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THE SENSITIVITY OF THE SERVQUAL SCORE TO THE CHOICE OF THE FUZZY CONVERSION SCALE

WRAŻLIWOŚĆ WSKAŹNIKA SERVQUAL NA WYBÓR ROZMYTEJ SKALI KONWERSJI

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Summary: The Fuzzy SERVQUAL method enables to assess the service quality when the measurement results of the performance perception and expectations are expressed in the form of fuzzy numbers. The measurement results expressed in the form of fuzzy numbers are the results of applying the fuzzy conversion scales which are the most popular form of fuzzy scales. Fuzzy conversion scales assume that their points are expressed in the form of fuzzy numbers. The choice of fuzzy number parameters which describe the various points of measurement scales is most often subjective. The aim of the article is to assess the impact of the choice of the fuzzy conversion scale on the stability of the assessment results of the service quality using the fuzzy SERVQUAL method. The stability assessment was made both for the individual dimensions and the overall SERVQUAL score. The results of employee satisfaction surveys of the West Pomeranian Province local government were used for the purpose of the assessment. The results suggest that there is no significant impact of the form of fuzzy conversion scales on the stability of the assessment results of the service quality using the fuzzy SERVQUAL method.

Keywords: fuzzy sets, fuzzy numbers, fuzzy scales, fuzzy SERVQUAL.

Streszczenie: Rozmyta metoda SERVQUAL umożliwia ocenę jakości usług w sytuacji, gdy wyniki pomiaru percepcji i oczekiwań wyrażone są w postaci liczb rozmytych. Wyniki pomiaru wyrażone w postaci liczb rozmytych są efektem stosowania rozmytych skal konwersji, będących najpopularniejszą formą skal rozmytych. Rozmyte skale konwersji zakładają, że ich punkty wyrażone są w postaci liczb rozmytych. Wybór parametrów liczb rozmytych opisujących poszczególne punkty skal pomiarowych jest najczęściej subiektywny. W artykule oceniono wpływ wyboru rozmytych skal konwersji na stabilność wyników oceny jakości usług z zastosowaniem rozmytej metody SERVQUAL. Oceny stabilności dokonano zarówno dla poszczególnych wymiarów, jak i dla ogólnego wskaźnika SERVQUAL. W ocenie wykorzystano wyniki badania satysfakcji pracowników jednostek samorządu terytorialnego województwa zachodniopomorskiego. Wyniki analizy sugerują brak istotnego wpływu postaci rozmytych skal konwersji na stabilność wyników oceny jakości usług z zastosowaniem rozmytej metody SERVQUAL.

Słowa kluczowe: zbiory rozmyte, liczby rozmyte, skale rozmyte, rozmyty SERVQUAL.

1. Introduction

SERVQUAL is one of the most widely used evaluation models of the services quality. This is based on the assumption that the perceived quality of service is the difference between customer expectations and the service performance. Although it is not a universal model and there is a lot of criticism concerning it, still it is the subject of research, and it is frequently used in the area of measuring the quality of services. Due to the fact that in recent years there has been a large number of theoretical and practical studies combining the achievements of research on the quality of service with the fuzzy set theory, also SERVQUAL has been modified so that it can take into account the uncertainty of the assessments of the respondents concerning both the evaluation of performance and expectations in relation to the service quality attributes. This made it possible to take into account the uncertainty thanks to using the fuzzy measurement scales, but at the same time with the fuzzy variants of the SERVQUAL method we face a group of scales referred to as the fuzzy conversion scales.

Fuzzy conversion scales are formed by converting pre-defined linguistic labels (mostly representing Likert scale points) to the form of fuzzy numbers [de la Rosa et al. 2013]. The need to take into account the uncertainty of subjective assessments of respondents seems to be indisputable, but selecting fuzzy conversion scales as a method in empirical research can raise a lot of doubts. A review of former studies using fuzzy the SERVQUAL method clearly confirms the fact that the choice of the fuzzy conversion scales is subjective and is not usually substantiated by the authors. The scales that are used vary in terms of the number of points, linguistic labels and parameters of fuzzy numbers representing these expressions. Also it has not been indicated if the analysis conducted using fuzzy conversion scales provide significantly different results compared to the classical approach operating on the artificial strengthening of scales and treating measurement results as the results from the ratio scale (although Likert scales were used).

