ANALYSIS OF THE SELECTED EVALUATION FACTORS IN PUBLIC PASSENGER TRANSPORT USING PIOTRKOW TRYBUNALSKI AS AN EXAMPLE

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Abstract:

The aim of the article is to analyse the selected evaluation factors of the quality of transport services in the public passenger transport using Piotrów Trybunalski as an example. Based on the analysis of the literature on the subject, the examples of factors and criteria for evaluating public passenger transport are presented. Then, numerical data characterising the needs for passenger transport in Piotrków Trybunalski were analysed. Based on this, a questionnaire was developed consisting of 10 questions regarding the quality of transport services provided by MZK Piotrków Trybunalski, and then interviews were conducted. The conclusions from the research are included in the article.

Keywords

public passenger transport, Piotrków Trybunalski, transport needs research, efficiency of transport solutions

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Introduction

Urban transport forms the basis of communication within cities, as well as their connections with external centres. It covers both organized (collective public transport) and individual transport. Its most important category is collective public transport (cpt). It allows for the simultaneous movement of more people by the same means of transport, thus relieving the city's transport system. The effectiveness of solutions in this area depends on many factors. The key one of them is the appropriate selection of vehicles for the transport tasks. It must take into account, the load on specific communication routes, the busiest hours, or the efficiency of the vehicles themselves (economic and ecological parameters), organisational solutions enabling the reduction of the nuisance impact on the natural environment. These are just examples of factors, one of many that should be taken into account.
The aim of the article is to evaluate selected quality factors of transport services in public passenger transport using Piotrków Trybunalski's public transport as an example.

Various tools can be used for this type of data analysis, e.g. a computer simulation method [3], [6], the application of the ARIMA model [4], or neural networks [5], [7]. The study uses mainly a literature review on the subject and the results of the survey conducted.

1. Factors used to evaluate public passenger transport

The literature on the subject contains many studies related to quality, technology and safety in public passenger transport [12], [13], [14].
The main parameters/assessment factors for cpt include [2]:

- punctuality, regarding compliance between the actual arrival and departure of the vehicle, a predefined timetable,
- comfort, related to the condition of the rolling stock and its equipment,
- reliability, relating to the implementation of timetables,
- availability of the transport infrastructure (including interchange nodes, stops, shelters, platforms, stations, ticket machines, cash desks),
- regularity of transport, concerning mainly the regularity of departures of all lines of communication, it is about the frequency of running individual lines,
- speed, relating primarily to pursuing the highest possible speed of covering communication distances,
- directness of the connections, ensuring direct access to strategic places, (most requested by passengers),
- costs at a level that is affordable for residents,
- availability of information in the field of timetables ticket prices and the possibility of their purchase, discounts through various media,
- quality of transport services [11].

The quality of public transport services includes a set of criteria that, in accordance with the PN-EN 13816: 2004P Transport. Logistics and services. Public passenger transport. Definitions, objectives and measurements of the quality of services, Polish Committee for Standardisation, Warsaw 2004, have been divided into the following 8 categories:

- obtainability: the range of the offered collective public transport service in geographical units, time, frequency and means of transport,
- accessibility: access to the collective public transport system, including connections with other modes of transport,
- information: systematic provision of knowledge about the collective public transport system to help in planning and making the trip,
- time: time issues related to the planning and making a trip,
- customer care: service elements to meet passenger requirements,
- comfort: elements of the service to ensure travellers relax and rest,
- safety: sense of personal protection of passengers
- environmental impact: the environmental impact resulting from the provision of the service.

Fig. 1. The number of passengers handled by MZK in the years 2004 - 2018 in an average month of public transport operation in thousands of people [9], [10]

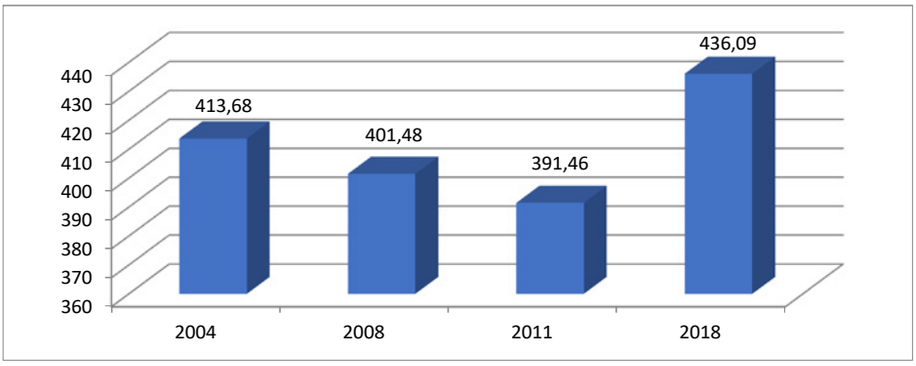
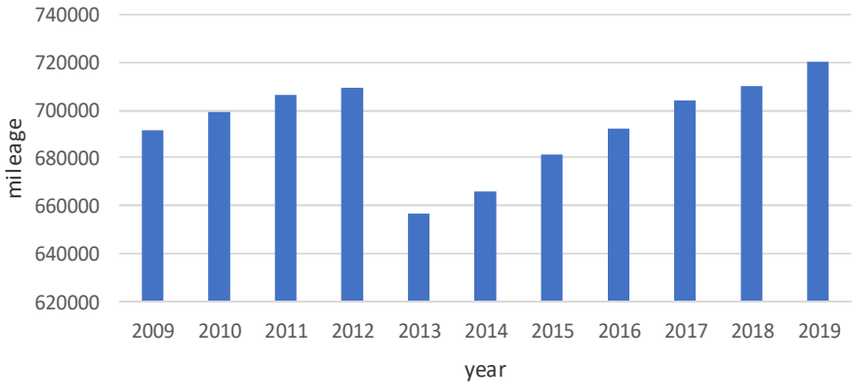


