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WROCŁAW PUBLIC TRANSPORT PASSENGERS' SATISFACTION SURVEY BY MEANS OF CSI AND IPA

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ABSTRACT: This paper aims to assess the satisfaction level of passengers who use public transport services in Wrocław and to identify the quality characteristics that the service provider needs to improve if it wants to increase the overall quality of its services. The passenger satisfaction survey was conducted according to the stages of a procedure outlined in the article. In pursuit of the stated goal, CSI and IPA were used. The main measurement tool used was a survey questionnaire. The survey was conducted on a sample of 500 respondents, which allows us to trust the results at 95%, assuming an "estimation error" of ±5%. A total of 14 quality characteristics were selected to evaluate the level of satisfaction of passengers that use services provided by MPK Wrocław. Quality characteristics that each respondent rated were: spatial accessibility, frequency of connections, regularity of departures, directness of travel, speed of travel, punctuality of departures, reliability of travel, travel time, safety, accessibility of information, travel cost, travel comfort, travel integration and investment cost. Statistical data analysis was carried out using Statistica 13.3 software, as well as functions and commands available in Microsoft Excel. The results allowed the authors to conduct a detailed analysis related to the service quality of Wrocław's public transport. Urban transport organisers and operators should use these results to shape their transport offerings, primarily in terms of increasing the quality of transport services. This is very important since it is, among other things, the quality of public mass transport that determines the quality of life of residents, as well as the conditions for the economic development of the transport network.

KEYWORDS: sustainable development, public mass transport, services quality, Customer Satisfaction Index (CSI), Importance-Performance Analysis (IPA)

Introduction

The negative impact of transport on the environment and human health is well known. However, when comparing the environmental costs of public transport and individual automobile transport, it should be objectively stated that greater ecological damage is caused by the latter, with which residents have to cope regardless of their transport choices. If, in addition to air pollution and noise generation, other effects are added, such as the development of urban heat islands or the problem of secondary dust emission, the vision of a "clean" city cannot materialise without introducing measures to reduce road traffic in the city (Trako Projekty Transportowe, 2019). Solving the problem of congestion in the city, caused by the increasing number of cars owned by city residents as well as a large influx of vehicles from outside the city, is one of the goals-both environmental and social-arising from the assumptions of sustainable development of public mass transport in agglomerations (Zawieska & Skotak, 2015).

In order for this goal to be achievable, public mass transit offerings must be competitive with individual transport and therefore must be of high quality. The quality of public mass transit services is determined by the degree to which transport demands made by residents (i.e. passengers – the users of mass transit and potential users of such means of transport who previously used their vehicles) are anticipated and fulfilled. Transport demands are requirements related to meeting the mobility needs of residents (Kauf et al., 2018) made on the public service providers (carrier and/or organiser). In other words, these are quality determinants (characteristics, criteria) that define the level of utility value of[1] public mass transit service (Babis, 1986). The number and types of transport demands are virtually unlimited and constantly changing. They largely depend on the currently experienced traffic conditions, the automotive status of the traveller, as well as the level and lifestyle of the cities. A lot of empirical research and theoretical deductions have been devoted to establishing a list of transport demands. While there is considerable overlap between most of them, there are some discrepancies too. They concern the following (Wyszomirski, 2007):

- combining specific demands into a synthetic one,
- passing over specific demands as less important,
- including rare or even particular demands.

Although the identification of transport demands does not cause significant problems (travel duration, convenience, cost, and travel safety are usually mentioned) (Ciesielski et al., 1994; Wyszomirski, 2007), prioritising

[1] The value in the use of a public mass transit services is the movement of people in space and time.

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their importance is relatively difficult; determined sometimes by transport conditions present in the local market (Kauf et al., 2018). Knowing the rank of each transport demand is of fundamental importance, as it determines which elements of the transport offer should be improved first. The results of a study conducted in 18 cities to prioritise transport demands indicate that the most important are the following: directness of travel, timeliness of departures, frequency of connections, spatial accessibility, cost and convenience of travel, speed and reliability of travel, the rhythmicity of departures and accessibility of information (Wyszomirski, 2008).

The starting point in improving the quality of public mass transit services is the passengers' experience. The quality of public mass transit services as perceived (experienced or felt) by passengers has a direct impact on their satisfaction with the service. In order to determine the level of happiness, it is necessary to carry out marketing surveys to find out the passengers' opinions on the importance of transport demands and the degree to which they are fulfilled. The importance of a criterion determines its relevance in public mass transport services. In other words, the respondent determines how vital each service quality characteristic is to them. The level of performance, on the other hand, is the level of fulfilment of a given characteristic by the service provider. Passenger satisfaction is measured primarily by methods used to measure service quality. Among the most commonly mentioned in the literature and used in practice are the Servqual method and its variations, i.e. CSI and IPA.

The literature on measuring the quality of services of various means of public mass transit (e.g. public transport, passenger rail transport) is numerous. However, it should be emphasised that, apart from a few exceptions, there is still a lack of research works in the field of measuring how satisfied passengers are with the quality of public mass transit services that comprehensively analyse this problem (Sembiring et al., 2018; Justitia et al., 2019). Therefore, the paper's main objective is to develop a procedure for studying the level of passenger satisfaction when using public mass transit services, taking into account the use of CSI and IPA. In addition, a specific objective has been defined, which is to assess the level of satisfaction of passengers using public transport services in Wrocław and to identify transport postulates that require immediate improvement on the part of the service provider, which will give them a chance to quickly improve the quality of services. The subject of research is passenger transport services on streetcar and bus lines of public transport in the area of operation of MPK Sp. z o.o., based in Wrocław. It is worth pointing out that no research papers have been found in the literature on the study of passenger satisfaction using the CSI and IPA for passengers of the Wrocław public transport. There are only papers in which the authors present the structure of the respondent's answers to questions

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related to evaluating the quality of Wrocław public transport services, so their cognitive value is limited (Adamiczka & Adamiczka, 2015; Rada Miejska Wrocławia, 2016). This research gap has inspired the author to investigate this area.

The results presented in this paper are part of the INTERCON project financed under the programme launched by the Minister of Science and Higher Education, i.e. "Regional Initiative of Excellence", between 2019 and 2022, entitled "Structural modelling in the study of the quality of public mass transit services, on the example of MPK Sp. z o.o. in Wrocław. A Passenger's Perspective." The project aims to develop a concept for a structural model, which can be used to analyse the quality of public mass transit services, understood as a public utility, from the passenger's point of view. The model can be later used as a tool for developing the services and improving the quality of life of Wrocław residents.

Research method

The survey of satisfaction levels among passengers who use public mass transit consists of nine stages (Figure 1). The procedure is relatively simple and can be easily carried out in various service areas. The results obtained are quantitative in nature, allowing conclusions to be drawn and comparisons to be made between services.

In stage one of the procedure, the quality characteristics of the transport service should be defined. The set of features to be included in the questionnaire (stage three) can be determined using, among other things, expert knowledge or individual and/or group interviews conducted on purposively selected samples of respondents (Śmiatacz, 2012; Snarski, 2012). The number of characteristics is not strictly defined. As they point out (Wolniak & Skotnicka-Zasadzień, 2008), the use of eight to ten quality characteristics that describe a service is sufficient.

