

## RATING OF ROAD INFRASTRUCTURE AND PUBLIC TRANSPORT IN RADOM ACCORDING TO RESPONDENTS' SEX AND AGE

Marzenna Dębowska-Mróż<sup>1</sup> , Andrzej Rogowski<sup>2,\*</sup> 

<sup>1</sup>Kazimierz Pułaski University of Technology and Humanities in Radom, Faculty of Transport, Electrical Engineering and Computer Science, Malczewskiego 29, 26-600 Radom, Poland, email: m.mroz@uthrad.pl, <https://orcid.org/0000-0002-4563-175X>

<sup>2</sup>Kazimierz Pułaski University of Technology and Humanities in Radom, Faculty of Transport, Electrical Engineering and Computer Science, Malczewskiego 29, 26-600 Radom, Poland, a.rogowski@uthrad.pl, <https://orcid.org/0000-0002-9988-3805>

\* Corresponding author

Reviewed positively: 10.12.2021

### Information about quoting an article:

Dębowska-Mróż M., Rogowski A. (2020). Rating of road infrastructure and public transport in Radom according to respondents' sex and age. Journal of civil engineering and transport. 2(4), 215-235, ISSN 2658-1698, e-ISSN 2658-2120, DOI: [10.24136/tren.2020.016](https://doi.org/10.24136/tren.2020.016)

**Abstract** – The article presents the results of surveys on public transport and road infrastructure of Radom. There were 855 questionnaires obtained. The 19 questions of the survey were used. The survey, in addition to questions about age and gender, contained questions with specific answer options with single or multiple choice and questions in which the respondent rated the various elements of the transport system. From 8 questions, a 5-point Likert scale was created as a basis for evaluating public transportation and road infrastructure. The reliability of the scale was assessed using the standardized Cronbach's coefficient. The analysis was done in selected groups of respondents with respect to age of respondents, gender of respondents and with respect to both characteristics simultaneously. Using the chi-square test of independence, the dependence of the scores on the age and gender of the respondents was examined. To compare the significance of differences in ratings between the separate groups of respondents, the test of significance of averages was used. The results of the survey indicate that although the overall rating is positive, due to the high percentage of negative ratings, it is necessary to take measures to improve, among other things: safety at bus stops and public transportation vehicles, availability and distribution of parking spaces. The results of the survey were compared with the results of previous surveys. Compared to the 2014 survey, a significant improvement was found in the condition of road infrastructure and the condition and distribution of bike lanes.

**Key words** – public transport, quality of public transport, surveys, transport accessibility

**JEL Classification** – R41, O18, L99

### INTRODUCTION

The transport system in cities is one of the determinants of the quality of life for inhabitants and economic entities operating in this space. The condition, quality and functioning of this system depends on many internal and external factors that determine the freedom of movement of residents, employees or tourists to specific locations in the cities and the spaces directly adjacent to them. In cities, the analysis covers both local and supralocal traffic: regional, national and, in some cases, international.

The evaluation of the quality of urban public transport is carried out in terms of at least four

entities: the passenger, the carrier, the transport manager, the local authority (municipality). Each of these groups evaluates public transport through the prism of its own possibilities, needs and preferences. The most important thing for passengers is an efficient transport service. The managing authorities will strive for effective spending and economical management of financial resources. The operator, on the other hand, is interested in the outcome of the assessment because of the element of competitiveness, possible economic effects, and also because of job satisfaction. All these aspects are related to transport accessibility.

Four quality attributes are particularly important

### Rating of road infrastructure and public transport in Radom according to respondents' sex and age

---

for customer satisfaction: frequency, travel time, safety, and punctuality [1-2]. Cost, staff behaviour, cleanliness and comfort are also important [3]. Reliability and frequency of service are generally important attributes of public transport services. However, for car users, the most important factors are largely affective and related to individual perception, motivation and context. Reduced fare promotions and other transport policy measures that break habits can be effective in encouraging car users to try public transport services. Features beyond basic accessibility, reliability, and mobility provision, perceived by the target market as important service attributes, must then be provided in order to sustain a shift away from car use after promotional tactics expired [4]. Some studies (surveys) show that the main factor influencing commuters' preference for the personal car is the availability of parking space. Women's preference for public transportation is also evident. Congestion is the factor that most discourages the use of public transportation. High fares are not necessarily a deterrent to public transportation [5].

Currently, transportation policies and related transportation research that focus on replacing (passive) car travel with more active modes such as walking, cycling, and public transportation [6].

Accessibility refers to the ability of people to reach goods, services, and activities, which is the ultimate goal of most transportation activities. Accessibility is influenced by many factors: mobility, proximity, connectivity of the transportation system, quality and affordability, convenience, social acceptability, mobility substitutes and land use patterns. Accessibility can be evaluated from a variety of perspectives, including for particular groups, modes, locations, or activities [7].

Conventional planning tends to evaluate transportation system performance primarily on the basis of motor vehicle travel conditions, using indicators such as roadway service levels, traffic speeds, and vehicle operating costs. Other accessibility factors are often overlooked or underestimated. This leads to a preference for mobility over accessibility and for motorized transportation over other modes. Planning decisions often involve trade-offs between different forms of accessibility. Wider roads designed to maximize automobile traffic speeds create barriers to walking and bicycling. Dense development reduces automobile traffic speeds and parking spaces, but improves pedestrian, bicycle, and public transit accessibility [7].

The problem of transport accessibility is widely

considered in the work [8]. The authors of the paper are based on an extensive literature review particularly distinguishing in-vehicle comfort, operational aspects, travel time improvement, environmental impact of public transport services, mode choice and the impact of trip length on passenger preferences.