Fig. 2. Total mileage of buses in Poland in 2009-2019 in thousands of veh-km [17]



The above-mentioned factors and criteria are just examples that are used to evaluate public passenger transport and guided the authors to formulate survey questions.

2. The numerical data characterizing the transport needs of Piotrków Trybunalski

In the case of the public transport of the city of Piotrków Trybunalski, detailed statistical research relating is not being conducted. In Piotrków Trybunalski during the years 2004-2018, a research was conducted four times at intervals of several years, enabling the identification of the basic features of cpt in Piotrków Trybunalski (Fig. 1).[9], [10]. Based on it, it was possible to determine the number of passengers using MZK services in the discussed period.

The presented data shows that the number of passengers decreased between 2004 and 2011. However, in the period from 2011 to 2018, there was a significant increase in the number of passengers, which amounted monthly to an average over 436 thousand. The indicator in this case, calculated per 1,000 inhabitants, was approximately 436. It proves a certain level of interest in public transport services in Piotrków Trybunalski. The indicators were highly diversified in terms of the day and time of operation. In 2018, on an average weekday, 17.79 thousand passengers were transported. On Saturdays, 8,33 thousand used public transport, and on Sundays, 5,84 thousand passengers. This data shows that the weekdays are characterized by the highest traffic load.
The data presented is in line with the nationwide trend, i.e. the work performed by buses in Poland in the years 2009 to 2012 increased, then decreased by approx. 8%, to systematically increase in the following years to the level of approx. 72 thousand veh-km in the 2019 (detailed data is presented in Fig. 2.)

When analysing the load of the use of public transport rolling stock, it is necessary to distinguish between time intervals. In the cpt of Piotrków Trybunalski, the highest load in terms of the number of passengers occurs on working days, from 8 am to 5 pm. The percentage of the number of passengers by the day of the week in the individual hourly intervals is presented in Table 1.

Similar results were obtained for the remaining days, while they were also characterised by an increased traffic between 5 pm and 8 pm. On weekdays, though, there is also a high use of public transport from 5 to 8 in the morning, which is primarily related to using public transport on the way to work.

When analysing data, it is worth paying attention to the statement of the number of passengers on a weekday, as well as the number of vehicles available at that time. Data on the number of places in buses, including seats, is also important. The Table 2 shows maximum and minimum number of buses available per hour on a weekday.
Table 2. Available maximum and minimum number of buses per hour on a weekday [1], [8] .

When analysing all this data, it should be stated that ensuring driving comfort and safety requires the use of vehicles with the largest number of seats on the most heavily loaded routes It is worth noting that in these cases not only the city centre is important, but also the outskirts, where the load on vehicles may be greater.
The information presented allowed for the basic characteristics of the use of vehicles in public transport in Piotrków Trybunalski and initial diagnosis of their use. However, the available data does not allow a detailed assessment of the effectiveness of the vehicle selection. Therefore, later in the work, we will present our own survey research carried out among MZK passengers in Piotrków Trybunalski.

Table 1. Percentage share of the number of passengers in the individual hours by type of the day analysed [1] [8]

Hourly period	Day of the week		
	Weekday	Saturday	Sunday
5-8	15,8 %	9,7%	3,9%
8-11	24,7%	21,5%	25,1%
11-14	24,6%	23,3%	22,8%
14-17	22,9%	23,2%	22,6%
17-20	9,1%	16,9%	20,3%
20-23	2,6%	6,3%	5,4%
23-5	0,3%	0,1%	0,0%

Table 2. Available maximum and minimum number of buses per hour on a weekday [1], [8]

Parameters	Values	
	Maximum	Minimum
Number of buses available	28	10
Number of passengers per hour	1458	8
Total number of places available in buses per hour	2545	909
Number of available seats per hour	924	330

3. Results of the author's own research

The proprietary survey research was conducted in January and February 2020. It covered 135 respondents (public transport passengers), characterised by different gender, age, professional activity, level of education, as well as having a driving license. The origin of the passengers and their place of residence were not taken into account in the survey record. The characteristics of the respondents by sex and age are presented in Fig. 3.

