

The Measurement of Expected and Perceived Service of a Municipal Transport Based on Selected Medium-Sized Cities¹

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In the literature four basic postulates of transport are usually mentioned: time, convenience, cost and security of travel. The hierarchy of importance of individual postulates of transport depends on subjective evaluations of urban transport users. In the research carried out within the framework of research work financed from funds for science in 2010-2013 titled 'Reference Model of City logistics and the quality of Life of Inhabitants', measured the difference between the expected and perceived quality of urban transport services and defined a hierarchy of evaluated quality criteria. The solution to the problem with too many variables is the possibility of using factor analysis. This analysis allows the reduction of many interrelated variables

Keywords: quality of transport services, factor analysis, cluster analysis

1. INTRODUCTION

A quality of service is a set of criteria, appropriate measures, which a service provider is responsible for while declaring their compliance with an applicable norm². A quality is a collective feature, not appointed, immeasurable, but which can be described and set in quantities³.

Transport services offered on the market are characterized by features that require a different approach to the creating the quality in the case of material products. These features are:

- simultaneity of production and consumption,
- lack of storage,
- uncertainty about to the repetition of good behaviour of operating staff,
- intangibility of services.

The primary criterion for assessing the quality of urban transport is the demand related to fulfilling the needs of traffic. In the literature there are usually mentioned four basic postulates of transport as: time, convenience, cost and security of travel⁴. The hierarchy of importance of individual postulates of transport depends on subjective evaluations of urban transport users.

Relevant elements of service quality are also defined concepts in the literature, as follows⁵:

- expected quality, preferred by a customer,
- target quality, so the desired quality, achievements, which for example a company aims at
- supplied quality, daily available, offered in normal conditions,
- felt quality, perceived by a customer.

Durability relationships with customers depend on the quality of services provided. Hence both the

¹The research carried out within the framework of scientific work financed by the study fund in the years 2010-2013 as a research project.

² W. Starowicz, *Charakterystyka polskiej normy*, Transport Miejski i Regionalny Nr 10 2004, p. 5.

³ R. Kolman, *Ilościowe określenie jakości*, PWE, Warszawa 1973, p.11.

⁴ J. Jackiewicz, P. Czech, J. Barciak, *Standardy jakości usług w komunikacji miejskiej – część 1*, Zeszyty Naukowe Politechniki Śląskiej, Transport z. 67 2010, p. 56.

⁵ I. Dembińska-Cyran, J. Hołub-Iwan, J. Perenc, *Zarządzanie relacjami z klientem*, Diffin 2004, p. 25.

knowledge about the position occupied by the quality in reference to a customer value hierarchy is important as well as the knowledge of a customer's needs and requirements. The value of this knowledge is particularly important taking into the consideration an extremely rapid change and increasing difficulties in anticipating needs and preferences. Hence it is important to select properly and apply techniques to measure the customer satisfaction with transport services.

In the research carried out within the framework of research work financed from funds for science in 2010-2013 titled „Reference Model of city logistics and the quality of life of inhabitants”, measured the difference between the expected and perceived quality of urban transport services and defined a hierarchy of evaluated quality criteria. The main aim of the project is to build a reference model of urban logistics, which can be applied as a tool to improve logistics in order to make the quality of urban life better. The model will be based on the analysis of processes, solutions and good practices in logistics systems of medium-sized cities.

For research under the project were selected three medium-sized cities:

- Gorzow Wielkopolski,
- Zielona Gora,
- and Jelenia Gora.

The choice of cities of this size resulted primarily from low cost solutions while introducing improvements in transportation and logistics and also meant the members of the research team which included representatives of universities located in the surveyed cities.

The results presented in this paper were developed due to the information which dealt with the evaluation of the quality of municipal transport services defined in the course of the project in Gorzow Wielkopolski.

2. AN ANALYSIS AND ASSESSMENT OF THE QUALITY OF URBAN TRANSPORT SERVICES

The service, which experiences a customer has a complex character. It consists of many different elements associated with both the product (service) and with the circumstances of the delivery of this product (service) to a client.

Customer service policy can be interpreted as general goals and objectives of the company aimed at a client. Whereas the source of information about the needs and preferences in reference to the service are customers themselves.