The aim of this article is to assess the impact of the fuzzy conversion scales choice on the evaluation results of perceived service quality using the fuzzy SERVQUAL method. For the purposes of the article the fuzzy conversion scales used with the fuzzy SERVQUAL method have been analysed. The comparative analysis carried our related to both SERVQUAL measures at the level of quality measurements of services and individual attributes of quality. The results of employee satisfaction surveys of public administration units in Poland were used in the analysis, using the SERVQUAL method.

2. The fuzzy SERVQUAL method

Let us assume that $\tilde{P}_{ij}$ is the fuzzy performance of the *j*-th service attribute expressed in the form of the fuzzy triangular number attributed by the *i*-th respondent:

$$\tilde{P}_{ij} = \left(p_{ij}^a, p_{ij}^b, p_{ij}^c\right),\ i = (1,2,...,n),\ j = (1,2,...,m), \tag{1}$$

where: p_{ij}^a, p_{ij}^c – respectively the left and right spread of fuzzy number $\tilde{P}_{ij}$, p_{ij}^b – the mean value of the fuzzy number $\tilde{P}_{ij}$ for which the membership function reaches the value of 1.

In a similar way we will denote $\tilde{E}_{ij}$ as the fuzzy expectation of the *i*-th respondent to the performance level of the *j*-th service attribute, also expressed in the form of fuzzy triangular number:

$$\tilde{E}_{ij} = \left(e_{ij}^a, e_{ij}^b, e_{ij}^c\right) \tag{2}$$

where: e_{ij}^a, e_{ij}^c – respectively the left and right spread of the fuzzy number $\tilde{E}_{ij}$, e_{ij}^b – the mean value of the fuzzy number $\tilde{E}_{ij}$ for which the membership function reaches the value of 1.

Using the principles of fuzzy arithmetic for fuzzy numbers we will calculate the perceived quality of the *j*-th attribute according to the equation:

$$\tilde{Q}_j = \bar{\tilde{P}}_j - \bar{\tilde{E}}_j, \tag{3}$$

where: $\bar{\tilde{P}}_j = \dfrac{\tilde{P}_{1j} + \tilde{P}_{2j} + ... + \tilde{P}_{nj}}{n} = \left(\dfrac{\sum_{i=1}^{n} p_{ij}^a}{n}, \dfrac{\sum_{i=1}^{n} p_{ij}^b}{n}, \dfrac{\sum_{i=1}^{n} p_{ij}^c}{n}\right)$ – the fuzzy average performance of the *j*-th attribute,

$\bar{\tilde{E}}_j = \dfrac{\tilde{E}_{1j} + \tilde{E}_{2j} + ... + \tilde{E}_{nj}}{n} = \left(\dfrac{\sum_{i=1}^{n} e_{ij}^a}{n}, \dfrac{\sum_{i=1}^{n} e_{ij}^b}{n}, \dfrac{\sum_{i=1}^{n} e_{ij}^c}{n}\right)$ – the fuzzy average expectation to the performance level of the *j*-th attribute.

By averaging the results of measuring the quality of the attributes belonging to individual dimensions we can evaluate the quality of each dimension. We will obtain the perceived quality of the *k*-th dimension according to the following equation:

$$\widetilde{Q}_k = \frac{\sum_{j \in J_k} \widetilde{Q}_j}{m_k}, \; k = (1,2,...,K) \tag{4}$$

where: J_k – a set of attributes belonging to the *k*-th dimension, m_k – the number of attributes belonging to the *j*-th dimension.