Requirements for the definition, setting of objectives and measurement of service quality in public passenger transport EN 13816:2002 [9]. It also provides guidelines for selecting appropriate measurement methods. This standard provides an extensive list of service quality attributes, grouped into eight areas:

1. availability: extent of the service offered in terms of geography, transport modes, operating hours, and frequency,
2. accessibility: access to the public transport system including interface with other transport systems,
3. information: to assist the planning and execution of journeys, under normal conditions as well as under abnormal conditions such as delays,
4. time: length of trip time; this area also includes adherence to schedules in the form of punctuality or regularity,
5. customer care: customer interface, staff behaviour and attitudes, and ticketing options,
6. comfort: service elements that make journeys relaxing, enjoyable, or productive, e.g. through station facilities, seating and personal space, ride comfort, vehicle condition, atmosphere, and complementary services such as on-board Wi-Fi,
7. safety: sense of personal protection from crime and accidents,
8. environmental impact: environmental impact resulting from the provision of the public transport service.

One of the widely used research methods is a survey conducted on a random group of the general population or on selected groups of respondents. This method is used in many scientific areas. It is also used in mobility research - more generally in the area of transportation. In paper [10], the authors used the results of a survey to analyze the factors that would induce car users to use public transportation. The study included a specific group of graduate students from the National University of Malaysia. The authors used a logit model and SPSS software. Fearnley et al [11] analyze the factors that would induce travelers to change their mode of travel considering all modes of transportation in urban areas. They base their

research on surveys. However, due to the acquisition of questionnaires, a group of urban residents in Norway who are drivers with an overrepresentation of older people is actually studied. In paper [12], the authors studied the preference of transportation mode choice among university students in Joinville, Brazil. They developed an online survey to assess revealed and stated preferences. They applied a multinomial logit model and used R software. In [13], the study used primary survey data collected by the authors on a bus route in Montreal, Canada, to assess whether users' image of public transportation is associated with their satisfaction and intention to continue using public transportation in the future. Two binary logit models were developed, and the results reveal that having a positive image of transit increases users' chances of satisfaction and intention to continue using transit in the future.

### 1. RESEARCH OBJECT

Today, Radom is a city with the status of a county located in the central-eastern part of Poland. It is the second largest settlement in the Mazovia Province (after Warsaw). In terms of size, Radom is the fourteenth largest city in Poland. It covers an area of 111.8 km<sup>2</sup> and has 212 thousand inhabitants. Women constitute 52.9% of the population. Since 1995, the population of Radom has been constantly decreasing.

Radom can be considered as a strongly urbanized city in the central part of its administrative borders, within the radius of about 3 km from the city center. Most of the city inhabitants live here and all the main city institutions, public buildings, services, utilities etc. are located here. Outside this area, there is mostly single-family housing, agricultural land or undeveloped land and industrial areas.

Movements in Radom are mainly connected with commuting to work and to school. Thus, the morning and afternoon peaks are very visible in the daily analyses of the traffic distribution in the city.

The system of bus lines is very well developed and covers the majority of streets in the city center

as well as provides more important direct connections via the medium-distance lines passing through the city center and connecting its opposite areas.

The research of the transport system of Radom and the mobility of its inhabitants is carried out by the researchers of the Faculty of Transport, Electrical Engineering and Computer Science of the University of Technology and Humanities in Radom. The largest (both in terms of scope and number of surveys and measurements) is the study [14]. In this article, on the basis of surveys, we present the rating of public transport and road infrastructure of Radom by different groups of respondents taking into account the age and gender of respondents. The results were compared with the results of previous studies [14] and [15].

### 2. METHODOLOGY

The assessment of road infrastructure and public transport in Radom was based on a survey conducted in 2018<sup>1</sup>. The target group was not specified. We received 858 questionnaires. There were 3 groups of questions used in the analysis<sup>2</sup>. First group of questions characterized respondents – age, gender. The second group consisted of 11 questions<sup>3</sup>, in which the respondent evaluated the chosen element of the public transport or road infrastructure. The respondent had to choose one of the given answer options. The third group consisted of 6 multiple-choice questions<sup>4</sup>. For the eight questions of the second group<sup>5</sup>, the answer choices constituted a five-point Likert scale<sup>6</sup>. For this group of questions, a point scale was created (5 – the best rating, 1 – the worst rating). The average number of points from 8 questions is the rating (points) of public transport and road infrastructure of Radom given by the respondent. The average of rating for all respondents or the group of respondents is the rating of public transport and road infrastructure.

For selected groups of respondents, the reliability of the scale was checked by calculating the standardised Cronbach's coefficient:

<sup>1</sup> By Angelika Banasik, a student of the Faculty of Transport and Electrical Engineering at the University of Technology and Humanities in Radom, as part of her engineering thesis titled "Comparison of transport accessibility of different modes of transport in a selected area based on studies", supervised by Dr Marzenna Dębowska-Mróż.

<sup>2</sup> A total of 19 of the 21 that the survey covered. The survey questionnaire was not included in the paper. The survey questions and acceptable response options are included in the corresponding figures in the chapter "Results and discussion". The numbers of the figures are also the numbers of the survey questions.

<sup>3</sup> These are questions 3 to 13.

<sup>4</sup> These are questions 14 to 19.

<sup>5</sup> These are questions 6 to 13.

<sup>6</sup> very good, good, satisfactory, bad, very bad.

**Rating of road infrastructure and public transport in Radom according to respondents' sex and age**

$$\alpha_{st.C} = \frac{k\bar{r}}{1 - (k - 1)\bar{r}} \quad (1)$$

where

k – number of scale items,

$\bar{r}$  – average correlation coefficient between all pairs of items<sup>7</sup>.

Due to the age of respondents four groups were separated<sup>8</sup>: 16-25 years old, 26-35 years old, 36-45 years old and 46-55 years old. There were 6 basic groups of respondents, for which analyses were conducted<sup>9</sup>. For some analyses an additional 8 groups of respondents were created, taking into account both gender and age.

