000	0.013
P03	0.000	0.505		0.182	0.013	0.001	0.450	0.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.002	0.000	0.000	0.000	0.003
P04	0.003	0.617	0.182		0.001	0.043	0.013	0.000	0.002	0.000	0.000	0.000	0.000	0.343	0.000	0.000	0.096	0.000	0.001	0.000	0.077
P05	0.000	0.003	0.013	0.001		0.000	0.131	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P06	0.371	0.016	0.001	0.043	0.000		0.000	0.010	0.343	0.010	0.000	0.010	0.000	0.002	0.000	0.000	**1.000**	0.000	0.031	0.029	0.789
P07	0.000	0.114	0.450	0.013	0.131	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.343	0.000	0.000	0.000	0.000	0.000	0.000	0.001
P08	0.080	0.000	0.000	0.000	0.000	0.010	0.000		0.169	**1.000**	0.003	0.683	0.000	0.000	0.000	0.000	0.002	0.000	0.823	0.773	0.004
P09	**1.000**	0.001	0.000	0.002	0.000	0.343	0.000	0.169		0.080	0.000	0.121	0.000	0.000	0.000	0.000	0.302	0.000	0.200	0.190	0.077
P10	0.027	0.000	0.000	0.000	0.000	0.010	0.000	**1.000**	0.080		0.001	**1.000**	0.001	0.000	0.001	0.000	0.006	0.001	**1.000**	**1.000**	0.001
P11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.001		0.002	0.710	0.000	0.710	0.000	0.000	**1.000**	0.030	0.010	0.000
P12	0.043	0.000	0.000	0.000	0.000	0.010	0.000	0.683	0.121	**1.000**	0.002		0.000	0.000	0.000	0.000	0.002	0.000	0.845	0.752	0.001
P13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.710	0.000		0.000	**1.000**	0.000	0.000	0.683	0.000	0.000	0.000
P14	0.000	0.724	**1.000**	0.343	0.008	0.002	0.343	0.000	0.002	0.000	0.000	0.000	0.000		0.000	0.000	0.003	0.000	0.000	0.000	0.004
P15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.713	0.002	**1.000**	0.000		0.000	0.000	0.681	0.000	0.001	0.000
P16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
P17	0.385	0.039	0.002	0.091	0.000	**1.000**	0.003	0.002	0.302	0.006	0.000	0.002	0.000	0.003	0.000	0.000		0.000	0.008	0.006	**1.000**
P18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	**1.000**	0.000	0.683	0.000	0.683	0.000	0.000		0.000	0.000	0.000
P19	0.134	0.000	0.000	0.001	0.000	0.031	0.000	0.823	0.200	**1.000**	0.030	0.845	0.000	0.000	0.000	0.000	0.008	0.000		0.823	0.015
P20	0.099	0.000	0.000	0.000	0.000	0.029	0.000	0.773	0.190	**1.000**	0.010	0.752	0.000	0.000	0.000	0.000	0.006	0.000	0.823		0.002
P21	0.182	0.013	0.003	0.077	0.000	0.789	0.001	0.004	0.077	0.001	0.000	0.001	0.000	0.004	0.000	0.000	**1.000**	0.000	0.015	0.002	

Table A3. Signum test results.

	Mean Expectations	Relation	Mean Perception	Difference Δ	Zeta (from Signum)	p
Q1	3.830357	>	3.696429	−0.133928	3.614784	0.000301
Q2	3.785714	≈	3.812500	+0.026786	0.755929	0.449692
Q3	3.928571	>	3.839286	−0.089285	2.598076	0.009375
Q4	3.857143	>	3.794643	−0.062500	2.267787	0.023342
Q5	3.973214	≈	3.910714	−0.062500	1.809068	0.070440
Q6	3.937500	>	3.723214	−0.214286	4.694855	0.000003
Q7	3.821429	≈	3.866071	+0.044642	1.109400	0.267258
Q8	3.785714	>	3.625000	−0.160714	4.006938	0.000062
Q9	4.178571	>	3.687500	**−0.491071**	7.142749	0.000000
Q10	3.651786	≈	3.616071	−0.035715	0.801784	0.422678
Q11	3.785714	>	3.482143	−0.303571	5.659453	0.000000
Q12	3.375000	<	3.625000	+0.250000	5.102520	0.000000
Q13	3.383929	≈	3.455357	+0.071428	1.322876	0.185877
Q14	3.553571	<	3.830357	+0.276786	5.388159	0.000000
Q15	3.785714	>	3.455357	−0.330357	5.918364	0.000000
Q16	3.910714	>	3.241071	**−0.669643**	7.682213	0.000000
Q17	3.758929	≈	3.732143	−0.026786	0.485071	0.627626
Q18	3.821429	>	3.473214	−0.348215	6.084870	0.000000
Q19	3.642857	≈	3.607143	−0.035714	0.866025	0.386476
Q20	3.767857	>	3.625000	−0.142857	3.061862	0.002200
Q21	3.973214	>	3.741071	−0.232143	4.902903	0.000001

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