The next questions concerned the level of education and the fact of having a driving license. These questions were dictated by the fact that different age groups have different approaches to issues related to, among the others, the environmental protection, which translates into the use of public transport services. Among the respondents, the most numerous group were people with secondary (38%) and vocational (36%) education. 57% of the respondents had a driving license (Fig. 4).

The distinguished and analysed characteristics of the surveyed population allowed to determine the most important factors that could influence their evaluation of the public passenger transport and the frequency of using the PiotrkówTrybunalski cpt. The characterised selection of the sample should allow for the possibility of generalising the results, as the age groups of the studied population, their education, and the fact of having a driving license were evenly distributed.
The first question of the survey conducted was related to the frequency of the respondents using public transport in Piotrków Trybunalski. The most numerous group (53%) in this case indicated the frequent use of public transport (Fig. 5).
The second question of the survey was to distinguish the reasons for using public transport by the respondents (Fig 6). They could also indicate several answers. The most frequent reason for using cpt were indicated – the lack of one's own car (77%), commuting to/from work (39%), as well as matching transport connections to the needs (36%).

Fig. 3. Gender and age of the respondents

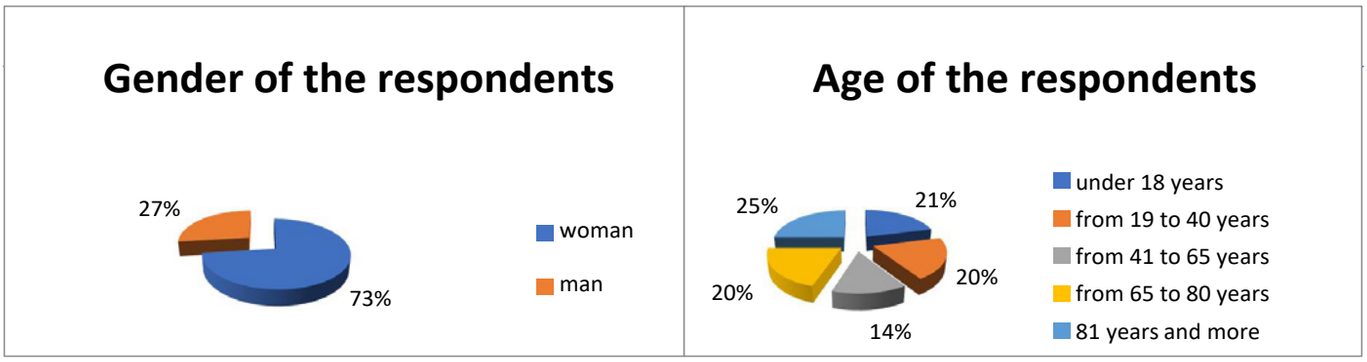


Fig. 4. The level of education and possession of a driving license by the respondents

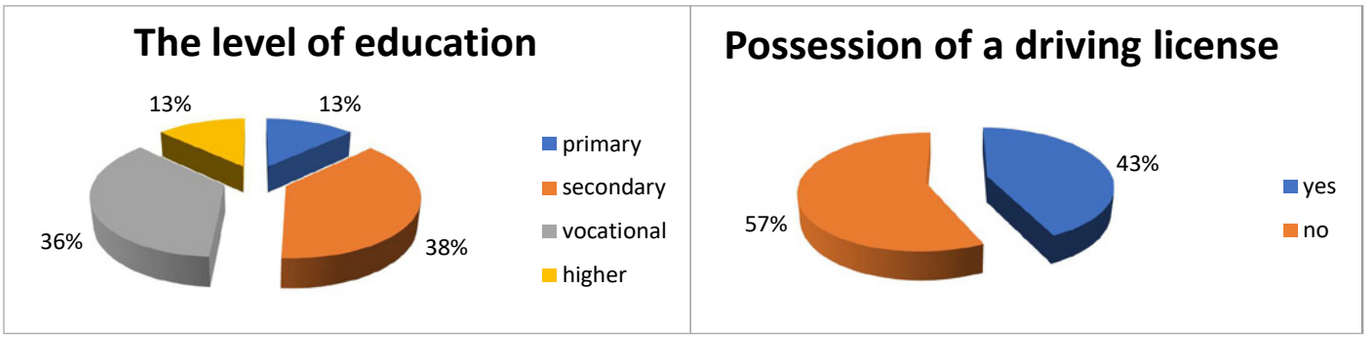
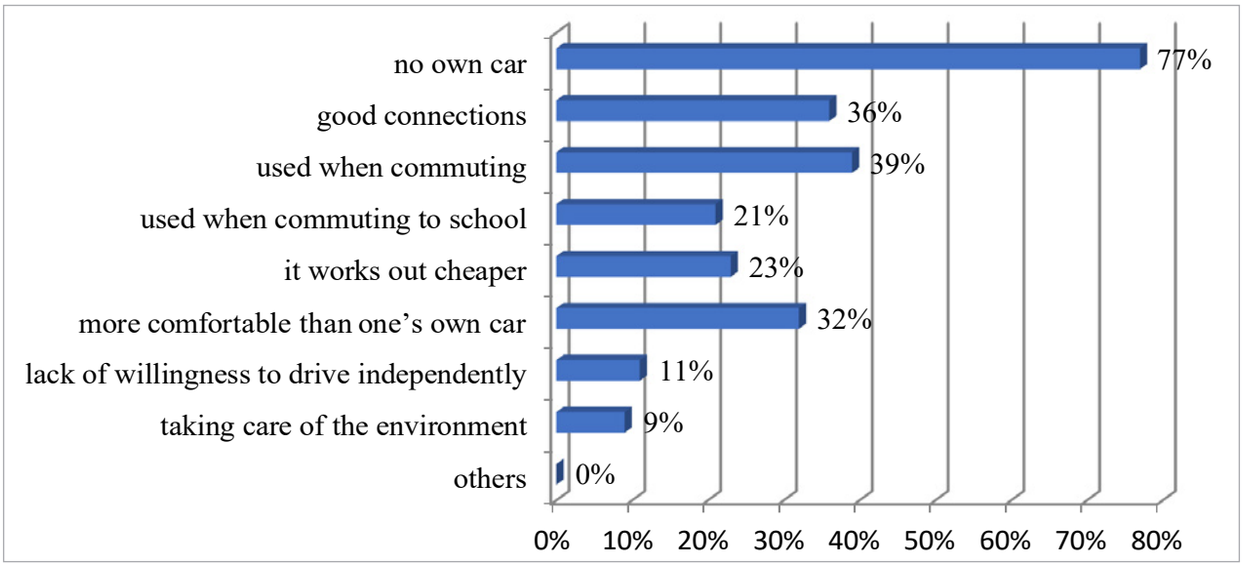