In order to examine whether the answers to the individual questions depend on the gender and age of the respondents<sup>10</sup>, chi-square tests of independence were carried out. The significance level of  $\alpha = 0.05$  was assumed. In the case of examining the dependence of responses on gender, the age of respondents was not taken into account. In addition, the study of dependence of responses on age was considered separately in the group of men and separately in the group of women. Tests

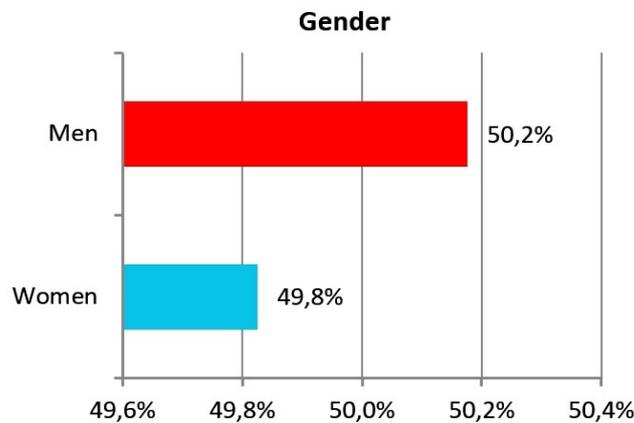
were carried out for all single-choice questions<sup>11</sup>.

In order to examine whether the evaluation of public transport and road infrastructure<sup>12</sup> differs (statistically significantly) among the different groups of respondents, a statistical test of significance of means was carried out ( $H_0: \bar{x}_1 - \bar{x}_2 = 0; H_1: \bar{x}_1 \neq \bar{x}_2$ ):

$$U = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\hat{s}_1^2}{n_1} + \frac{\hat{s}_2^2}{n_2}}} \quad (2)$$

**3. RESULTS AND DISCUSSION**

The sample obtained is balanced in terms of gender (Figure 1). This proportion is generally maintained in each of the age groups considered except for the 36-45 years group (Table 2, Figure 2). In this group, the number of men is significantly higher than women. The situation is definitely different when it comes to the age of respondents. Respondents aged 16-25 constitute about 80% of all respondents (Figure 2). The smallest group are the oldest people – aged 46-56<sup>13</sup>.



**Fig. 1. Structure of respondents according to gender**

<sup>7</sup>  $\bar{r} = \frac{2}{k(k-1)} \sum_{i=1}^{k-1} \sum_{j=i+1}^k \rho(i, j)$  where  $\rho(i, j)$  correlation coefficient.

<sup>8</sup> The survey included 6 age groups. For the 56-65 years and over 65 years groups, no questionnaires were obtained.

<sup>9</sup> Two by gender and four by age. Aggregate results for all respondents were also taken into account.

<sup>10</sup> Separately for gender and separately for age of respondents.

<sup>11</sup> Four tests were performed for each question.

<sup>12</sup> According to the scoring scale created for questions 6-13.

<sup>13</sup> Detailed data on the size of each group of respondents is provided in Table 1.