The selection of the research sample (stage two) consists in extracting from the population a certain number of representatives on whom the survey will be conducted. As (Miszczak & Walasek, 2013) points out, the sampling procedure should be preceded by defining the population using public transport services, determining the scope of sampling, selecting the sampling technique, determining the sample size, and selecting the sample elements.

Stage three is the development of the survey questionnaire, with which the satisfaction of passengers using public mass transit will be measured. The questionnaire should consist of three main parts, i.e. the introduction, the central part or questions, and the metric. The introduction should include, among others, the title of the survey, information about the person or company conducting the survey, the purpose of the survey, and the approximate

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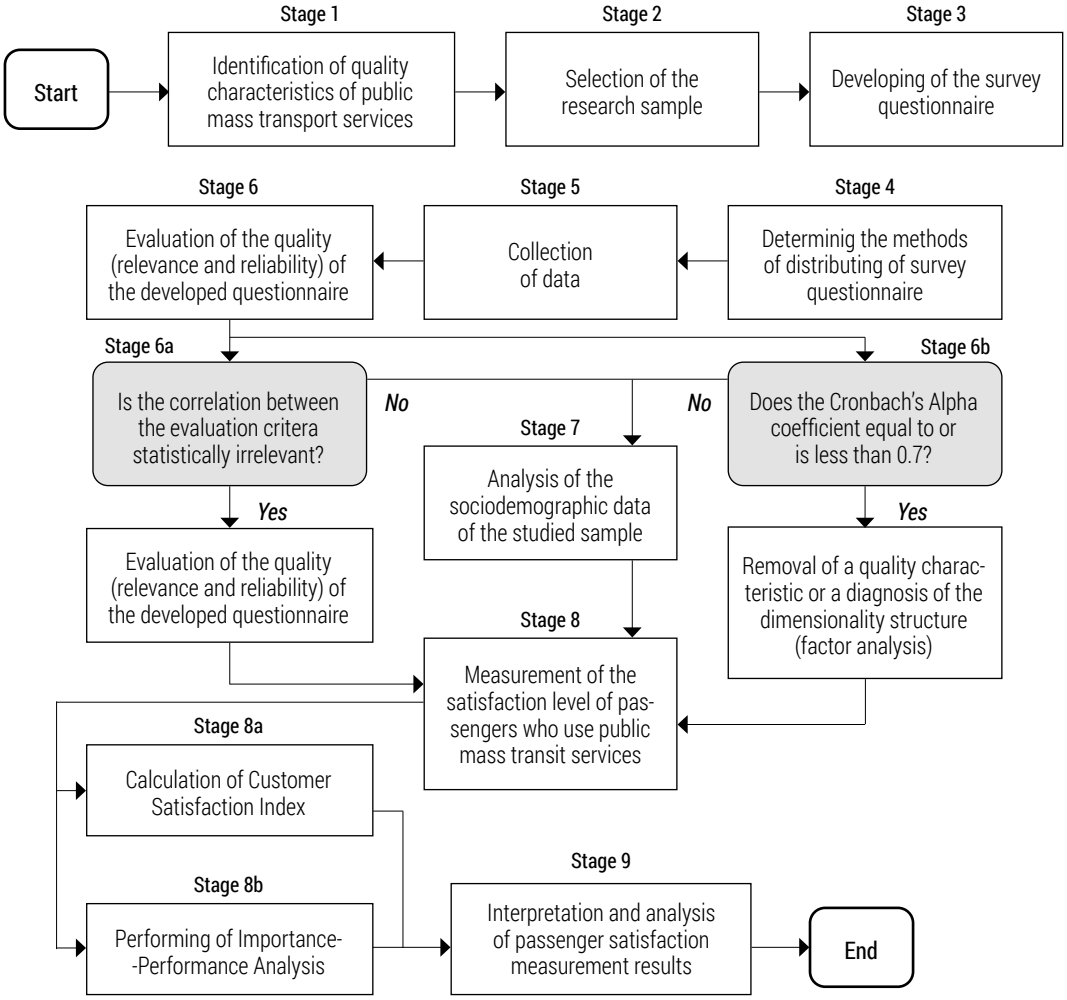

Figure 1. Stages of the procedure for surveying the level of satisfaction of passengers who use public transport services

time of completion. The main part of the questionnaire consists of a set of quality characteristics of the service, as defined in stage one. The correctness of the results obtained is determined by the comprehensibility of the definitions of quality characteristics; therefore, it is worth including them in the questionnaire. Each quality characteristic is evaluated in two aspects, i.e. the importance and the level of its performance. A bipolar ordinal scale, such as the five-point Likert scale, can be used to assess the importance and the level of performance of each characteristic in the questionnaire. The concept of the main part of the questionnaire is provided in Table 1. Furthermore, in the

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main section of the survey questionnaire, additional questions related to the purpose or topic of the study can be included. These questions may include the frequency of the use of transport services, the reasons for undertaking urban travels, car ownership, or public transport entitlements. The final part of the questionnaire contains metric questions, i.e. the questions relating to the respondent's demographic and social affiliation, i.e. gender, age, or occupational status.

Table 1. Sample questionnaire for measuring the quality of public transport services

No.	Service quality characteristic	Definition of service quality characteristic	Mark with "X"	
			The level of performance of the characteristic by the mass transit provider 1 pt – Very low 2 pt – Low 3 pt – Medium 4 pt – High 5 pt – Very high	How important is the criterion for you? 1 pt – Not important 2 pt – Of little importance 3 pt – No matter 4 pt – Important 5 pt – Very important
1.	.....	.....	1 2 3 4 5	1 2 3 4 5
...	.....	.....	1 2 3 4 5	1 2 3 4 5
C.	.....	.....	1 2 3 4 5	1 2 3 4 5

Stage four should indicate how the survey questionnaire will be delivered to respondents. Methods of distributing surveys have been described in detail in the works (Szyjewski, 2018; Kauf & Tłuczak, 2013), among others.

The fifth stage is the collection of qualitative and quantitative data on the level of performance and importance of the characteristics determining the quality of the services as well as relating to the demographic and social affiliation of the sample, or additional questions. The collected data will be analysed in the seventh and eighth stage.

Before analysing the data, it is necessary to determine the relevance and reliability of the created survey questionnaire (stage six). An assessment of relevance will ensure that the service quality characteristics adopted in the questionnaire accurately, or not, describe the passenger's perceived and expected quality under study. For this purpose, correlation coefficient can be used between the two examined variables quality characteristics), i.e. Pearson's linear correlation coefficient (Greń, 1982):

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})\cdot(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2\cdot\sum_{i=1}^{n}(y_i-\bar{y})^2}}, \quad (1)$$

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where:
x_i – variable value (quality characteristic) X,
y_i – variable value (quality characteristic) Y,
x – arithmetic mean variable,
y – arithmetic mean of variable,
n – number of respondents, where $i = 1, ..., n$.