Fig. 6. Reasons for using public transport by the respondents



The third question of the survey concerned the adequacy/adjusting communication connections to the needs of the respondents. Positive opinions in this case accounted for only 33%. As many as 53% of people indicated that for them the transport offer is not adjusted to the existing needs (Fig. 8).

Amongst the reasons for the negative opinion on the adequacy of the public transport offer in Piotrków Trybunalski, the respondents indicated too small number of routes, the lack of accessibility of some areas, and a low frequency of transport.
The fourth question of the survey concerned the quality evaluation of the urban transport services in Piotrków Trybunalski. The respondents had a five-point scale at their disposal, in which 1 was very bad and 5 was very good. The respondents most often rated the transport services as average (47% were given a grade of 3 for service quality). The remaining results are shown in Fig. 8. Based on this data, the mean value of the assessment was calculated, which was approximately 3.19.

In the fifth question, the respondents were asked to indicate the factors that had the greatest and the smallest impact on the effectiveness of cpt. The respondents could indicate several possibilities. Among the responses obtained, the highest share was occupied by the appropriate timetable (91%), the convenience of using public transport (75%), and the adequacy of price and quality of services (73%). The results obtained are presented in detail in Fig. 9. On the other hand, Fig. 10 presents the factors considered by the respondents to be the least important when assessing the impact on the efficiency of cpt. In this regard, the respondents most often mentioned the skills of the drivers (68%), a large number of lines in the city (53%) and the technical condition of the vehicles (50%).

Fig.5. The frequency of using public transport services

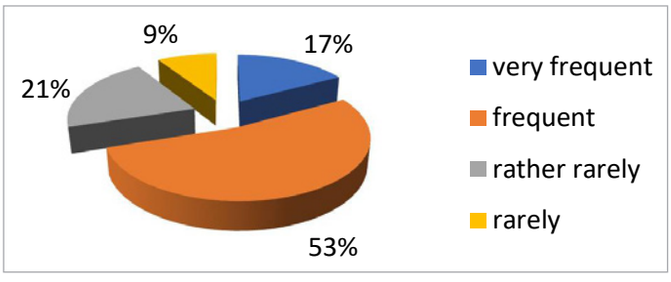


Fig. 7. Adjusting the offer of public transport to the needs of passengers in Piotrków Trybunalski (according to the respondents)

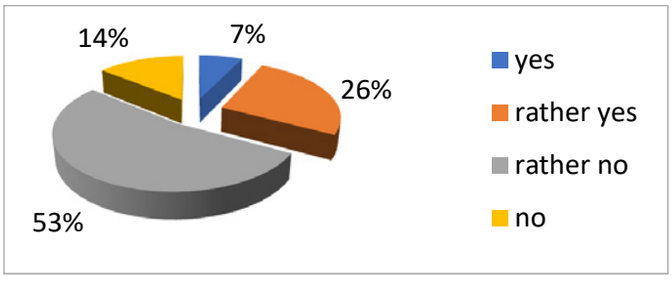


Fig. 8. Assessment of the quality of urban transport services according to the respondents (1 - very bad, 5 - very good)