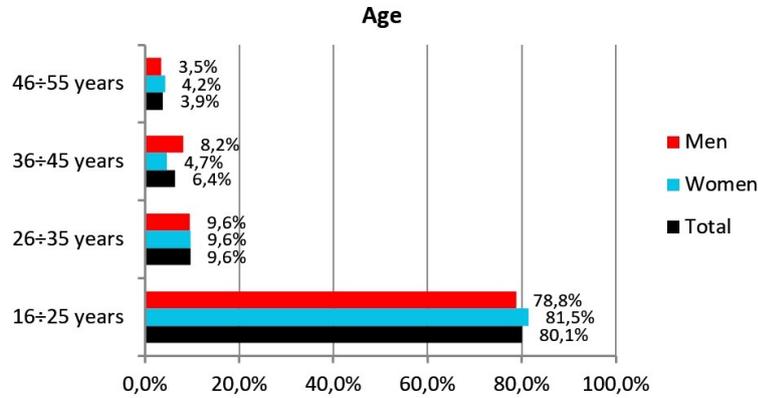


Fig. 2. Structure of respondents according to age and gender

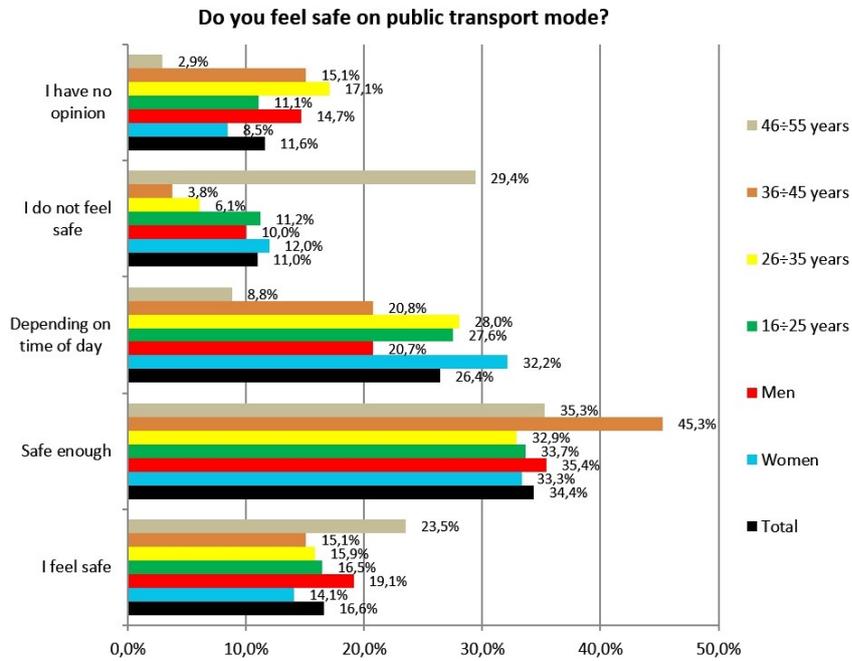
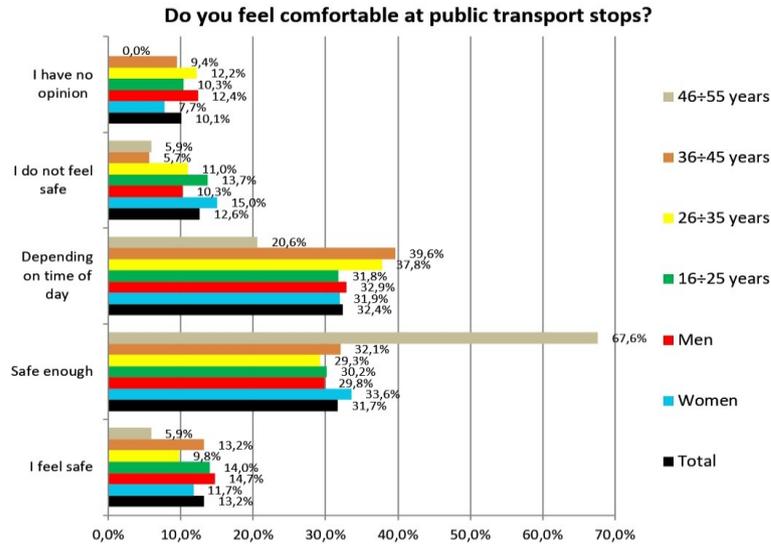


Fig. 3. Assessment of safety in urban transport

This fact causes that the group of the youngest respondents has a decisive influence on the total results. The evaluation of people aged over 56, so also at the senior age, is not taken into account. So we can say that the (total) results provide information about the assessment of public transport and infrastructure of Radom by young people. In case of comparing the results with other surveys, comparisons should be made in relevant age groups (possibly including gender).

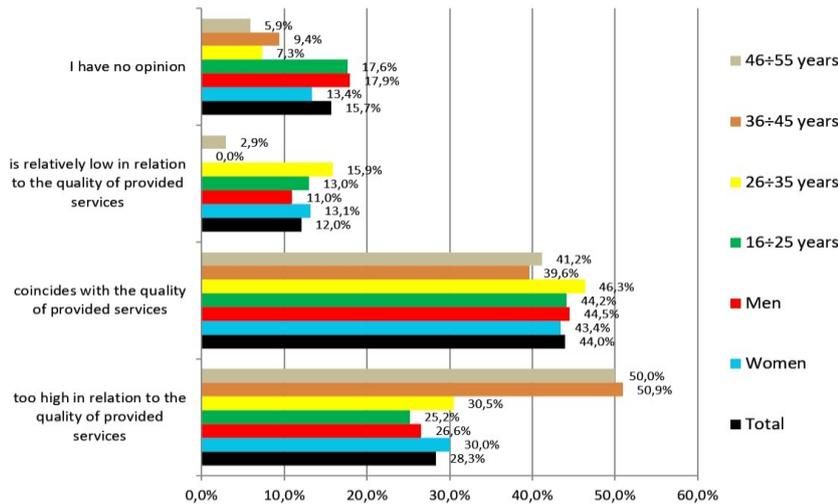
The majority of respondents think that using public transport is safe (Figures 3 and 4). Both at bus stops and on buses. Only 11-12.6% state that they do not feel safe. However, about 30% of respondents think that feeling safe depends on the time of the day and 11% have no opinion. The group of respondents aged 45-56 stands out here. Over 29% of respondents in this group do not feel safe in public transport vehicles (but only 6% at bus stops).

**Rating of road infrastructure and public transport in Radom according to respondents' sex and age**



**Fig. 4. Assessment of safety at urban transport stops**

**Do you think that the price of tickets for using public transportation services is:**



**Fig. 5. Assessment of the price of services in urban transport**

At the same time over 67% feel safe at bus stops. The chi-square test of independence does not give grounds to reject the hypothesis of independence of evaluation from age in the group of male respondents (for both questions<sup>14</sup>). In other cases, the hypothesis should be rejected.

44% of all respondents think that the price of provided services is adequate to their quality and

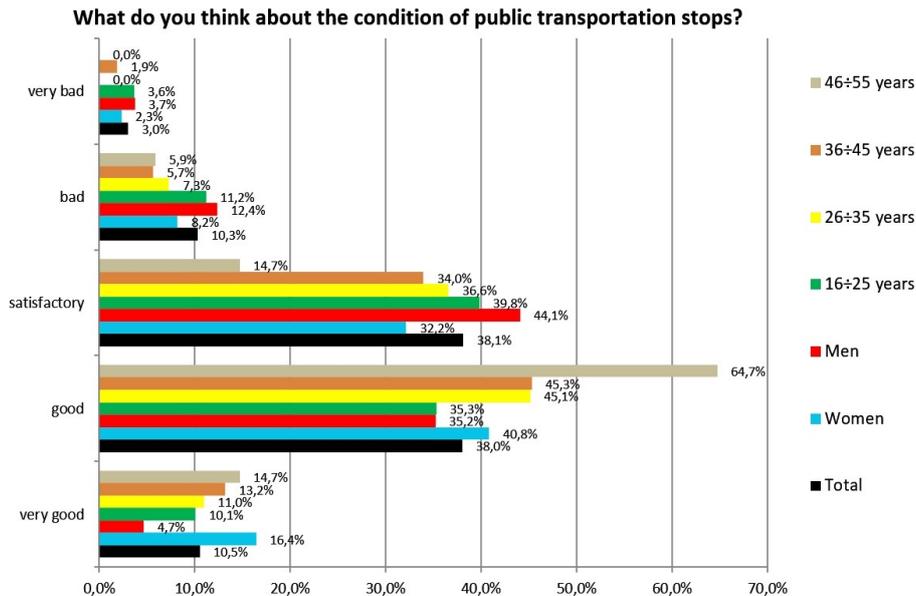
38% think that it is too high (Figure 5). Nearly 16% have no opinion on this issue. The distribution of answers in most groups of respondents is similar to the distribution of all respondents. However, it is definitely different among respondents aged 36-45 and 46-55. Over 50% think the price is too high and the percentage of undecided is much lower. There are practically no people in this group who think