Pearson's coefficient takes values in the range (-1; 1). The value of the coefficient determines the strength of the correlation between the variables (service quality characteristics), while the sign of the coefficient indicates its direction. By comparing different ranges of absolute values of the coefficient, used to interpret the results obtained, it can be seen that with data from the area of social sciences, the strength of the correlation is determined as follows (Moore et al., 2013):

- $|r|<0.3$ – no or very weak correlation,
- $0.3\leq|r|<0.5$ – weak correlation,
- $0.5\leq|r|<0.7$ – moderate (medium) correlation,
- $|r|>0.7$ – strong correlation.

To estimate the interscale correspondence of individual quality characteristics, it is necessary to determine the correlation matrix between these characteristics. According to (Justitia et al., 2019), the value $r \geqslant 0.3$ can be taken as a criterion for a satisfactory level of consistency. It is worth noting that the interpretation of the correlation's strength and direction is less important than the information on whether the correlation is statistically relevant. To verify the significance of the correlation coefficient, the hypothesis that X and Y variables are not correlated should be checked, i.e. null hypothesis H_0: $r = 0$, against the alternative hypothesis H_1: $r \neq 0$. Student's t-distribution for the predetermined α significance level and for $D - 2$ degrees of freedom shows t_α critical value, so that $P\{|t| \geqslant t_\alpha\} = \alpha$. If the comparison of value calculated based on formula 2, i.e.:

$$t_{(\alpha,n-2)} = \frac{r}{\sqrt{1-r^2}} \cdot \sqrt{D-2} \quad (2)$$

with t_α critical value results in $|t| \geqslant t_\alpha$ inequality, then H_0 hypothesis about the absence of correlation between the variables has to be rejected. However, when the $|t| < t_\alpha$, there are no grounds to reject H_0 hypothesis, that and variables are uncorrelated.

However, by performing a reliability analysis of a survey questionnaire, the internal consistency of the tool is determined. More specifically, a reliable survey questionnaire is one that, when used twice, will yield similar results.

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To determine the reliability of the tool's measurement, Cronbach's Alpha coefficient (Cronbach, 1971) can be used, the basis of which is the assumption that a person's responses to each question should be similar. This coefficient is, therefore, a measure of the consistency of a set of scales[2]. Cronbach's alpha coefficient (formula 3) estimates the proportion of the variance of the actual score that stemming from the questions given by comparing the sum of the variance of the questions to the variance of the sum scale (Parkitna, 2020):

$$\propto_C = \frac{K}{K-1} \cdot \left(1 - \frac{\sum_{k=1}^{K} {s_k}^2}{{s_{sum}}^2}\right), \tag{3}$$

where:
α_C – the function of Cronbach's Alpha coefficient,
s_i^2 – variance of individual items (questions),
s_{sum}^2 – variance of the sum of all items,
K – number of items in the questionnaire, where $k = 1, ..., K$.

Cronbach's Alpha coefficient takes values from 0 to 1, although it can sometimes be negative (the presence of negative correlations between items). Cronbach's Alpha values approaching 1 indicate high reliability of the scale. According to J.C. Nunnally's criterion, scale is considered reliable if the value α_C is higher than 0.7 (Nunnally, 1970).

If, when assessing accuracy, the correlation between the scale items is statistically irrelevant, and/or when assessing reliability, Cronbach's alpha coefficient is not satisfactory, then a decision should be made to remove such items from the scale or to identify the variable's coefficient structure.

The seventh stage includes the characteristics of the research sample on which the research was conducted. According to the APA standard (American Psychological Association, 2019), these characteristics should include basic demographic data, such as the age, gender, education, or social and economic status, as well as other important sample-specific data related to the subject of the survey.

Measurement of the level of satisfaction of passengers who use public mass transit services is carried out in the eighth stage. Calculation of CSI values is carried out in four stages (Sembiring et al., 2018; Utomo et al., 2013)[3], i.e.:

Determination of the average importance of the quality characteristics studied (formula 4) and the average level of their performance (formula 5):

2 Individual questions from the survey are called scale items.

3 In the works of (Hall, 2013; Raposo et al., 2008), other ways of calculating CSI can be found, which is related, among others, to the different perception of customer satisfaction in different countries (CSI models) (Skowron, 2010; Rajendran & Arun, 2019).

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$$\overline{I_c} = \frac{1}{n} \cdot \sum_{i=1}^{n} I_c^n \,, \tag{4}$$

$$\overline{P_c} = \frac{1}{n} \cdot \sum_{i=1}^{n} P_c^n, \tag{5}$$

where:
I_c – average importance of service quality characteristic *c* for respondents,
P_c – the average level of performance of service quality characteristics *c* by the transport company,
n – number of respondents, where $i = 1, ..., n$,
I_c^n – weights assigned by respondents to service quality characteristic *c*,
P_c^n – levels of performance assigned by respondents to service quality characteristic *c*.

Calculation of the weighting factors for each quality characteristic (IF_c):

$$IF_c = \frac{\overline{I_c}}{\sum_{c=1}^{C} \overline{I_c}}, \tag{6}$$

where:
c – number of the next characteristic under study,
C – number of quality characteristics included in the analysis, where $c = 1, ..., C$.

Calculation of the overall weighted score on passenger satisfaction evaluation (*IS*):

$$IS = \sum_{c=1}^{C} \overline{P_c} \cdot IF_c, \tag{7}$$

Calculation of the overall *CSI*:

$$CSI = \frac{IS}{HS}, \tag{8}$$

where:

$$HS = \sum_{c=1}^{C} P_c^{max} \cdot IF_c, \tag{9}$$

where:
HS – maximum overall weighted score relating to the passenger satisfaction rating,
P_c^{max} – the maximum number of points a respondent could assign to the level of performance of service quality characteristic *c*.

CSI takes values from 0 to 1. Table 2 includes ranges of CSI values that will facilitate the interpretation of the level of satisfaction of passengers using the company's transport services. It is worth noting that the ranges presented

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are not universal[4] and, in certain cases, should be changed depending on the specifics of a particular industry or organisation (Wolniak & Skotnicka-Zasadzień, 2008).

Table 2. Interpretation of CSI

Range of values	Interpretation of CSI
CSI ≤ 0.40	The passenger is extremely dissatisfied with the service provided.
0.40 < CSI ≤ 0.60	The passenger is dissatisfied with the service provided.
0.60 < CSI ≤ 0.75	The passenger is moderately satisfied with the service provided.
0.75 < CSI ≤ 0.90	The passenger is satisfied with the service provided.
0.90 < CSI ≤ 1.00	The passenger is extremely satisfied with the service provided.

Source: author's work based on Wolniak and Skotnicka-Zasadzień (2008).

Importance-Performance Analysis (IPA) comes down to the construction of a two-dimensional graph, referred to as an IPA graph[5]. To construct the chart, the following should be performed (Niemiec, 2015; Tucki et al., 2018):

Determination of the division points of the graph using the following formulas:

$$\bar{\bar{I}} = \frac{1}{C} \cdot \sum_{c=1}^{C} \bar{I}_c, \tag{10}$$

$$\bar{\bar{P}} = \frac{1}{C} \cdot \sum_{c=1}^{C} \bar{P}_c, \tag{11}$$

where:

$\bar{\bar{I}}$ – the average of the average weights assigned to service quality characteristic *c*,

$\bar{\bar{P}}$ – the average of the average levels of performance assigned to service quality characteristic *c*.