According to the basis of the SERVQUAL method, the overall service quality consists of the quality assessment of all the attributes. The equation for the overall service quality (often referred to as the overall SERVQUAL score) will therefore be as follows:

$$\widetilde{Q} = \sum_{j=1}^{m} \widetilde{Q}_j = \sum_{j=1}^{m} \left(\widetilde{P}_j - \widetilde{E}_j \right). \tag{5}$$

One of the modifications of the SERVQUAL method proposed by Parasuraman et al. [1991] allows for the possibility to determine the importance weights of attributes and dimensions of service quality. In this study, it was assumed that the importance weights are determined for the dimensions of quality. These weights are usually determined by splitting the pool of 100 points by each of the respondents between the dimensions to reflect the share of each of them in the overall assessment of the service quality. Using the importance weights we can calculate a weighted evaluation of the quality of the k -th dimension according to the equation:

$$\widetilde{Q}_k(\text{weighted}) = w_k \widetilde{Q}_k = w_k \frac{\sum_{j \in J_k} \widetilde{Q}_j}{m_k}, \tag{6}$$

where: w_k – the weight of the *k*-th dimension.

The equation for the overall service quality incorporating the weighted evaluation of quality dimensions (overall weighted SERVQUAL score) will now look like this:

$$\widetilde{Q}_k(\text{weighted}) = \sum_{k=1}^{K} \widetilde{Q}_k(\text{weighted}). \tag{7}$$

3. Fuzzy conversion scales for the fuzzy SERVQUAL method

We distinguish fuzzy scales end fuzzy conversion scales in the subject literature [de la Rosa et al. 2013]. Fuzzy conversion scales are measurement scales whose points are expressed in the form of fuzzy numbers. The main reason for the fuzzy scales

application is to take into account the uncertainty associated with differences in the perception of estimation points of the rating scales by the respondents. Fuzzy numbers represent the ambiguity in the perception of the evaluating, valuing and other expressions by the respondents. The fuzzy conversion scales used in the subject literature together with the fuzzy SERVQUAL method are listed below.

Table 1. Fuzzy conversion scales used with the fuzzy SERVQUAL method

Author	Perception	Expectation
1	2	3
Aydin, Pakdil [2008]	Strongly disagree – (0; 0; 0; 0) Disagree – (0; 0,11; 0,19; 0,42) Undecided v (0,32; 0,41; 0,58; 0,65) Agree – (0,58; 0,8; 0,9; 1) Strongly agree – (1; 1; 1; 1)	Unimportant – (0; 0; 0; 0) Of little importance – (0; 0,11; 0,19; 0,42) Moderately important – (0,32; 0,41; 0,58; 0,65) Important – (0,58; 0,8; 0,9; 1) Very important – (1; 1; 1; 1)
Hu et al. [2010]	Very dissatisfied – (0; 0,1; 0,2) Dissatisfied – (0,1; 0,2; 0,3) Slightly dissatisfied – (0,2; 0,35; 0,5) Fair – (0,4; 0,5; 0,6) Slightly satisfied – (0,5; 0,65; 0,8) Satisfied – (0,7; 0,8; 0,9) Very satisfied – (0,8; 0,9; 1)	1 – (0; 0,1; 0,2) 2 – (0,1; 0,2; 0,3) 3 – (0,2; 0,35; 0,5) 4 – (0,4; 0,5; 0,6) 5 – (0,5; 0,65; 0,8) 6 – (0,7; 0,8; 0,9) 7 – (0,8; 0,9; 1)
Maruvada, Bellamkonda [2010]	Very poor – (0; 0; 2) Poor – (0; 2; 4) Fair – (2; 4; 6) Good – (4; 6; 8) Excellent – (6; 8; 8)	Very unimportant – (0; 0; 2) Unimportant – (0; 2; 4) Fair – (2; 4; 6) Important – (4; 6; 8) Very important – (6; 8; 8)
Firuzan et al. [2012]	Very unsatisfied – (0; 0; 2) Unsatisfied – (0; 2; 4) Middle – (2; 4; 6) Satisfied – (4; 6; 8) Very satisfied – (6; 8; 8)	Very unimportant – (0; 0; 2) Unimportant – (0; 2; 4) Middle – (2; 4; 6) Important – (4; 6; 8) Very important – (6; 8; 8)
Charles et al. [2013]	Very dissatisfied – (0; 0,1; 0,2) Dissatisfied – (0,1; 0,2; 0,3) Fair – (0,4; 0,5; 0,6) Slightly satisfied – (0,5; 0,65; 0,8) Satisfied – (0,7; 0,8; 0,9) Very satisfied – (0,8; 0,9; 1)	1 – (0; 0,1; 0,2) 2 – (0,1; 0,2; 0,3) 3 – (0,4; 0,5; 0,6) 4 – (0,5; 0,65; 0,8) 5 – (0,7; 0,8; 0,9) 6 – (0,8; 0,9; 1)
Lupo [2013]	Very bad – (0; 1; 3) Poor – (2; 3; 5) Average – (3; 5; 7) Good – (5; 7; 9) Excellent – (7; 9; 9)	Equal importance – (1; 1; 3) Moderate importance – (1; 3; 5) Strong importance – (3; 5; 7) Very strong importance – (5; 7; 9) Extremely more importance – (7; 9; 9)
Shah [2013]	Very poor – (0; 0; 0,25) Poor – (0, 0;25, 0,5) Medium – (0,25; 0,5; 0;75) Satisfactory – (0,5; 0,75; 1) Extremely satisfactory – (0,75, 1, 1)	Very low – (0; 0; 0,25) Low – (0, 0;25, 0,5) Medium – (0,25; 0,5; 0;75) High – (0,5; 0,75; 1) Very high – (0,75, 1, 1)