<sup>14</sup> The p-value is: 0.6760 for question 3 and 0.0797 for question 4.

that the price is too low in relation to the quality of services. The survey shows that gender has no influence on the evaluation ( $p\text{-value} = 0.1979$ ). However, when tested for the other groups, the hypothesis should be rejected.

Respondents were asked to assess the condition of public transport stops (Figure 6). When comparing

with answers to question 4 (safety at bus stops) there is a big convergence of answers<sup>15</sup>. One could conclude that the state of bus stops is perceived mainly through a sense of security. However, unlike question 4, among women the evaluation does not depend on age ( $p\text{-value} 0.3695$ ).



**Fig. 6. Assessment of the condition of public transport stops**

Over 85% of respondents in each group find the readability of timetables at least satisfactory (Figure 7). The youngest people are the most satisfied with this element. Only 5% find the readability of timetables bad or very bad. Even better rated is the accessibility of public transport (Figure 8). In this case the group of the youngest people also stands out. 11% of respondents from this group assess bad the accessibility of public transport. What's more, a very high percentage of the oldest respondents assessed the accessibility as very good (only 3% assessed it as bad). In the case of question 7, there are no grounds for rejecting the hypothesis that evaluations are independent of

age ( $p\text{-value} 0.6149$ ), even in the case of men ( $p\text{-value} 0.0835$ ). In the other two cases, such a relationship is present<sup>16</sup>. Assessment of accessibility depends on both gender and age of respondents.

Respondents evaluate the condition of roads in the city relatively well. For over 70% of all respondents (except the oldest group) it is at least satisfactory<sup>17</sup> (Figure 9). Even better rating was given to the state of transport solutions<sup>18</sup> (Figure 10). It is surprising that only 9% of respondents aged 46-55 rated Radom's communication solutions as bad and almost 62% as good. Women give higher ratings than men. The chi-square tests show that age has no influence on the ratings<sup>19</sup>.

<sup>15</sup> In question 6 it was not possible to withhold judgement. Those with no opinion on the issue of safety mostly gave an answer other than "very bad".

<sup>16</sup> In the women's group, there is an age dependence on the readability rating of the timetables.

<sup>17</sup> Let's add that the survey was conducted before the renovation of one of Radom's main streets (for transit traffic) and the opening of the ring road leading transit traffic towards Krakow and Warsaw.

<sup>18</sup> This suggests that respondents do not (at least not directly) associate transport solutions with the state of the roads.

<sup>19</sup> The  $p\text{-value}$  is: for question 9 – 0.1221, for question 10 – 0.7541 and 0.0943 in the group of women (in the group of men the correlation is present,  $p\text{-value}$  is 0.0377).

Rating of road infrastructure and public transport in Radom according to respondents' sex and age