The value of is placed on the abscissae axis, while the on the ordinate axis. At these points, lines are drawn to divide the graph into 4 areas (quadrants, decision boxes).

Determination of the coordinates for each quality characteristic, taking into account the values of the average relevance and the values of the average level of performance, using formula (4) and formula (5), respectively.

4 In the literature, different interpretations of the CSI value can be found, *inter alia*, in the works: (Justitia et al., 2019; Sembiring et al., 2018; Utomo et al., 2013.

5 Other names can also be found in the literature, such as IPA matrix (Biesok et al., 2016), quality map (Woźniak & Zimon, 2016), or IPA model (Rodzeń & Stoma, 2018).

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Application of the coordinate points of each quality characteristic to the graph.

Each of the quality characteristics analysed is qualified into one of the four areas (Figure 2). This makes it possible to propose appropriate approaches for each of the identified areas (Rogala, 2020).

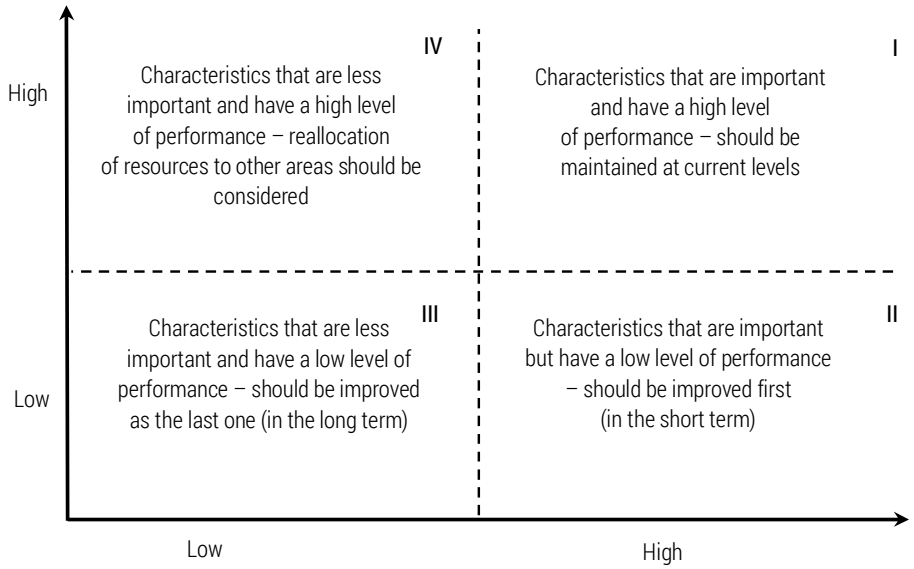

Figure 2. Interpretation of four decision areas placed on the IPA chart

Source: author's work based on Rogala (2020); Wolniak and Skotnicka-Zasadzień (2008).

In the final stage of the survey procedure (ninth stage), the passenger satisfaction survey results should be interpreted and analysed.

Results of the research

Based on the analysis of the literature on the subject, a set of 14 quality characteristics, typical for Wrocław's public transport services, was identified (Table 3). Passengers rated the relevance (importance) of each quality characteristic and the degree to which MPK Wrocław performed them.

Setting the maximum margin of statistical error at 1% (for a confidence level of $\alpha = 0.99$, response distribution of 0.5, and population size of 642,700[6]), it was calculated that the survey sample should consist of 25,975 people. It is

6 According to the Statistics Poland, it is the number of inhabitants of Wrocław as at 31 December 2021 https://wroclaw.stat.gov.pl/zakladka2/

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virtually impossible to implement the survey for such a large sample due to its cost. In addition, to determine the importance of characteristics to the passenger and the level of their performance by the service provider, adopting such a low error value and such a high level of confidence is not necessary, given the frequent change in the views of public transport passengers. In the end, the survey was conducted on a sample of 500 respondents, which allows us to trust the results at 95%, assuming an "estimation error" of ±5%. Sampling was quota-targeted with an algorithm for drawing panellists meeting two criteria, i.e. the respondent had to be a resident of Wrocław and had to have used public transport in Wrocław at least once since the beginning of 2022.

Table 3. Quality characteristics of public transport services with interpretation

No. (a)	Quality characteristic (ca)	Definition of quality characteristic	Publication in which quality characteristic was used
1.	Accessibility	Distance to get to a stop in order to use a given transport network (temporal and spatial).	Wyszomirski and Grzelec (1998); PKN (2004); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).
2.	Frequency	The number of rides made on the same line within a specified time interval.	Wyszomirski and Grzelec (1998); Starowicz (2007); Mikulska and Starowicz (2015).
3.	Regularity	Equal intervals between consecutive departures on the same line.	Wyszomirski and Grzelec (1998).
4.	Directness	Connection without the need to transfer.	Wyszomirski and Grzelec (1998); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).
5.	Speed	Driving time including stopping at stops.	Wyszomirski and Grzelec (1998); Starowicz (2007).
6.	Punctuality	Compliance of departures with the timetable.	Wyszomirski and Grzelec (1998); Starowicz (2007); Mikulska and Starowicz (2015).
7.	Reliability	Getting to a particular destination at the appointed time.	Wyszomirski and Grzelec (1998); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).
8.	Travel time	Time to get to the stop + time to wait for the arrival of the means of transport + transit time + time of any transfers + time to reach the destination.	PKN (2004); Mężyk and Zamkowska (2004); Mikulska and Starowicz (2015).
9.	Safety	Safety while waiting at the bus stop and during transit (e.g. monitoring system in vehicles, monitoring system and lighting of bus stops, proper technical condition of vehicles, experience and skills of drivers, separated lanes for public transport vehicles).	PKN (2004); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).

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No. (a)	Quality characteristic (ca)	Definition of quality characteristic	Publication in which quality characteristic was used
10.	Information	Availability and communication of information related to travel route planning (e.g. schedules, fare tariffs, ticket outlets, announcements about changes in the transport network), and travel route signage (visual or audio information at stops or inside vehicles).	Wyszomirski and Grzelec (1998); PKN (2004); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).
11.	Travel cost	Fare + any additional fees (e.g. for carrying luggage, pets).	Wyszomirski and Grzelec (1998); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).
12.	Comfort	Conditions of waiting at the stop and staying in the vehicle, e.g. cleanliness, seating, degree of congestion, ergonomics.	Wyszomirski and Grzelec (1998); PKN (2004); Mężyk and Zamkowska (2004); Starowicz (2007); Mikulska and Starowicz (2015).
13.	Integration	Synchronisation of fares and schedules of different transport lines on common sections.	Solecka (2013).
14.	Investment cost	The cost associated with the construction, expansion, reconstruction of nodal infrastructure (e.g. bus stops, transfer nodes), line infrastructure (roads), and the purchase of rolling stock.	Solecka (2013).

Source: author's work based on Wyszomirski and Grzelec (1998); PKN (2004); Mężyk and Zamkowska (2004); Starowicz (2007); Solecka (2013); Mikulska and Starowicz (2015).