The process of determining the quality of services should take into account the stratification of services, which in the case of transport services include:

- the need for movement which is the core product,
- factors such as punctuality, cleanliness, service reliability, creating a real product,
- and additional elements which fulfil extra needs of clients interpreted as potential product.

It is also important to meet a customer's needs. First, it is necessary to meet the needs resulting from offering the actual product and only then the potential one⁶.

To measure the quality of urban public transport Likert-type scales can be used. These scales can measure the absolute level of customer satisfaction or the size of the gap between the perception of seen quality and expectations associated with the desired level of quality. One of the most popular scales of this type is the scale of SERVQUAL (*Service Quality*)⁷.

In this way obtained grades may relate to many aspects of quality of transport services. Additionally, a comparison of received grades with psycho-graphic consumer's features makes the resulting set of variables very large and interconnected with each other. An analysis of many individual variables does not give the ability to assess the relation between all variables.

The solution to the problem with too many variables is the possibility of using factor analysis. This analysis allows the reduction of many interrelated variables⁸.

⁶ L. Garbarski, I. Rutkowski, W. Wrzosek, *Marketing. Punkt zwrotny nowoczesnej firmy*, PWE Warszawa 2000, p. 25.

⁷ A. Sagan, *Jeden obraz ukazuje więcej niż 10 liczb, czyli jak budować mapy zadowolenia klienta*, StatSoft Polska 2004, s. 35-60.

⁸ G. Wieczorkowska, J. Wierziński, *Statystyka. Analiza badań społecznych*, SCHOLAR 2007, p. 86.

The main advantage of factor analysis is the ability to determine the optimal number of hidden variables, which will explain sufficiently the interrelationships between observed multiple variables. In addition to the received factors the hierarchy of their importance can also be determined from the viewpoint of the customer.

The study was carried out according to the following steps:

Stage 1.

1. Diagnosis of the city logistics system based on secondary data.
2. Identification of quality management areas in the public transport in the city
3. Identification of subjective criteria assessment of the quality of the municipal transport service.

Stage 2.

1. Survey - a subjective assessment of the quality of services in the field of municipal transport. Analysis of inhabitants preferences for the quality of services in the area of public transport. Identification of the hidden dimension for assessing service quality in the field of public transport (factor analysis).

Stage 3.

1. Customer segmentation - cluster analysis.

Applied data for the construction of factorial model may be responses to the SERVQUAL scale obtained from the studies carried out in the first quarter of 2011 in Gorzow Wielkopolski.

The research sample was the residents of Gorzow Wielkopolski, between 18 and 70 years of age. During the study two variables were controlled: age and gender. In the study the following assessed features were given:

- punctuality of vehicles (x_1),
- frequency of the circulation of vehicles (x_2),
- travel safety (x_3),
- travelling conditions in vehicles (x_4),
- waiting conditions at bus stops (x_5),
- accessibility to public transport (x_6),
- ticket prices (x_7),
- direct connections (x_8),
- drivers' manners (x_9),
- overall quality of information (at bus stops and in vehicles and on vehicles) (x_{10}),

- readability and ease of remembering timetables (x_{11}),
- opportunity of talking about public transport (x_{12}),
- frequency of tickets' control (x_{13}).

The basis for determining the individual evaluation criteria were regular research on the quality of services carried out by the Municipal Department of Communications in Gorzow Wielkopolski.

In the first phase of research the relative quality gaps were determined (differences between real preferences and travellers' evaluations) and the absolute quality gaps (differences of maximum, possibly ideal customers' expectations for service and actual ratings of respondents)⁹. The results of this study phase are presented in Table 1.

Table 1. Gaps in the quality of public transport

Quality Value	Relative quality gap	Absolute quality gap
Punctuality of vehicles (x_1)	-1,00	-1,67
Frequency of the circulation of vehicles (x_2)	-1,08	-1,89
Travel safety (x_3)	-0,93	-1,67
Travelling conditions in vehicles (x_4)	-1,05	-2,02
Waiting conditions at bus stops (x_5)	-1,02	-2,12
Accessibility to public transport (x_6)	-0,80	-1,79
Ticket prices (x_7)	-1,16	-2,22
Direct connections (x_8)	-0,99	-1,94
Drivers' manners (x_9)	-0,73	-1,72
Overall quality of information (at bus stops and in vehicles and on vehicles) (x_{10})	-0,60	-1,61
Readability and ease of remembering timetables (x_{11})	-0,51	-1,65
Opportunity of talking about public transport (x_{12})	-0,44	-2,07
Frequency of tickets' control (x_{13})	-0,18	-1,65

Source: own calculations.