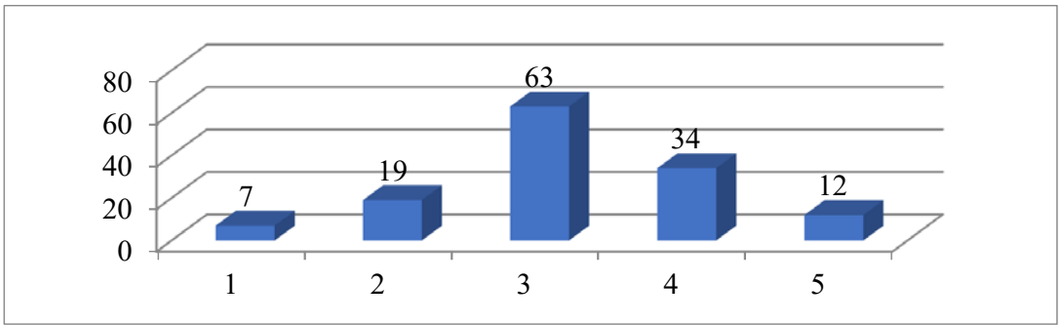
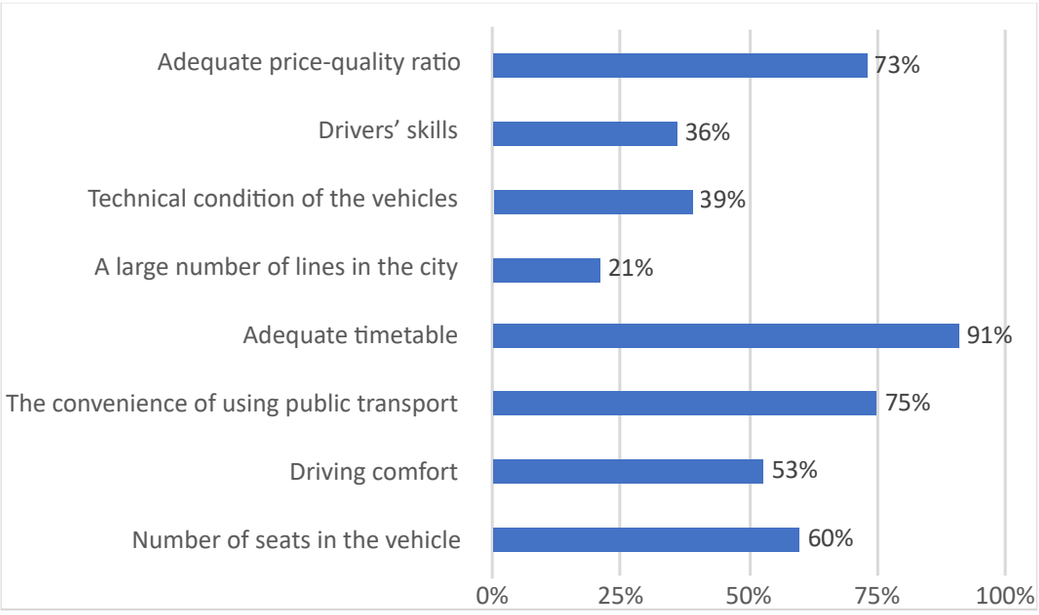


Fig. 9. Factors having the greatest impact on the efficiency of urban transport according to the respondents



Another question from the survey concerned the assessment of the importance of various parameters in the evaluation of the urban transport services quality. In this case, the respondents had a five-point scale at their disposal. Based on the obtained results, the mean score for each parameter was calculated. The values obtained this way are presented in Fig. 11. They show that the greatest importance for the respondents was the adequacy of price and quality. The least significant for the respondents was the insufficient number of passengers on the buses during off-peak hours.

The seventh question of the survey conducted concerned the evaluation of the public transport availability (understood as the number of available bus lines and the distances between the bus stops) according to a five-point scale. The results obtained are presented in Fig. 12. Based on them, the mean value was calculated, which was approximately 3.46.

Fig. 11. Average of the assessment of the importance of individual elements and preferences according to the respondents