Table 1, cont.

1	2	3
Yu [2003]	Strongly disagree – (0; 0; 0; 0) Disagree – (0; 0,11; 0,19; 0,42) Undecided v (0,32; 0,41; 0,58; 0,65) Agree – (0,58; 0,8; 0,9; 1) Strongly agree – (1; 1; 1; 1)	Unimportant – (0; 0; 0; 0) Of little importance – (0; 0,11; 0,19; 0,42) Moderately important – (0,32; 0,41; 0,58; 0,65) Important – (0,58; 0,8; 0,9; 1) Very important – (1; 1; 1; 1)
Sarjono [2014]	Very dissatisfied – (1, 2, 3) Dissatisfied – (3, 4, 5) Quite satisfied – (5, 6, 7) Very satisfied – (7, 8, 9)	Very dissatisfied – (1, 2, 3) Dissatisfied – (3, 4, 5) Quite satisfied – (5, 6, 7) Very satisfied – (7, 8, 9)
Braendlea et al. [2014]	Very low – (0; 0; 0,2) Low – (0; 0,2; 0,4) Medium – (0,2; 0,4; 0,6) High – (0,4; 0,6; 0,8) Very high – (0,6; 0,8; 1) Excellent – (0,8; 1; 1)	Profoundly Trivial – (0; 0; 0,2) Trivial – (0; 0,2; 0,4) Medium – (0,2; 0,4; 0,6) Important – (0,4; 0,6; 0,8) Very important – (0,6; 0,8; 1) Profoundly important – (0,8; 1; 1)
Stefano et al. [2015]	Very poor – (0; 1; 2) Poor – (1; 2; 3) Fair – (2; 3; 4) Good – (3; 4; 5) Very good – (4,5; 5; 5)	Very low – (0; 1; 2) Low – (1; 2; 3) Fair – (2; 3; 4) High – (3; 4; 5) Very high – (4,5; 5; 5)
Liu et al. [2015]	Very bad – (1; 1; 3) Bad – (1; 3; 5) Fair – (3; 5; 7) Good – (5; 7; 9) Very good – (7; 9; 9)	Very bad – (1; 1; 3) Bad – (1; 3; 5) Fair – (3; 5; 7) Good – (5; 7; 9) Very good – (7; 9; 9)

Source: own elaborations.

The five-point fuzzy conversion scales dominate in the studies devoted to the fuzzy SERVQUAL method. The points of these scales are represented mainly by the symmetric triangular fuzzy numbers. In most cases the authors of the studies assume the same spreads of fuzzy numbers assigned to the points of the scale. Asymmetric fuzzy numbers are usually assigned to the extreme points. It is also characteristic that, in most cases, the same parameters of the fuzzy numbers representing the points of the rating scales in both perception and expectations are set. The only exception is the study prepared by Lupo [2013].