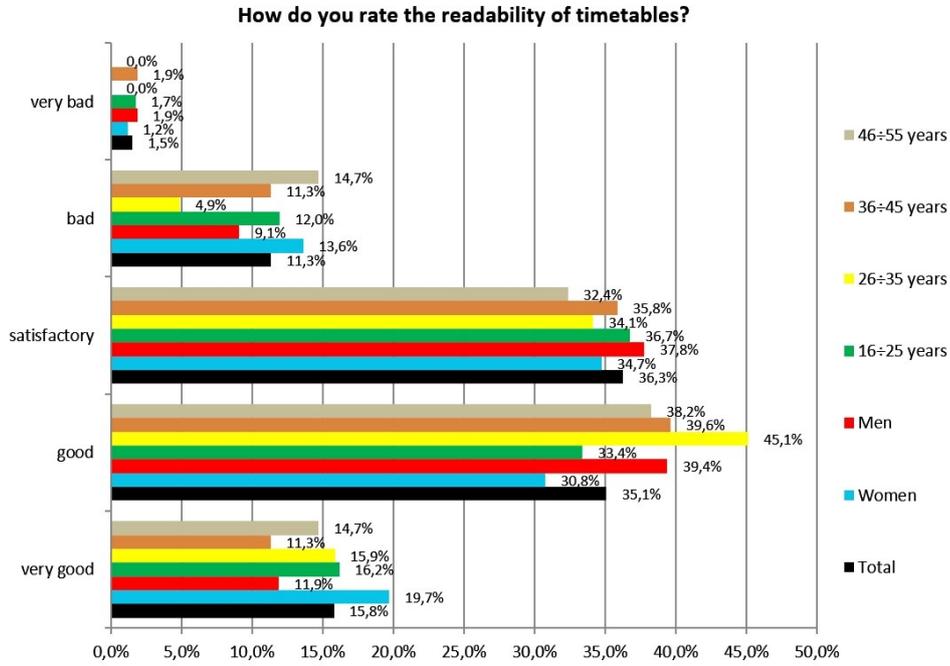


Fig. 7. Assessment of the readability of timetables

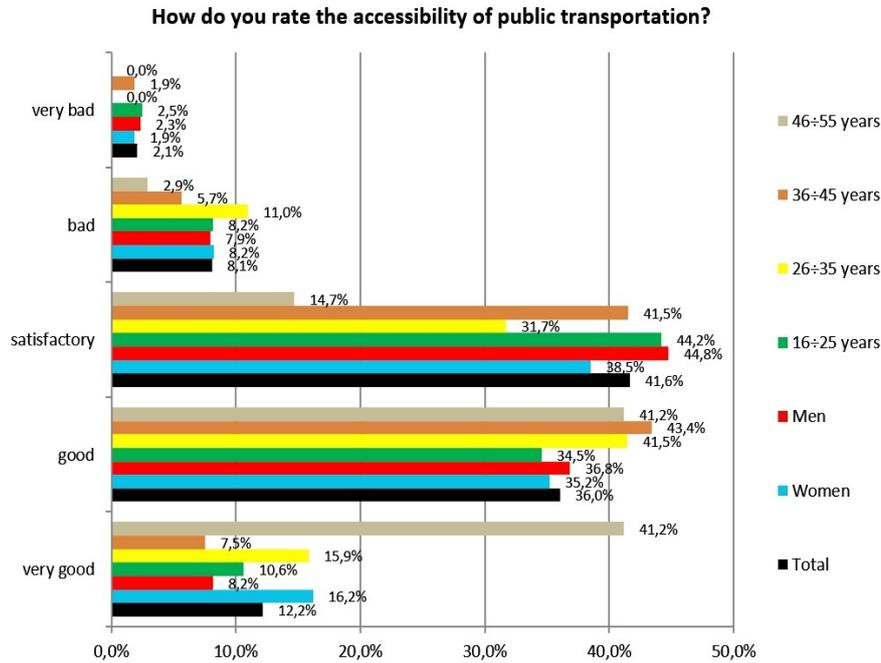


Fig. 8. Assessment of the accessibility of public transport

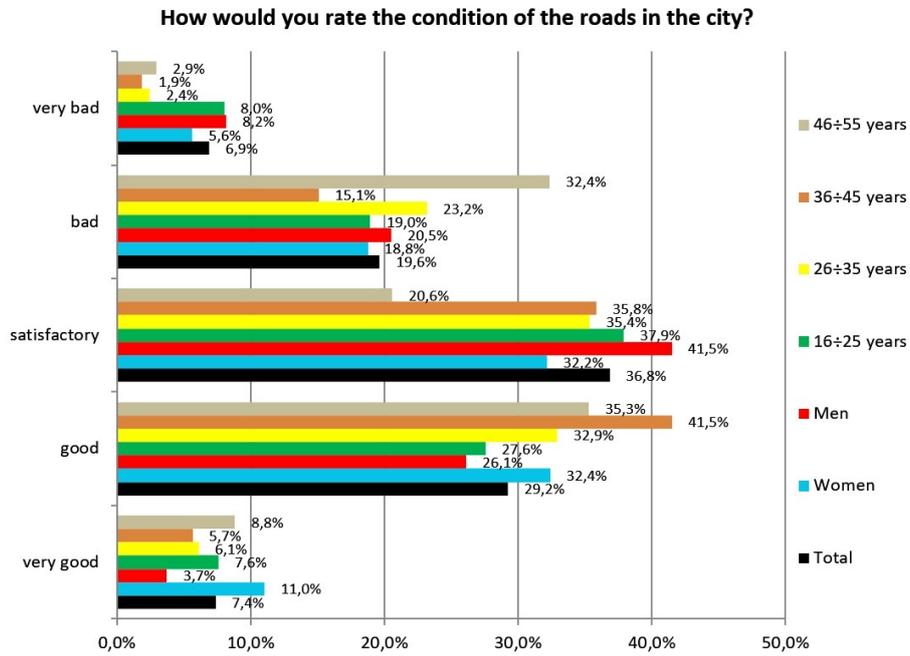


Fig. 9. Assessment of the condition of roads in the city

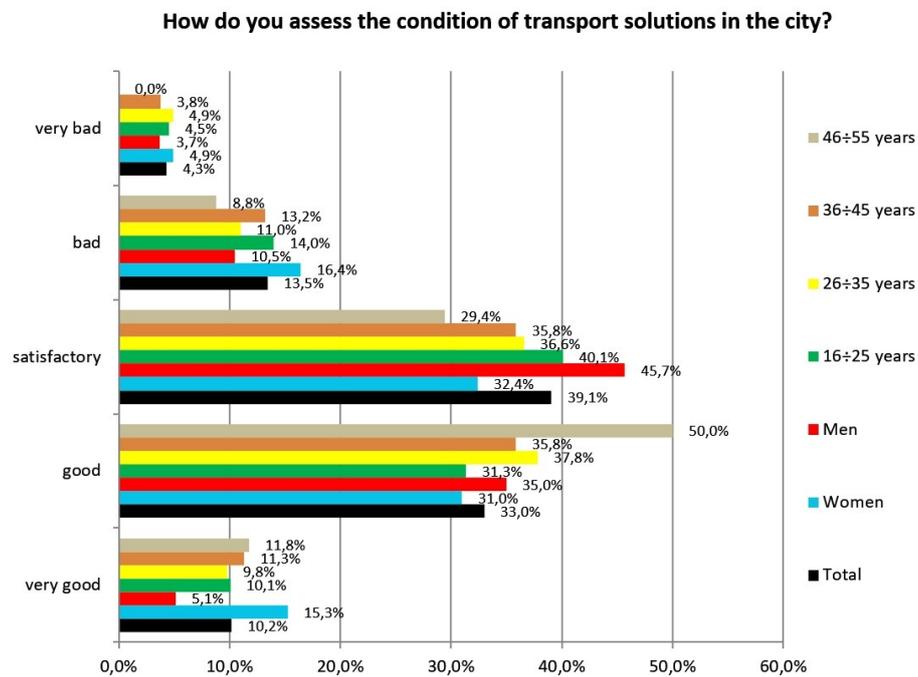


Fig. 10. Assessment of the state of transport solutions in the city

### Rating of road infrastructure and public transport in Radom according to respondents' sex and age

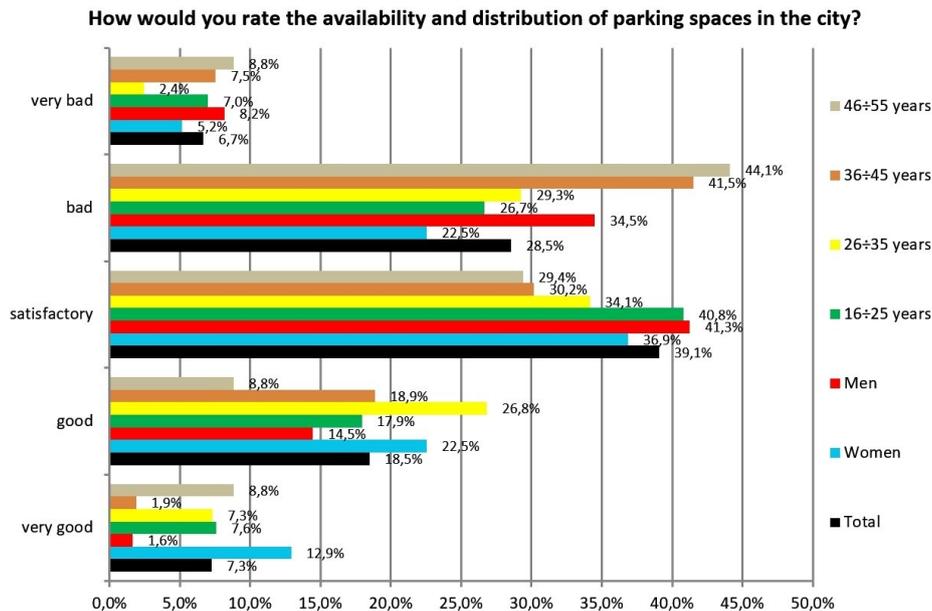
Respondents gave poor ratings to the accessibility and distribution of parking spaces (Figure 11) - much worse than to transport solutions. No more than 36% of respondents in particular groups gave at least good ratings (the highest percentage among women and the youngest people<sup>20</sup>). Negative ratings reach 53%. The highest percentage is in the group of people aged 46-55, 36-45 and men<sup>21</sup>. If we take age into account (without taking gender into account), the chi-square test does not give reasons to reject the hypothesis of independence (p-value 0.0740). The condition and distribution of cycle lanes were rated much higher (Figure 12). The percentage of negative ratings does not exceed 30% (the lowest in the oldest group, the highest in the youngest groups). The assessment does not depend on the age of the respondents<sup>22</sup>, also in the groups taking into account their gender (however, for women the percentage of "good" and "very good" answers is higher than for men). However, it significantly depends on gender<sup>23</sup>.

The assessment of the condition and safety of pavements and pedestrian crossings in the city, similarly as in the case of bicycle paths, does not