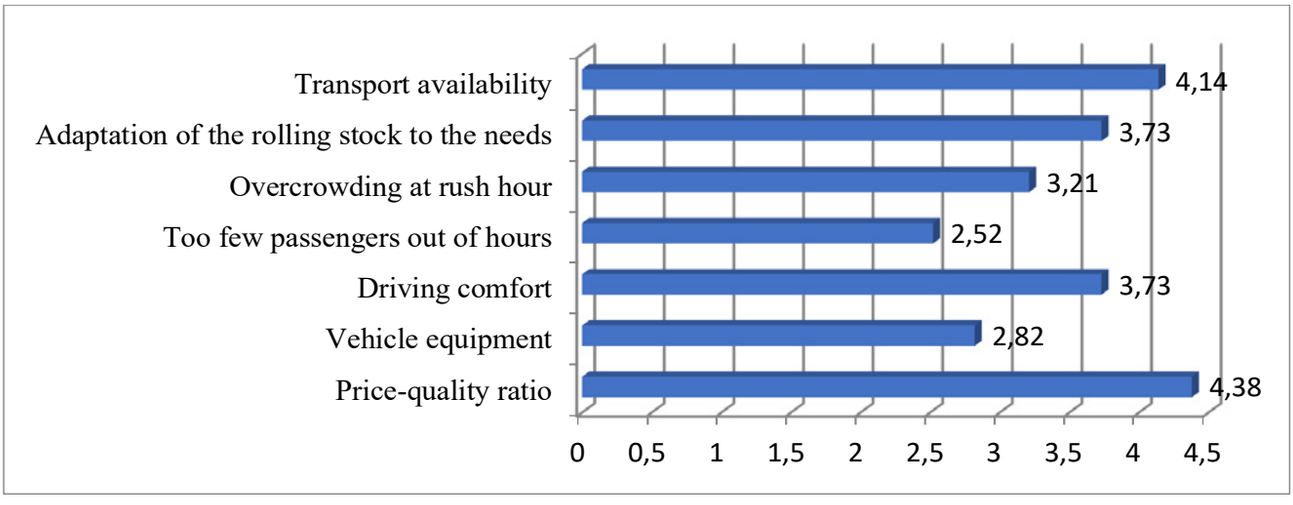
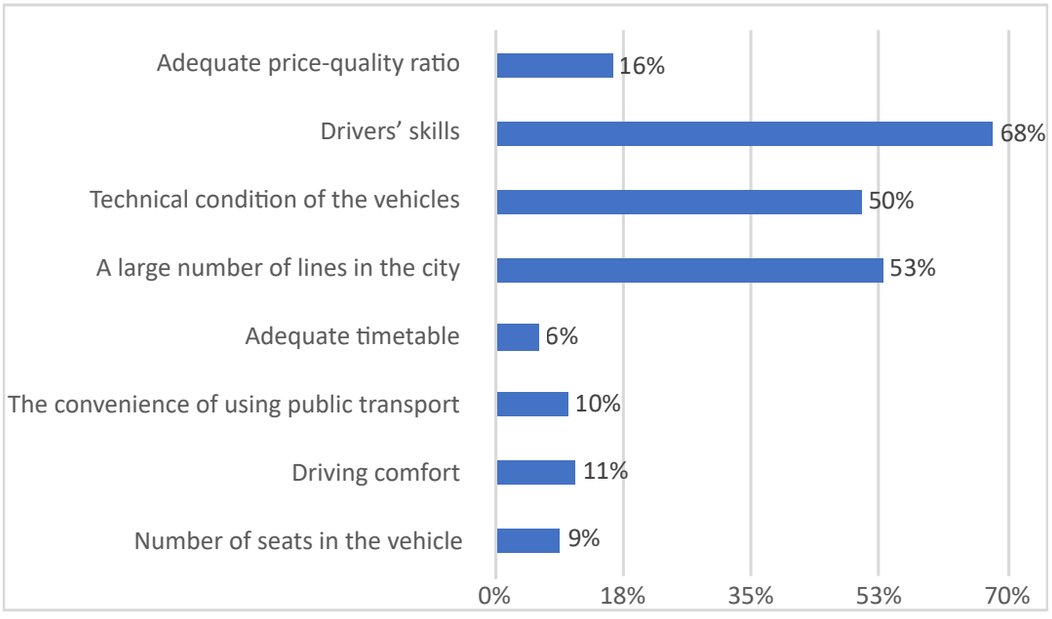


Fig. 10. Factors having the lowest impact on the efficiency of urban transport according to the respondents



In the eighth question of the survey, the respondents were asked to assess the level of adaptation of the vehicles to the needs of passengers. The results obtained in this respect are presented in Fig. 13. The average score calculated based on them was 3.69.

The ninth question of the survey concerned the assessment of vehicle congestion in rush hours. The results obtained are presented in Fig. 14. Based on them, the mean value was calculated, which was approximately 2.87. This is a lowest result obtained, showing that public transport is highly congested during rush hours. On the other hand, Fig. 15 presents also assessments of vehicle congestion outside peak hours. The average value in this respect was 3.81.

The last question of the survey concerned the proposed possible changes in urban transport. In this case, the respondents pointed to outdated rolling stock and ineffective use of its capacity. This applies in particular to the excessive load of vehicles during peak hours and empty runs outside of them. Respondents also believed that a change in vehicle equipment would be important. The up to date listing of the number of buses in MZK in Piotrków Trybunalski is presented in Fig. 16. In total, all 33 buses with combustion engines provide 1092 seats and 1916 standing places.

The results presented of author's own research allowed a detailed analysis of the conditions of public transport in Piotrków Trybunalski. Based on them, it was possible to formulate appropriate conclusions.