4. The results of the analysis of fuzzy SERVQUAL score sensitivity to the choice of the fuzzy conversion scale

The impact of the choice of the fuzzy conversion scale on the results of the fuzzy SERVQUAL method has been assessed on the basis of the result analysis of employee satisfaction surveys carried out in 16 units of local government (municipal offices

and county offices) located in the West Pomerania province as part of the project "Implementation of management improvements in local government units in the area of the Western Pomerania province"[1]. The study was conducted in 2010, 469 employees were involved. The authors decided to measure employee satisfaction using the SERVQUAL method modified appropriately to the needs of the study[2]. Five-point rating scales were used to measure perceptions and expectations. The points of these scales were verbal categories. The reliability of the measurement, assessed on the basis of Cronbach's alpha statistics, with the SERVQUAL method used in this study was 0,939.

For the purposes of this analysis, the original estimate scales to measure perceptions and expectations were replaced by fuzzy conversion scales as suggested by the authors of the research listed in Table 1.

The thus obtained measurement results were compared with one another and with the measurement results obtained on the basis of the originally adopted rating scales. The results of the measurement of employee satisfaction with the use of the fuzzy SERVQUAL method and fuzzy conversion scales were marked with the names of the authors who proposed these scales.

The quality attributes listed under SERVQUAL dimensions are summarized in Table 2.

According to the rules of fuzzy number arithmetic, quality gaps are also expressed in the form of triangular fuzzy numbers. In order to compare the gaps expressed as triangular fuzzy numbers, the defuzzyfication method proposed by Chen [1999] was used.

Defuzzyficated values made the basis for drawing up attribute rankings in terms of quality gaps - the greater the difference between perception and expectations, the higher position in the attribute ranking. The results are summarized in Table 3.

The ranking compliance was evaluated using Kendall's tau coefficient. The statistic value close to unity means the high compliance of the attribute positions in the rankings and shows the lack of impact of the fuzzy conversion scale choice on the results of the order indications of the quality attributes which require improvement activities. The compliance results are shown in Table 4.

[1] The research was part of the task: "Customer and Local Government Employee Satisfaction" carried out as an element of the project: "Implementation of management improvements in local government units in the area of the Western Pomerania province". Project manager: Prof. T. Lubińska, PhD, Szczecin University; task manager: Prof. Jolanta Witek, PhD.

[2] Even though the SERVQUAL method has been proposed as a method of measuring service quality, it is also successfully used as a method in customer satisfaction research (both external and internal). This is due to the fact that service quality is one of the essential components of customer satisfaction. The SERVQUAL method was used to measure employee satisfaction, among others, in studies by: Comm and Mathaisel [2000], Lee [2006], Nejati et al. [2007], Markowicz [2009], Marroquin Brand [2014].

Table 2. Description of attributes

Symbol	Attributes
RELIABILITY	
x_1	Timely handling of cases between co-workers at the office
x_2	Reliable handling of cases between co-workers at the office (no errors)
RESPONSIVENESS	
x_3	Desire to help from the other office staff
x_4	Cooperation in handling of cases by customers with other office staff
x_5	Desire to help, from the other office staff in emergencies and crisis situations
x_6	Desire to help, from the superior
x_7	Identifying the employees with the office
ASSURANCE	
x_8	Confidentiality (non-commenting) of customer cases by the office staff
x_9	Adjust the level of knowledge and skills to the position held
x_{10}	Mutual respect and kindness at work
x_{11}	Sense of job security
EMPATHY	
x_{12}	Desire to share information helpful in the handling of customer cases
x_{13}	Transmission of information between employees in a meaningful way
x_{14}	Adapting working time to the needs of customers
x_{15}	Efficient flow of information between employees and superiors
x_{16}	Clarity in commands formulated by the superior
TANGIBLES	
x_{17}	Decor
x_{18}	Functionality of the workplace (space, lighting, etc.)
x_{19}	Availability of working appliances (fax, telephone, computer, copier)
x_{20}	Financial motivation
x_{21}	Non-financial motivation
x_{22}	Training
x_{23}	Opportunity for professional development

Source: "Implementation of management improvements in local government units in the area of the Western Pomerania province". Project manager: Prof. T. Lubińska, PhD, Szczecin University; task manager: Prof. Jolanta Witek, PhD own elaborations.