⁹ W. Starowicz, *Preferencje i satysfakcja pasażerów z usług transportu zbiorowego w Lubinie*, Materiały konferencyjne z VI Konferencji Komunikacji Miejskiej, Lubin 2003, p. 45.

For all evaluated aspects, the differences between perceived and expected quality were obtained. The biggest difference was related to the ticket prices. Quite large differences were also obtained in the case of driving conditions and the conditions of waiting at the bus stops.

By analysing many aspects of service quality it can be assumed that certain factors will be perceived by the respondents 'as one'. Although they describe various determinants for respondents they may be representatives of one hidden factor.

One can therefore assume that the group of analyzed 13 features will be simplified by using a reduced number of hidden factors. For this purpose an exploratory factor analysis was carried out.

The use of factor analysis requires fulfilling the following assumptions¹⁰:

- linearity and monotonicity of relationships between variables,
- normal or close to a normal distribution of variables,
- using variables with terms of at least 5-7 answers,
- adequate number of observations (above 100, optimally 2000 cases),
- the ratio of the number of variables corresponding to the number of observations (the ratio should be 1 to 3 or even 1 to 5).

The construction of factor model proceeds in several stages. The first step is the construction and initial analysis of the correlation matrix between the original variables. The factor analysis can be applied only if there are sufficiently high correlation coefficients between the variables under consideration¹¹. The next step is to choose the appropriate factor model (orthogonal or diagonal), which identifies the way of choosing factors¹² and a factorial method.

These methods can be divided into: methods numbered among principal component analysis (*Principal Components*

¹⁰ A. Sagan, *Analiza rzetelności skal satysfakcji i lojalności*, StatSoft Polska 2003, p. 39-52.

¹¹ It is assumed that the evaluation of correlation coefficients between the variables under consideration should be at least 0,3.

¹² In the segmentation studies the most commonly used is an orthogonal identification.

Analysis) and methods of factor analysis such as a method of main factors.

Prior to testing, one can also try to assess the adequacy of the assumptions of factor analysis. For this purpose KMO statistic was used (*Kaiser-Meyer-Olkin Measure of Sampling Adequacy*). Therefore to confirm the importance of received results Bartlett's test was used.

In Bartlett's test there was as a very large discrepancy. The value of chi-square statistics measuring these differences amounted to 2273,51, and the associated risk of confusion (significance), while recognizing the importance of all coefficients is less than 0,001. The degree of adequacy of tests for the assumptions of factor analysis measured by KMO statistic was 0,898. It is a very good result¹³.

In the next stage of the research in order to determine the optimum number of factors (hidden variables) a method of eigenvalue greater than unity was used as well as the criterion of Cattelan's landslip (*Factor Scree Plot*)¹⁴.

The results of this phase of the study are presented in Table 2 and Figure 1.

Table 2. Eigenvalues of the correlation matrix defining the variances of the following factors and their percentage in the overall volatility of the whole set

Factor	Eigenvalues	Percentage of the total variability	Cumulative percentage of the total variability
1	6,7053	51,5792	51,5792
2	1,3301	10,2313	61,8105
3	0,8520	6,5539	68,3643
4	0,6947	5,3435	73,7078
5	0,5765	4,4346	78,1424
6	0,4945	3,8041	81,9466
7	0,4528	3,4829	85,4295
8	0,4396	3,3812	88,8107
9	0,3354	2,5802	91,3909
10	0,3246	2,4969	93,8878