Fig. 12. Evaluation of the accessibility of public transport in Piotrków Trybunalski according to the respondents (1 - very bad, 5 - very good)

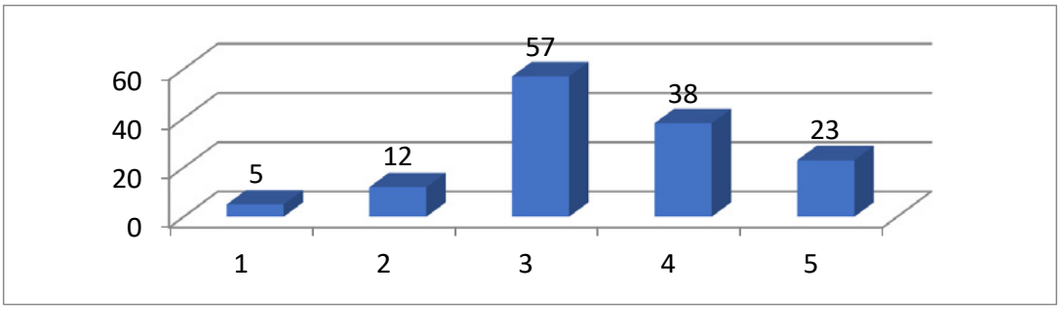


Fig. 13. Evaluation of the adaptation of the public transport vehicles in Piotrków Trybunalski to the needs of inhabitants according to the respondents (1 - very bad, 5 - very good)

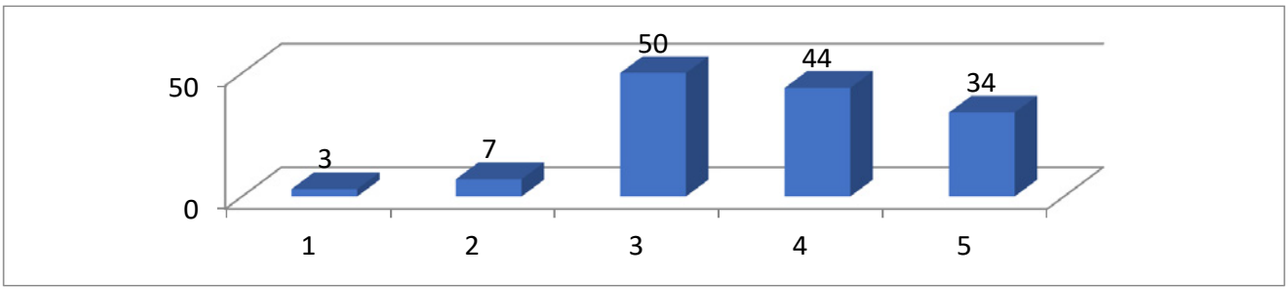


Fig. 14. Assessment of the congestion of public transport vehicles during rush hours according to the respondents (1 - very bad, 5 - very good)

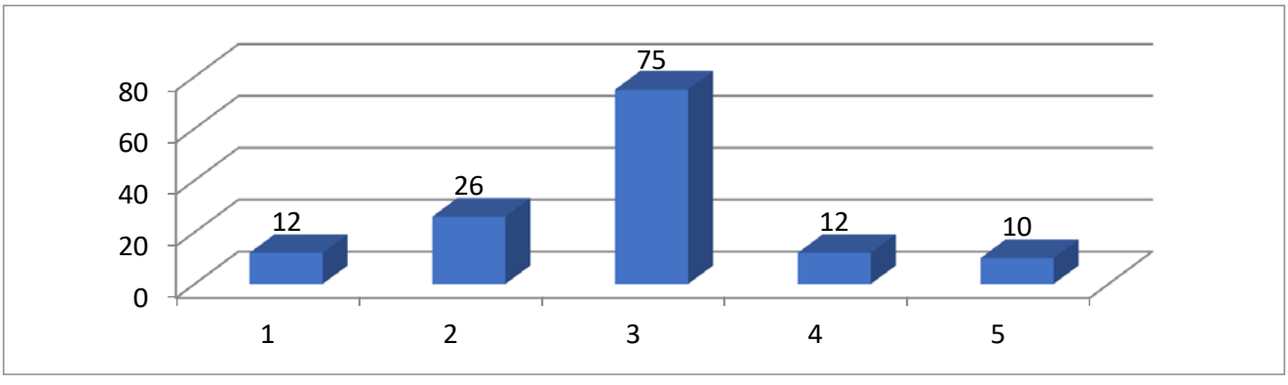


Fig. 15. Assessment of the congestion of public transport vehicles off-peak according to the respondents (1 - very bad, 5 - very good)