Table 3. Attribute positions in quality gap rankings for various fuzzy conversion scales

Attributes	Likert-type scale	Maruvada, Bellam-konda [2010]; Firuzan et al. [2012]	Shah [2013]	Stefano et al. [2015]	Liu et al. [2015]
1	15	17	17	17	17
2	14	14	14	15	14
3	12	11	11	12	11
4	16	13	13	14	13
5	11	10	10	10	10
6	21	21	21	21	21
7	18	18	18	18	18
8	7	7	7	7	7
9	13	16	16	13	15
10	9	9	9	9	9
11	4	4	4	4	4
12	19	20	20	20	20
13	17	15	15	16	16
14	23	23	23	23	23
15	8	8	8	8	8
16	10	12	12	11	12
17	20	19	19	19	19
18	5	5	5	5	5
19	22	22	22	22	22
20	1	1	1	1	1
21	2	2	2	2	2
22	6	6	6	6	6
23	3	3	3	3	3

Source: own elaborations.

Table 4. The results of the compliance of the attribute rankings

Kendall's tau		Likert-type scale	Maruvada, Bellamkonda [2010]; Firuzan et al. [2012]	Shah [2013]	Stefano et al. [2015]	Liu et al. [2015]
Likert-type scale	Correlation	1.000	0.929	0.929	0.960	0.937
	Significance	–	0.000	0.000	0.000	0.000
Maruvada, Bellamkonda [2010]; Firuzan et al. [2012]	Correlation	0.929	1.000	1.000	0.968	0.992
	Significance	0.000	–	–	0.000	0.000
Shah [2013]	Correlation	0.929	1.000	1.000	0.968	0.992
	Significance	0.000	–	–	0.000	0.000
Stefano et al. [2015]	Correlation	0.960	0.968	0.968	1.000	0.967
	Significance	0.000	0.000	0.000	–	0.000
Liu et al. [2015]	Correlation	0.937	0.992	0.992	0.967	1.000
	Significance	0.000	0.000	0.000	0.000	–

Source: own elaborations.

Kendall's tau coefficient values indicate a very high compliance of attribute rankings. In the case of the two scales used appropriately in the Maruvada and Bellamkonda [2010] and Shah [2013] studies, the attributed positions in the rankings were identical. Moreover, the greatest discrepancies for these scales were observed when compared to the results obtained using the Likert-type scale (tau = 0,929).

Using quality gaps for each of the attributes, the quality of the dimensions was estimated according to formulas (4) and (6). The estimation results are presented in Tables 5-6.

Table 5. The results of the quality dimension measurement using the fuzzy conversion scale (defuzzyficated values)

Measure	Likert-type scale	Maruvada, Bellamkonda [2010]; Firuzan et al. [2012]	Shah [2013]	Stefano et al. [2015]	Liu et al. [2015]
Q_1	–0.85928	–1.5549	–0.19436	–0.81876	–1.5549
Q_2	–0.83454	–1.52473	–0.19059	–0.8008	–1.52473
Q_3	–0.97548	–1.75426	–0.21928	–0.9293	–1.75426
Q_4	–0.77015	–1.39424	–0.17428	–0.73603	–1.39424
Q_5	–1.04447	–1.91288	–0.23911	–1.00781	–1.91288

Source: own elaborations.