The survey questionnaire consisted of the following:

1) Introduction – stating the purpose of the survey.
2) The main part, included three closed questions which the respondent answered by choosing a pre-prepared answer. The first two required questions in the passenger satisfaction survey were designed to determine the respondents' level of satisfaction with the performance level of 14 quality characteristics displayed by the transport company that provides public transport services and the importance (relevance) of these 14 characteristics to the respondent. Both questions were rated by respondents on a scale from 1 to 5. These two questions in the questionnaire are presented in a table, according to the example provided in Table 1. This part of the survey questionnaire also asked how frequently the MPK Wrocław transport services were used.
3) The respondent's metrics, through which primary socio-demographic data was collected, i.e. gender, age, and occupational status.

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The survey was conducted from 1 to 2 June 2022 on the Norstat.pl online panel. It is worth noting that a failure to answer all questions in the survey prevented its completion.

The correlation analysis showed that most of the correlations between the respondents' answers to the question on how well MPK Wrocław performs on the 14 quality characteristics (Table 4) and the respondents' evaluation of the relevance of these characteristics (Table 5) are statistically relevant (for $\alpha = 0.05$), which proves the relevance of the questionnaire as a tool for measuring the perceived and expected service quality.

Table 4. Pearson's correlation coefficients between the respondents' answers to the question on the evaluation of 14 characteristics describing the perceived quality of services

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}
C_1	1.00	0.41	0.46	0.38	0.42	0.34	0.40	0.34	0.43	0.45	0.12	0.37	0.43	0.22
C_2	0.41	1.00	0.56	0.47	0.48	0.51	0.51	0.44	0.41	0.44	0.12	0.45	0.53	0.28
C_3	0.46	0.56	1.00	0.46	0.53	0.62	0.60	0.45	0.45	0.47	0.15	0.49	0.56	0.28
C_4	0.38	0.47	0.46	1.00	0.45	0.33	0.37	0.38	0.35	0.37	**0.08***	0.35	0.49	0.22
C_5	0.42	0.48	0.53	0.45	1.00	0.54	0.56	0.43	0.41	0.37	0.10	0.46	0.50	0.20
C_6	0.34	0.51	0.62	0.33	0.54	1.00	0.67	0.37	0.41	0.36	0.20	0.48	0.48	0.20
C_7	0.40	0.51	0.60	0.37	0.56	0.67	1.00	0.47	0.43	0.41	0.09	0.47	0.48	0.24
C_8	0.34	0.44	0.45	0.38	0.43	0.37	0.47	1.00	0.28	0.29	0.10	0.40	0.38	0.15
C_9	0.43	0.41	0.45	0.35	0.41	0.41	0.43	0.28	1.00	0.41	0.13	0.55	0.38	0.24
C_{10}	0.45	0.44	0.47	0.37	0.37	0.36	0.41	0.29	0.41	1.00	**0.06***	0.40	0.41	0.24
C_{11}	0.12	0.12	0.15	**0.08***	0.10	0.20	0.09	0.10	0.13	**0.06***	1.00	0.15	0.14	0.22
C_{12}	0.37	0.45	0.49	0.35	0.46	0.48	0.47	0.40	0.55	0.40	0.15	1.00	0.43	0.28
C_{13}	0.43	0.53	0.56	0.49	0.50	0.48	0.48	0.38	0.38	0.41	0.14	0.43	1.00	0.24
C_{14}	0.22	0.28	0.28	0.22	0.20	0.20	0.24	0.15	0.24	0.24	0.22	0.28	0.24	1.00

* The value of the correlation coefficient *r* in bold indicates a statistically irrelevant correlation (for $\alpha = 0.05$)

Source: author's work based on Norstat.pl.

The level of Cronbach's Alpha for the set of questions diagnosing the perceived quality of services was 0.89, while for the expected quality of services was 0.88, which means very high reliability of the scales used in the questionnaire and allows for the further analysis of the data.

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Table 5. Pearson's correlation coefficients between the respondents' answers to the question on the evaluation of 14 characteristics describing the expected quality of services

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}
C_1	1.00	0.48	0.53	0.48	0.44	0.43	0.43	0.47	0.37	0.38	0.29	0.42	0.35	0.22
C_2	0.48	1.00	0.58	0.40	0.44	0.43	0.44	0.48	0.39	0.34	0.26	0.37	0.42	0.15
C_3	0.53	0.58	1.00	0.41	0.37	0.44	0.42	0.46	0.40	0.33	0.29	0.39	0.46	0.24
C_4	0.48	0.40	0.41	1.00	0.39	0.40	0.42	0.45	0.29	0.38	0.26	0.41	0.38	**0.08***
C_5	0.44	0.44	0.37	0.39	1.00	0.37	0.38	0.44	0.33	0.37	0.25	0.39	0.35	0.24
C_6	0.43	0.43	0.44	0.40	0.37	1.00	0.58	0.52	0.41	0.31	0.33	0.33	0.33	**0.06***
C_7	0.43	0.44	0.42	0.42	0.38	0.58	1.00	0.44	0.37	0.33	0.23	0.34	0.36	**0.09***
C_8	0.47	0.48	0.46	0.45	0.44	0.52	0.44	1.00	0.38	0.29	0.35	0.46	0.38	0.15
C_9	0.37	0.39	0.40	0.29	0.33	0.41	0.37	0.38	1.00	0.36	0.30	0.50	0.35	0.25
C_{10}	0.38	0.34	0.33	0.38	0.37	0.31	0.33	0.29	0.36	1.00	0.31	0.36	0.37	0.20
C_{11}	0.29	0.26	0.29	0.26	0.25	0.33	0.23	0.35	0.30	0.31	1.00	0.32	0.24	0.20
C_{12}	0.42	0.37	0.39	0.41	0.39	0.33	0.34	0.46	0.50	0.36	0.32	1.00	0.33	0.21
C_{13}	0.35	0.42	0.46	0.38	0.35	0.33	0.36	0.38	0.35	0.37	0.24	0.33	1.00	0.29
C_{14}	0.22	0.15	0.24	**0.08***	0.24	**0.06***	**0.09***	0.15	0.25	0.20	0.20	0.21	0.29	1.00

* The value of the correlation coefficient *r* in bold indicates a statistically irrelevant correlation (for $\alpha = 0{,}05$)

Source: author's work based on Norstat.pl.

Table 6. Sociodemographic characteristics of the studied sample

Variable	Subgroup	n	%
Gender	Woman	294	58.8%
	Man	206	41.2%
Age	≤ 18	5	1.0%
	19-26	104	20.8%
	27-39	208	41.6%
	40-59	138	27.6%
	≥ 60	45	9.0%
Occupational status	Student	69	13.8%
	Working person	364	72.8%
	Unemployed	29	5.8%
	Pensioner	38	7.6%

Source: author's work based on Norstat.pl.

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A total of 500 people took part in the passenger satisfaction survey of public transport services provided by MPK Wrocław, including 294 women (58.8%) and 206 men (41.2%) between 16 and 77 years of age. The largest percentage of respondents were employed individuals (72.8%). Detailed sociodemographic characteristics of the sample are shown in Table 6. It is worth noting that the survey included people who use public transport relatively frequently (32.8% of respondents travel by public transport several times a week, while 28.8% of respondents travel daily).