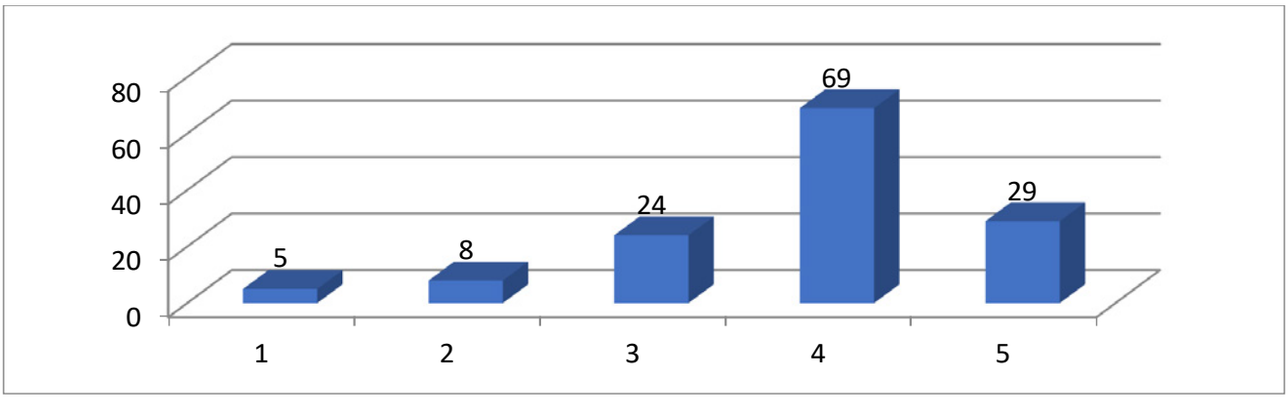
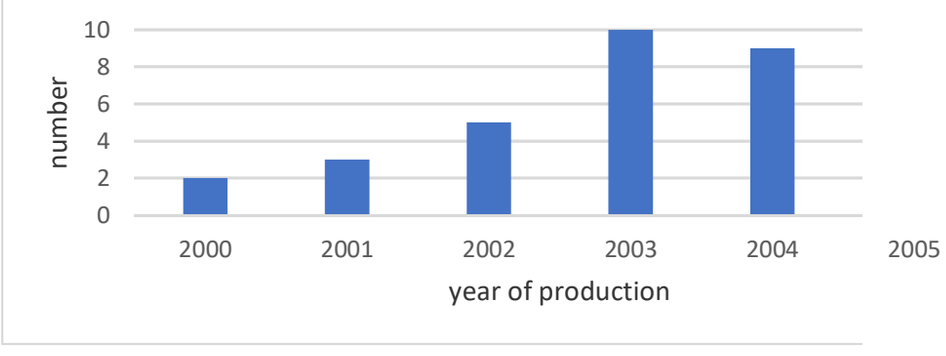


Fig. 16. Comparison of the number of MZK buses in Piotrków Trybunalski [16]



4. Summary

The information collected on the basis of the literature review and authors' own research made it possible to list some of the most important conclusions regarding the cpt offer of Piotrków Trybunalski:

1. The number of public transport passengers in Piotrków Trybunalski has recently increased and amounts to an average of 436 thousand people per month. This tendency may be the result of measures taken to limit car traffic in the city. At the same time, it can be assumed that the interest in public transport has increased by increasing its availability, as well as by affordable ticket prices. The adequacy of the price to the quality of services is one of the most important evaluation criteria according to the respondents.
2. The analysis of the data from previous years (2004-2008) has shown that the greatest load of the public transport vehicles occurs on weekdays from 8:00 to 17:00. During this time, the largest number of vehicles is made available, with an average of about 90 places per bus, including 33 seats. During rush hours on weekdays more than 2.5 thousand residents travel. At the same time, the vehicle load at night is insignificant, but still generates unnecessary costs. Optimisation in terms of vehicle frequency and their size would therefore be desirable in terms of pct efficiency.
3. The respondents differently assessed the individual parameters characterizing the public transport in Piotrków Trybunalski. The overall quality of services provided by public passenger transport was assessed as low, as its direct assessment mark was 3.19.
4. The respondents pointed out that buses were overcrowded during rush hours, which resulted in their poor evaluation of the pct offer. This is due to the fact that there are too many people using certain routes at that time. Optimisation in the planning of bus lines and the related number of available seats in passenger transport should therefore take into account the times of the day and the associated congestion.

Taking into account the above information, an important problem of the public transport in Piotrków Trybunalski is the inadequacy of the offer adjustment in terms of quantity and quality, due to the diversification of transport needs depending on the day and time period. The surveyed respondents also pointed to the obsolescence of the means of transport. The condition of the Piotrków Trybunalski pct fleet is confirmed by the data presented in Fig. 16. For years, the rolling stock is being gradually replaced, but the youngest vehicle is 16 years old. Therefore, further activities should focus on optimising the location of pct lines, their capacity depending on the identified needs and fleet investments. Attention should be paid to the traffic flow and the number of passengers using pct at different time intervals. The demands for changes concern both the rolling stock itself and the need to increase the service of individual communication lines in the selected time windows and days. Currently, the self-government authorities of Piotrków Trybunalski are planning to select new means of transport in the form of zero-emission buses. This investment could significantly improve the quality of services provided by urban transport, increase the number of available vehicles, and have a positive impact on the environmental protection and economic efficiency. However, activities related to the optimisation of the throughput of vehicles and the running frequency of the line are also necessary, depending on the identified needs.

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