depend on age, but depended on gender (Figure 13). The percentage of negative evaluations (in each group of respondents) does not exceed 17%, positive exceeds 43%. Ratings for women are higher than for men.

Of the permissible choices of options for evaluating the time period of public transport bus services<sup>24</sup>, "no service at night" was the most frequently chosen option (Figure 14). Among respondent groups, there is a clear differentiation in response option choices by age. People aged 46-55 were far more likely to select the options "too early last run (evening)" (38.2%) and "bus times are appropriate" (29.4%). In the case of 36-45 year olds, the most frequently selected options were "no opinion" (30.2%) and "too late first course (morning)" (20.8%). Also among 26-35 year olds, a significant proportion (26.8%) have no opinion on the timing of the course. The variation by gender is much smaller. However, it can be noted that:

- women have more critical comments than men,
- a higher proportion of men have no opinion on this issue.



**Fig. 11. Assessment of the accessibility and distribution of parking spaces in the city**

<sup>20</sup> Statistically the least likely to use a car as a mode of transport – at least as a driver.

<sup>21</sup> So in the groups that statistically use the car most often as a means of transport – at least as a driver.

<sup>22</sup> Which is somewhat of a surprise.

<sup>23</sup> The p-value is less than 0.00005.

<sup>24</sup> More than one option was allowed for this and subsequent questions.

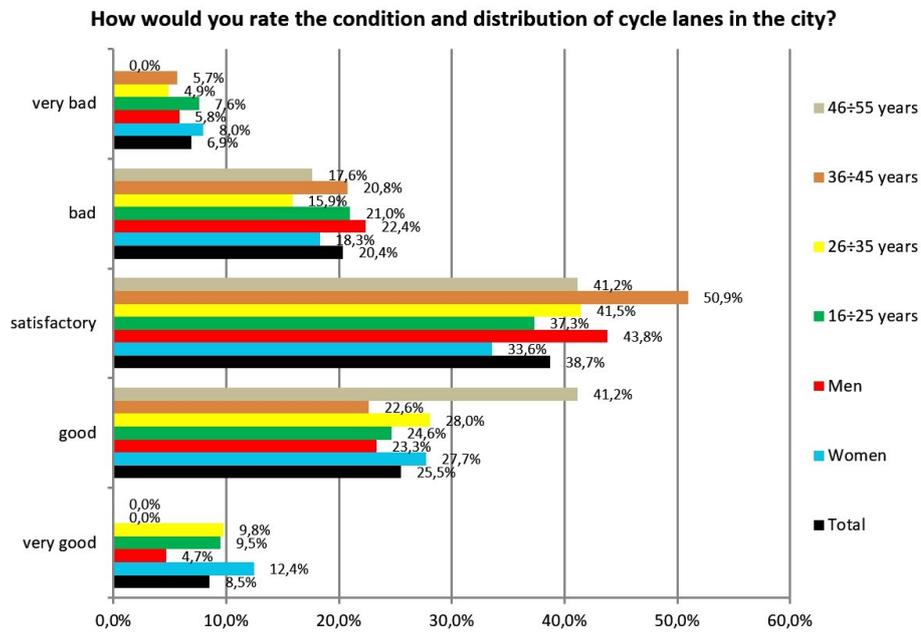


Fig. 12. Assessment of the condition and distribution of bicycle lanes in the city