Based on the respondent's answers, the average relevance/importance of each quality characteristic and the average level of their performance by MPK Wrocław were determined, as shown in Figure 3.

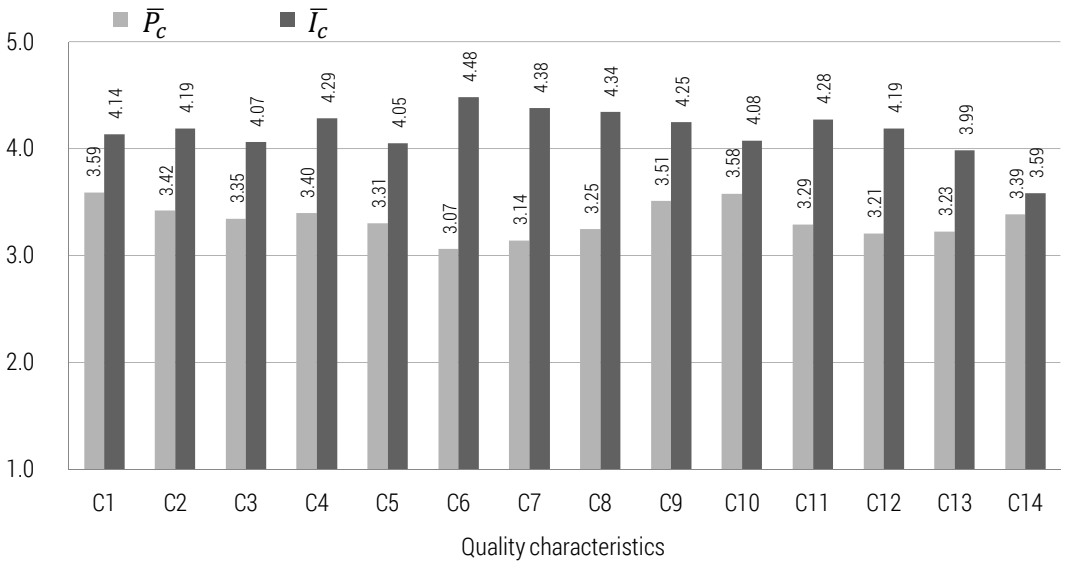

Figure 3. Average importance of the studied quality characteristics and the average level of their performance by MPK Wrocław from the passenger's perspective

Source: author's work based on Norstat.pl.

These values formed the basis for calculating CSI for individual characteristics and overall CSI of public transport services (Figure 4).

The calculated values of $\overline{P_c}$ and $\overline{I_c}$ also provided the basis for linking them to the IPA chart. The location of each point on the graph was determined by determining the size of the (3.34) and (4.17). Determining these quantities allowed us to lay out the boundaries of the separate quadrants (Figure 5).

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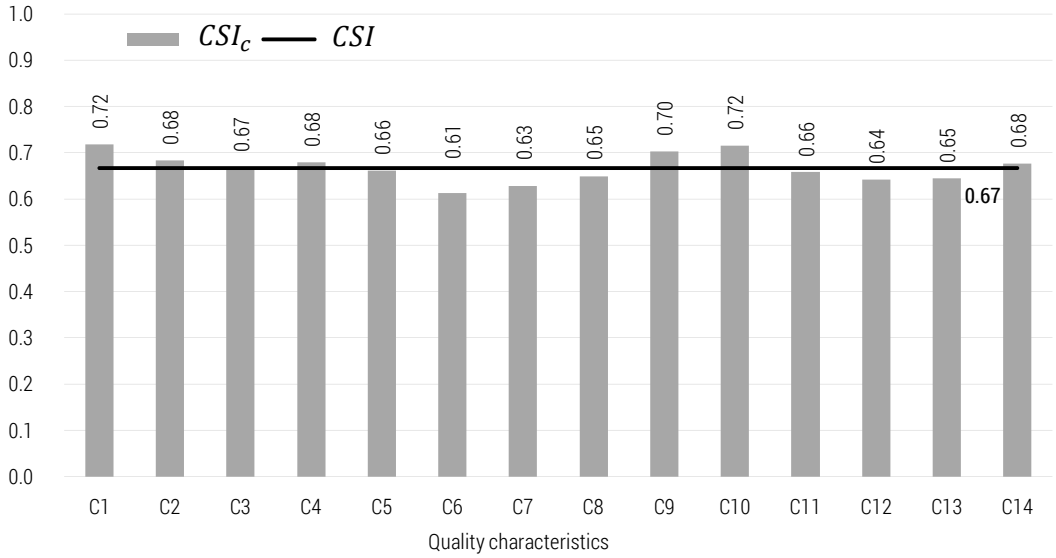

Figure 4. CSI values for individual characteristics and the value of the overall CSI for the transport services provided by MPK Wrocław

Source: author's work based on Norstat.pl.

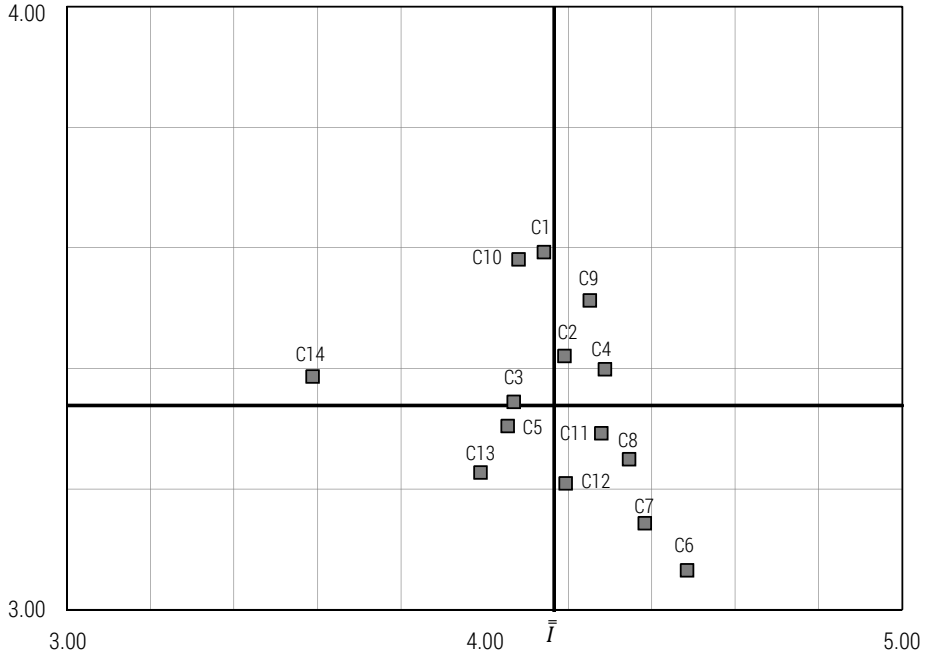

Figure 5. IPA chart for service quality characteristics of Wrocław public transport

Source: author's work based on Norstat.pl.

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The survey shows that passenger expectations for all quality criteria are higher than their performance level (Figure 3). The highest measurement difference is seen in the case of C_6 – punctuality (-1.42) or C_7 – reliability (-1.24), and C_8 – travel time (-1.09). In contrast, the lowest gap size occurs with C_{14} – investment costs (-0.20), so this criterion is the least likely to reduce the overall quality of Wrocław's public transport services.