Table 6. The results of the quality dimension measurement using the fuzzy conversion scale (defuzzyficated values)

Measure	Likert-type scale	Maruvada, Bellamkonda [2010]; Firuzan et al. [2012]	Shah [2013]	Stefano et al. [2015]	Liu et al. [2015]
Q_1 (weighted)	–0.20193	–0.3654	–0.04568	–0.19241	–0.3654
Q_2 (weighted)	–0.18026	–0.32934	–0.04117	–0.17297	–0.32934
Q_3 (weighted)	–0.2107	–0.37892	–0.04737	–0.20073	–0.37892
Q_4 (weighted)	–0.18099	–0.32765	–0.04096	–0.17297	–0.32765
Q_5 (weighted)	–0.18174	–0.33284	–0.04161	–0.17536	–0.33284

Source: own's elaborations.

Regardless which fuzzy conversion scale was used, perceived quality dimension evaluations were negative which means that the respondent expectations concerning quality dimensions were higher than the level of their perception. The same situation was observed for the weighted evaluation of the quality of the dimensions. The

choice of fuzzy conversion scale had no impact on the dimension ranking in terms of unweighted quality dimension evaluations. In the case of weighted evaluations, differences in the rankings were small and concerned the second and fourth dimensions.

One of the reasons for obtaining very high compliance between the attribute and dimension rankings, irrespective of which fuzzy conversion scale was used, may be the method of "fuzzyfication" of the results of the measurement. The authors of the fuzzy conversion scales apply several assumptions, which according to the author are not always met. The first of these is applying a fuzzy conversion scale common to all respondents participating in the survey. Moreover, the selection of fuzzy number parameters representing individual scale points is highly subjective. The second assumption implies an equal spread of fuzzy numbers assigned to the middle categories of the fuzzy conversion scale (except for extreme points, which for natural reasons should not be symmetric). Furthermore, these numbers are usually symmetric. This, combined with the defuzzyfication methods used in the study, leads to a shift of the measurement results on the scale continuum but the distance between the points of the scale remain still the same as in the classic approach which uses Likert-type scales. As a result, the calculated SERVQUAL scores vary greatly in their absolute values, but the relationship between their minorities and majorities are usually the same.

5. Conclusions

Opinion surveys of the respondents which measure, among other things, service quality and satisfaction usually assume the use of the measuring tool in the form of rating scales. However, some authors point out that the results of such a measurement may contain a substantial element of uncertainty resulting from differences in the interpretation of measurement scale points expressed in the form of verbal categories by the respondents. This, in turn, can affect the measurement results and suggest false recommendations concerning the direction of service improvements or the misinterpretation of the results of benchmarking used within an organization and also towards competing organizations. The solution may be the use of measuring methods of service quality based on fuzzy scales.

One of the most popular methods of measuring service quality is the SERVQUAL method, which for the reasons described above has gone through modifications based on fuzzy numbers and is called the fuzzy SERVQUAL method. In the approach which dominates in the subject literature, the fuzzy SERVQUAL method is used together with so-called fuzzy conversion scales. As shown in the analysis in the article, the scales usually include five verbal categories to which are assigned triangular, often symmetric fuzzy numbers. However, the empirical study used in the article showed that the use of fuzzy conversion scales proposed in the subject literature did not affect the results of the unweighted SERVQUAL scores. In the case of weighted scores a small change was observed in two cases. High compliance of at-

tribute rankings in terms of the size of the quality gaps suggests that the choice of fuzzy conversion scales has not affected, in a significant way, the identification of priority directions of quality improvement by using the fuzzy SERVQUAL method. Importantly, the results are similar to those obtained with the use of the approach of the artificial strengthening of Likert-type scales and treating these measurement results as metric scales.

According to the author, at least two issues require further research on the use of the fuzzy SERVQUAL method in service quality research. The first issue concerns the choice of method of ranking fuzzy numbers (defuzzyfication methods are the most common methods in service quality studies), which is undertaken by researchers in a subjective manner. The second issue, which is connected to the first, is checking the stability of the fuzzy SERVQUAL method depending on the asymmetry of the distribution of measurement results before and after a defuzzyfication process. This is especially true when extreme views dominate, as the corresponding fuzzy numbers placed on the fuzzy conversion scales are not symmetric, which can potentially affect the final results of the method.

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