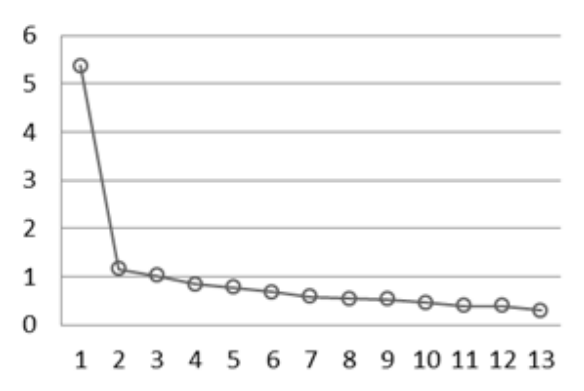
¹³ the interpretation of the value of KMO by Keiser: 0,9 - wonderful, 0,8- worth praising, 0,7 - good, 0,6 - the average, less than 0,5 - not acceptable, from: M. Norussis, *SPSS Professional Statistics 6.1*, s.52

¹⁴ A. Sagan, *Badania marketingowe. Podstawowe kierunki*, AE Kraków 1998, p. 149.

11	0,2983	2,2948	96,1826
12	0,2710	2,0845	98,2671
13	0,2253	1,7329	100,0000

Source: own calculations.

Figure 1. Graph eigenvalues



Source: own source.

On the basis of the first method it was agreed that further analysis should use the first two factors that explain a total of 61,81% of the variance of all variables.

Similar results were obtained by analyzing the landslip graph. On this graph the landslip starts from the eigenvalue of the third factor which suggests the acceptance of further analysis two remaining factors as well. In order to improve and to get so called a simple factor structure the matrix of factor loadings was rotated. In the study the procedure was carried out of orthogonal rotation Varimax type.

The results of this phase of the study are presented in Table 3.

Table 3. Values of charges next the appointed equations of observed variables

Variable	Factor 1	Factor 2
x ₁	0,7601	
x ₂	0,7907	
x ₃	0,7953	
x ₄	0,7970	
x ₅	0,7451	
x ₆	0,7280	
x ₇	0,6556	
x ₈	0,7840	
x ₉	0,5767	
x ₁₀	0,5857	

x ₁₁	0,7116
x ₁₂	0,8007
x ₁₃	0,7132

Source: own calculations.

In the presented table factor loadings were omitted with values less than 0,4, while the analysis was based on loads with values greater than 0,5.

The first factor explains the determinants associated with the conditions of movement within the city offered in urban transport services and they include: punctuality, frequency, security and ticket prices and additionally drivers' manners. Variables described by this factor include four most often indicated traffic postulates: travel time, convenience, cost and safety.

The second factor is related to additional aspects, including transport services in reference to complementary services, such as drivers' manners and quality of available information on the services performed, like:

- quality of available information on the performed services,
- opportunity to assess the quality of services (opportunity to talk about public transport),
- and assessment of controlling the payment of tolls.

This factor includes the indirect determinants in reference to offered services. Using the constructed 13 equations which define each variable observed only by two factors, so the built relationships can be reversed and two equations can be appointed, which will define the value of individual factors¹⁵. For such factors a hierarchy of importance was crated (Figure 2).

¹⁵ M. Rószkiewicz, *Zastosowanie narzędzi statystycznych w strategii pozycjonowania*, Warsaw University publishing, Warszawa 2003, p.14.

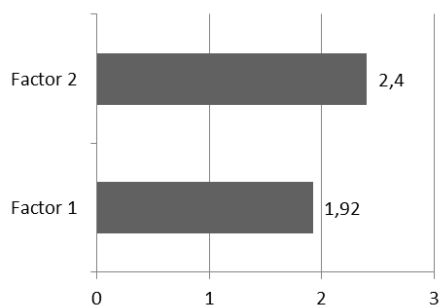


Figure 2: The significance of the determinants of quality assessment of urban transport services

Source: own source.

The most important for customers were the factors associated with the conditions of movement within the city using the urban transport services. A group of the least important factors turned out to be the determinants of drivers related to manners. It was also associated with the availability of information about timetables of public transport vehicles. Differences in average ratings between different factors, however, were relatively small.

Knowledge about how customers store the information and what constitutes a highlight of their field of analysis provides a basis for building an effective communication with customers.

Grouping determinants and knowledge about their significance may also be a basis for evaluating the transfer of information while reaching customers. The arrangement of these factors is also significant and exposing factors of those determinants, which customers feel to be the most important.