Negative gap sizes, which indicate passenger dissatisfaction with the service, translate directly into the size of the CSI. Based on the CSI ranges in Table 2, the calculated size of the overall CSI (0.67) indicates that passengers are, on average, satisfied with the transport services that MPK Wrocław provides. Analysing the CSI sizes for individual quality characteristics, it can be seen that passengers, using the MPK Wrocław services, are most satisfied with the spatial accessibility of stops (CSI_1 = 0.72) and information accessibility (CSI_{10} = 0.72), while they are least satisfied with punctuality (CSI_6 = 0.61) and reliability (CSI_7 = 0.63) of Wrocław's public transport.

Negative gap sizes with all quality characteristics indicate that MPK Wrocław should take certain measures to increase its level of performance. However, in order to achieve improvement in the overall quality of its services, MPK Wrocław does not have to improve all characteristics of a given service but only focus on those that are important to its passengers. The analysis of the data in the IPA chart (Figure 5) shows that C_6 – punctuality, C_7 – reliability, C_8 – travel time, C_{11} – cost of travel, and C_{12} – comfort require immediate intervention by the service provider (to increase the level of their performance), while C_2 – frequency of travels, C_4 – immediacy of travel, and C_9 – safety are characteristics for which the carrier does not need to take any special measures, only those that are necessary to maintain their current level of performance. In addition, as resources become available, MPK Wrocław, wishing to improve the overall quality of its services, should shorten driving times

(C_6) and better synchronise the fares and timetables of various transport lines on common sections (C_{12}). The level of performance of the criteria – spatial accessibility of stops, C_3 – the regularity of rides, C_{10} – information availability, and C_{14} – investment costs are the closest to passengers' expectations, so MPK Wrocław does not need to take any measures to increase their level of performance. In summary, the overall level of service quality will increase if MPK Wrocław increases the level of performance of the characteristics placed in the area 2 and 3 of the IPA chart (Figure 5), and provided that the level of performance of other characteristics is maintained at the current level.

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Conclusions

Road traffic in cities is constantly increasing, causing more and more congestion and negatively affecting the standard of living of city residents. One solution to reduce the use of personal cars is to encourage traffic participants to use public mass transit. Public mass transport services should, therefore, have characteristics attractive to traffic participants in order to lead to a lasting change in their transport preferences. To correctly identify the directions for the development of public mass transport, thus guaranteeing the demand for transport services, it is necessary to know the requirements for meeting mobility demands of the residents. The discrepancy (gap) that will arise between the expected (required, preferred) and perceived (received, sensed) quality of services expresses the level of passenger satisfaction with the services of a given provider.

The purpose of this article was to assess the level of satisfaction of passengers who use public transport services in Wrocław and to identify quality characteristics that require immediate improvement on the part of the service provider. This evaluation was carried out in accordance with the procedural stages presented in the article for surveying the level of satisfaction of passengers who use public mass transport services, taking into account the use of CSI and IPA.

The article presents the results of a survey conducted in June 2022 on a sample of 500 people. The evaluation of the relevance and reliability of the developed questionnaire showed that it is an appropriate tool for studying the satisfaction of passengers who use public transport services. A total of 14 service quality characteristics were selected for the satisfaction evaluation. CSI was used to determine passenger satisfaction. The overall CSI was 0.67, which means that passengers are, on average, satisfied with the services provided by MPK Wrocław. The average degree of performance of quality characteristics ranged from 3.07 to 3.59. Passengers considered spatial accessibility the best performing quality characteristic, while they rated the punctuality of public transport vehicle departures the lowest However, the ratings assigned by respondents to the relevance/importance of the quality characteristics indicate that the performance of 12 out of 14 characteristics is important (the average importance rating is greater than 4 points). The average importance of the quality characteristics ranged from 3.59 to 4.48. The most important characteristics of the services quality from the point of view of passengers are the punctuality of public transport vehicles departures (executed according to the timetable) and, rated as the least important, the cost of investments associated with the construction, expansion, or reconstruction of nodal infrastructure (e.g. stops, transfer nodes), line infrastruc-

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ture (roads), and the purchase of rolling stock. The survey also shows that passengers' expectations for all quality characteristics are higher than their performance level. The largest quality gap was recorded for the punctuality of public transport departures (-1.42), while the smallest was for the cost of investment (-0.20). The IPA analysis indicated that if the overall quality of the MPK Wrocław's services is to improve, the company should first increase the level of performance of five characteristics, i.e. punctuality, reliability, time, cost, and travel comfort.

Changes in the level of services provided and in the residents' transport preferences should be identified through systematic marketing surveys. The information provided by such surveys is a hint for the organiser and operator of urban transport about the actions they must take in order to create an optimal transport offer, primarily in terms of achieving the desired quality of transport services. It should be noted that the pursuit of better performance of the indicated characteristics may encounter a number of impediments (financial capabilities of the organiser and/or technical capabilities of the operator). Furthermore, it is beyond dispute that raising the quality of public transport rides involves an increase in fare prices, which are the most important element of public transport services. All these conditions make it very difficult to meet the expectations of low fares for the use of public transport services.

The results of the research presented in the article will be used to identify the "hidden" dimensions (categories) of the evaluation of the quality of public mass transport services using factor analysis. This task represents the next phase of the INTERECON project financed under the programme launched by the Minister of Science and Higher Education, i.e. "Regional Initiative of Excellence", between 2019 and 2022, entitled, "Structural modelling in the study of the quality of public mass transit services, on the example of MPK Sp. z o.o. in Wrocław. A Passenger's Perspective."

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References

Adamiczka, H., & Adamiczka, B. (2015). Analiza i ocena stanu obecnego oraz perspektywy rozwoju komunikacji miejskiej we Wrocławiu. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, (408), 11-35. https://doi.org/10.15611/pn.2015.408.01

American Psychological Association. (2019). *Publication manual of the American Psychological Association*. Washington: American Psychological Association.

Babis, H. (1986). *Kształtowanie jakości towarowych usług transportowych*. Szczecin: Wydawnictwo Uczelniane Politechniki Szczecińskiej.

Biesok, G., Wyród-Wróbel, J., & Świętek-Bysko, A. (2016). Wykorzystanie analizy IPA w badaniach satysfakcji z opakowań kosmetyków. Marketing i Rynek, (7), 18-29.

Ciesielski, M., Długosz, J., Gługiewicz, A., & Wyszomirski, O. (1994). *Gospodarowanie w transporcie miejskim*. Poznań: Wydawnictwo Akademii Ekonomicznej w Poznaniu.

Cronbach, L. J. (1971). Test validation. In R.L. Thorndike (Ed.), *Educational measurement* (pp.443). Washington: American Council on Education.

Greń, J. (1982). *Statystyka Matematyczna. Modele i zadania*. Warszawa: Państwowe Wydawnictwo Naukowe.

Hall, H. (2013). Zastosowanie metod NPS i CSI w badaniach poziomu satysfakcji i lojalności studentów. Modern Management Review, 20(1), 51-61.

Justitia, A., Semiati, R., & Ramadhini Ayuvinda, N. (2019). Customer Satisfaction Analysis of Online Taxi Mobile Apps. Journal of Information Systems Engineering and Business Intelligence, 5(1), 85-92.

Kauf, S., & Tłuczak, A. (2013). *Metody i techniki badań ankietowych na przykładzie zachowań komunikacyjnych opolan.* Opole: Wydawnictwo Uniwersytetu Opolskiego.

Kauf, S., Szołtysek, J., & Wieczorek, I. (2018). *Transport zbiorowy w zaspokajaniu mobilności mieszkańców miast. Doświadczenia JST.* Łódź: Wydawnictwo Narodowego Instytutu Samorządu Terytorialnego.

Mężyk, M., & Zamkowska, S. (2004). Podnoszenie jakości usług w przewozach pasażerskich. TTS, 11(3), 21-27.

Mikulska, A., & Starowicz, W. (2015). Analiza preferencji i satysfakcji pasażerów transportu publicznego w Kielcach. Transport miejski i regionalny, (3), 23-29.

Miszczak, A., & Walasek, J. (2013). Techniki wyboru próby badawczej. Obronność – Zeszyty Naukowe Wydziału Zarządzania i Dowodzenia Akademii Obrony Narodowej, 2(6), 100-108.

Moore, D. S., Notz, W. I., & Flinger, M. A. (2013). *The basic practice of statistics (6th ed.)*. New York: W. H. Freeman and Company.

Niemiec, A. (2015). Możliwość zastosowania analizy istotności-osiągnięć w identyfikacji i ewaluacji zestawu kluczowych mierników dokonań (KPIs). Zeszyty Naukowe Uniwersytetu Szczecińskiego, (873), Finanse, Rynki Finansowe, Ubezpieczenia, (77), 563-572.

Nunnally, J. C. (1970). *Introduction to Psychological Measurement*. New York: McGraw-Hill.

Parkitna, A. (2020). *Determinanty efektywności małego przedsiębiorstwa*. Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej.

PKN. (2004). *PN-EN 13816. Transport. Logistyka i usługi. Publiczny transport pasażerski. Definicje, cele i pomiary dotyczące jakości usług.* Warszawa: Polski Komitet Normalizacyjny.

Rada Miejska Wrocławia. (2016). Plan zrównoważonego rozwoju publicznego transport zbiorowego Wrocławia. https://www.wroclaw.pl/strategia-rozwoju-wroclawia-2030/files/plan-transportowy/plan-transportowy-wroclawia.pdf

DOI: 10.34659/eis.2023.84.1.527

Rajendran, R. P., & Arun, C. J. (2019). Evolution of customer satisfaction index as a performance metric: a comprehensive review. Journal of Xi'an University of Architecture & Technology, 11(12), 536-550.

Raposo, M. L., Alves, H. M., & Duarte, P. A. (2008). Dimensions of service quality and satisfaction in healthcare: a patient's satisfaction index. Service Business, 3(1), 85-100. https://doi.org/10.1007/s11628-008-0055-1.

Rodzeń, A., Stoma, M., & Dudziak, A. (2018). Inne metody pomiaru jakości usług transportowych, czyli alternatywy dla metody Servqual. Zeszyty Naukowe Politechniki Śląskiej: Organizacja i Zarządzanie, 130, 485-495. https://doi.org/10.29119/1641-3466.2018.130.41

Rogala, P. (2020). *Nurt normalizacyjny w zarządzaniu jakością*. Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.

Sembiring, P., Sinulingga, U., & Situmorang, M. (2018). Patient Satisfaction Analysis of Service Quality with Importance Performance Analysis (IPA) Method and Customer Satisfaction Index (CSI). *Proceedings of the International Conference of Science, Technology, Engineering, Environmental and Ramification Researches ICOSTEERR 2018 – Research in Industry 4.0*, Medan, Indonesia, 969-974. https://doi.org/10.5220/0010077609690974

Skowron, Ł. (2010). Modele ścieżkowe jako przykładowe metody badania satysfakcji i lojalności klientów. Ekonomiczne Problemy Usług, 54, 495-505.

Śmiatacz, K, (2012). *Badanie satysfakcji klientów na przykładzie rynku usług telefonii komórkowej w Polsce*. Bydgoszcz: Wydawnictwa Uczelniane Uniwersytetu Technologiczno-Przyrodniczego.

Snarski, P. (2012). Metody pomiaru satysfakcji klientów bankowych wykorzystywanych do analizy konkurencyjności banków. Ekonomia i Zarządzanie, 2, 92-108.

Solecka, K. (2013). *Wielokryterialna ocena wariantów zintegrowanego systemu miejskiego transportu publicznego* [Doctoral dissertation]. Politechnika Krakowska. https://repozytorium.biblos.pk.edu.pl/redo/resources/26345/file/suwFiles/SoleckaK_WielokryterialnaOcena.pdf

Starowicz, W. (2007). *Jakość przewozów w miejskim transporcie zbiorowym*. Kraków: Wydawnictwo Politechnika Krakowska.

Szyjewski, Z. (2018). Metody badania zachowań społecznych. Studia i Prace WNEIZ US, (54/2), 147-162. https://doi.org/10.18276/sip.2018.54/2-10

Trako Projekty Transportowe. (2019). Plan zrównoważonej mobilności miejskiej dla Wrocławia. https://bip.um.wroc.pl/artykul/305/39941/plan-zrownowazonej-mobilnosci-miejskiej-dla-wroclawia

Tucki, A., Świeca, A., Czeczelewski, J., & Boruch, P. (2018). Wykorzystanie metody IPA do oceny usług hotelu SPA Kazimierski Zdrój w Janowcu. EPT, 2(42), 135-144.

Urząd Statystyczny we Wrocławiu. (2022, September). https://wroclaw.stat.gov.pl/zakladka2

Utomo, W. H., Wijaya, A. F., & Widi, C. A. (2013). Customer Satisfaction Analysis to Health Service by Servual 5 Dimension Method and Customer Satisfaction Index. International Journal of Computer Applications, 70(12), 17-21. https://doi.org/10.5120/12014-8039

Wolniak, R., & Skotnicka-Zasadzień, B. (2008). *Wybrane metody badania satysfakcji klienta i oceny dostawców w organizacjach*. Gliwice: Wydawnictwo Politechnika Śląska.

DOI: 10.34659/eis.2023.84.1.527

Woźniak, J., & Zimon, S. (2016). Zastosowanie metody CSI do badania satysfakcji konsumentów na przykładzie wybranej sieci handlowej. Modern Management Review, 23(3), 219-228.

Wyszomirski, O. (Ed.). (2007). *Transport miejski. Ekonomika i Organizacja*. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego.

Wyszomirski, O., & Grzelec, K. (1998). *Badania marketingowe w komunikacji miejskiej.* Warszawa: Izba Gospodarcza Komunikacji Miejskiej.

Zawieska, J., & Skotak, K. (2015). Polityka transportu zrównoważonego w polskich miastach w kontekście jakości powietrza i emisji z sektora transport, cz. I. Transport miejski i regionalny, (11), 4-9.

DOI: 10.34659/eis.2023.84.1.527