3. USING CLUSTER ANALYSIS TECHNIQUES FOR MARKET'S SEGMENTATION

Market segmentation is one of the key stages in creating a marketing strategy. It allows customers to differentiate groups similar to each other and similarly responsive to these marketing instruments which are applied to them¹⁶.

¹⁶ A. Sagan, Łapczyński M., *Techniki segmentacji w badaniach rynkowych*, StatSoft Polska, 2009.

The process of identification and description of the segments can be divided into several key steps as follows:

- selection criteria for segmentation,
- identification of the optimal number of segments,
- assigning consumers to appropriate groups,
- description of individual segments.

There are many different types of divisions and segmentation. Those which are proposed in the literature include ways of the selection criteria and target segmentation. The most famous is the distinction between descriptive and predictive segmentation.

Within the framework of descriptive segmentation all the variables are treated as independent ones (input). However, in the case of predictive segmentation there are two types of variables:

- dependent variable, describing the behavioural aspects of consumers,
- and independent variables explaining the behaviour described in the segmentation criterion¹⁷.

The stage setting clear criteria for segmentation was preceded by an analysis of the reliability of measurement. The reliability of one-dimensional scale adopted in the study was based on α -Cronbach coefficient¹⁸. The resulting score of 0,91one can take as a very good one.

Therefore, further analysis was conducted to classify segments calculated by the algorithm of factor analysis so called *factor scores*, indicating the coordinates of the individual respondents in reference to obtain the factors. These factors will replace in further research the existing primary variables.

In addition, demographic characteristics of the surveyed respondents were also used, such as: gender, age, education, and an overall assessment of quality of life in a tested city (on a scale of 1 to

¹⁷ G. Migut, *Zastosowanie technik analizy skupień i drzew decyzyjnych do segmentacji rynku*, StatSoft Polska, 2009.

¹⁸ This coefficient takes values from 0 to 1 The minimum scale reliability determines Cronbach coefficient greater than 0,6.

5 where 1 is the lowest rating and 5 the highest one).

The received results were analyzed in the system of all accepted at the designed stage of the study of demographic variables. The results of this study phase are presented below (Figure 3-5).

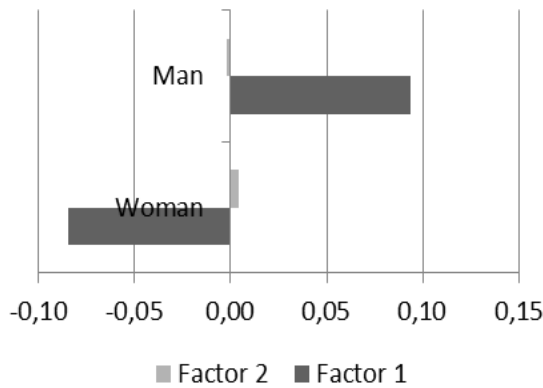


Figure 3. Differences in average ratings by gender

Source: own source.

In the case of factor 1, involving the variables directly related to offered urban transport services the significant differences were notified in reference to gender. Women definitely more critically assess the quality of services in this area than men.

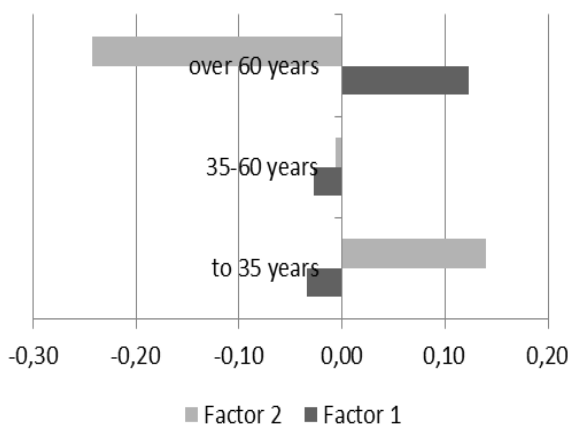


Figure 4. Differences in average ratings by age

Source: own source.

Significant differences by age concern in the case of factor 1 people up to 60 years old and the oldest respondents above 60 years of age. People from the third, the oldest age group better evaluate the conditions of urban public transport travel. However, the assessment of additional aspects of

travel were for this age group far lower than for other groups.

In the case of education important differences in the perception of the factors note the people with higher education and those with vocational education and basic one.

People with higher education better assess additional aspects of public transport services and worse the first factor on the variables forming the core transport services.

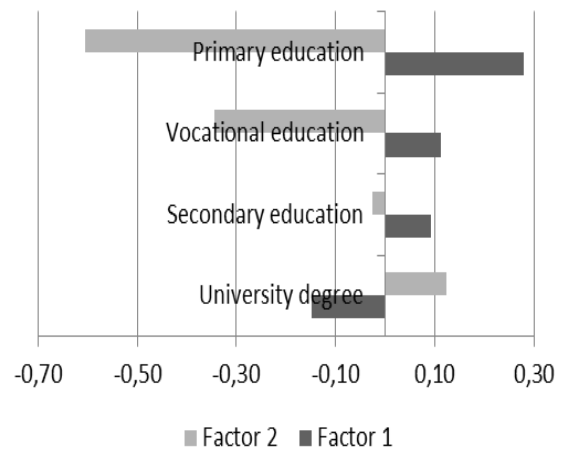


Figure 5. Differences in average ratings by education

Source: own source.

In the next stage of research, for customer segmentation of urban transport services cluster analysis was used. This method is one of the most widely used techniques in descriptive segmentation of customers.

The cluster was isolated by the method of *k-means*. This method belongs to a group of subdivision methods, which optimize the allocation of facilities carried out in accordance with the adopted criterion.

Prior to analysis, one should determine a number of clusters which analyzed objects will be divided into. For this purpose one can use cross-validation assessment.

Using this method of assessing the number of clusters allows to avoid *a priori* assumptions about the number of clusters. Determining automatically

the most appropriate number of clusters can be performed for example in *STATISTICA*¹⁹.

The analysis of the results shows that the respondents should be divided into three clusters. The results of this study phase are presented in table four.

The first segment had about 44% of respondents. The second segment is nearly 33%, while the third segment represents over 23% of the people.

Table 4. Characteristics of clusters

Variable	Cluster 1	Cluster 2	Cluster 3
Gender	Woman	Man	Woman
Age	35-60 years	to 35 years	to 35 years
Education	University degree	Secondary education	University degree
Overall rating	3,0	4,0	4,0
Percent (%)	43,79	32,79	23,42

Source: own calculations.

The first segment is dominated by women aged 35-60 with a university degree and who, the overall quality of life in Gorzow Wielkopolski, assessed at level 3.

The second segment is occupied mostly by men aged 35 with secondary education, assessing the overall quality of life in the city as a good one.

While the third segment is, primarily women, as in the second one mainly aged up to 35, they are also with secondary education and evaluate the overall quality of life as a good one.

4. CONCLUSIONS

Very rapid changes of market conditions affect the management of the transport companies as well. These companies if want to compete successfully for customers need to take an action that will allow them to maintain the current market position. The competition for urban mass transport systems is an individual transport itself.

Efficient management in the case of transport company means the need to implement a number of activities on the market. It also means constant

verification of the passenger transport system looking at the passengers' behavior. This involves the necessity of selecting appropriate evaluation criteria and methods of analysis of the collected material.

In the case of voluminous numerical material the problem with the analysis of many individual variables arises. It is also difficult to present such information in a clear way.

The solution to the problem with too much data can be for example: a factor analysis. This analysis reduces the number of studied variables and reach so-called hidden aspects of evaluation. In this way obtained variables are uncorrelated with one another. They can also be used in the analysis of segmentation.

As the result of studies carried out by authors following conclusions were drawn:

- there are differences between perceived and expected quality of services provided by the Municipal Department of Communications in Gorzow Wielkopolski the biggest difference was related to ticket prices;
- that further research should use the two factors that explain a total of 61,81% of the variance of all variables;
- the first factor explains the determinants associated with the conditions of movement within the city offered in urban transport services, the second one is related to the additional aspects, including transport services in reference to the complementary services, such as drivers' manners and the quality of available information on the performed services;
- women definitely more critically assessed the quality of municipal transport services than men;
- citizens from the oldest group of age, above 60 years old, better evaluated the driving condition of municipal transport than other group of age.

¹⁹ G. Harańczuk, *Analiza skupień na przykładzie segmentacji nowotworów*, StatSoft Polska 2005.

5. LITERATURE

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