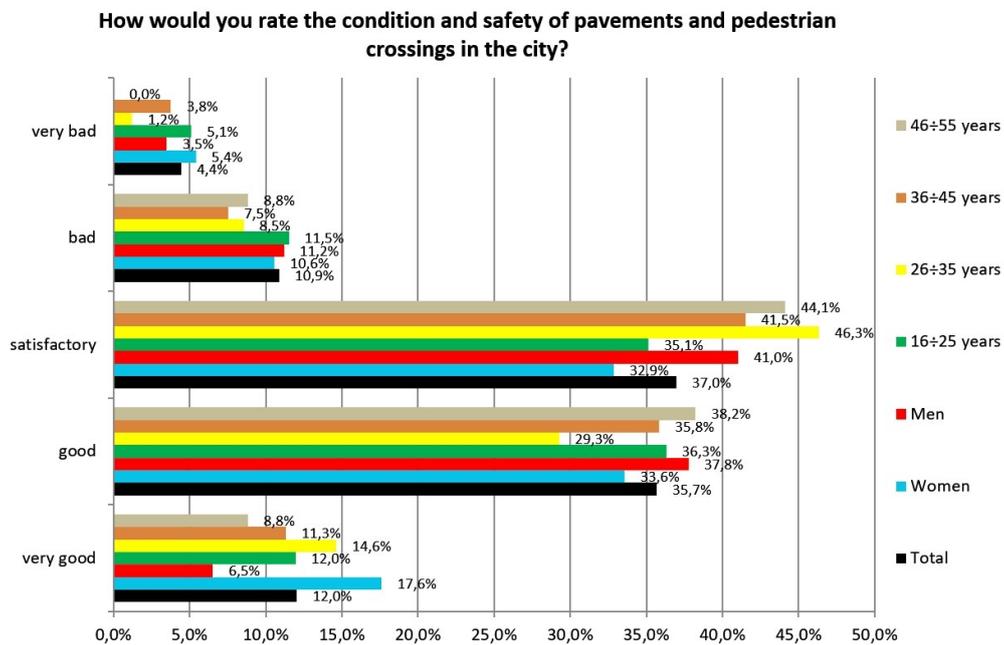
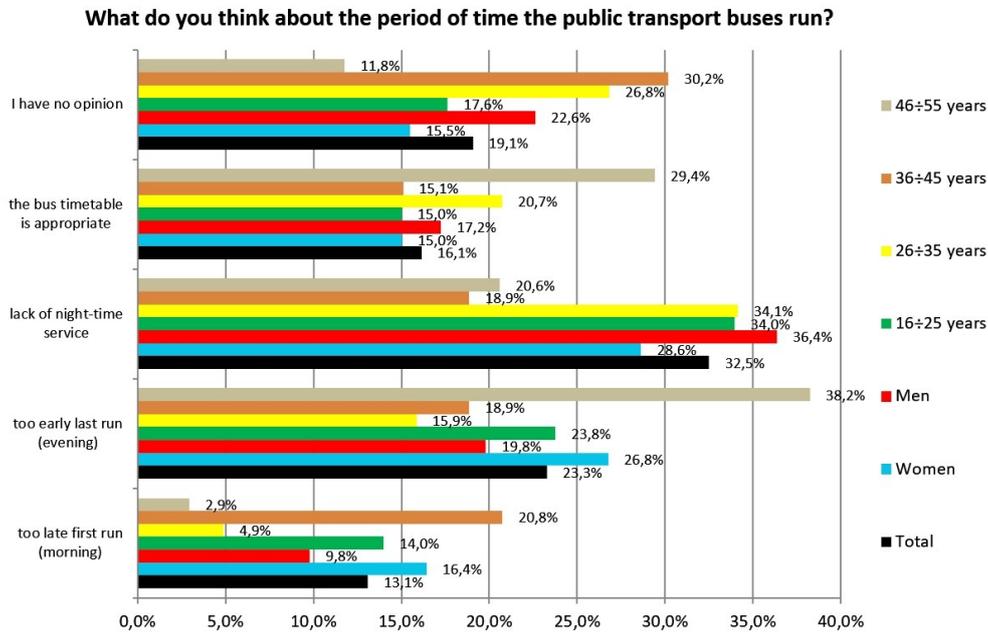


Fig. 13. Assessment of the condition and safety of pavements and pedestrian crossings in the city

**Rating of road infrastructure and public transport in Radom according to respondents' sex and age**



**Fig. 14. Assessment the time period of public transport bus services**

One of the questions in the survey was for respondents to indicate the advantages and disadvantages of public transport (Figures 15 and 16). In each question, the respondent was given a choice (multiple choice) of five "typical" disadvantages/benefits<sup>25</sup> of transport. The choice of questions clearly depends on the age and gender of the respondents. However, the variation is greater in the case of age. There is also more variation in the case of indicating advantages. People aged 26-35 most often indicated as a disadvantage (56.1% of respondents in this group) the infrequent running of buses. Men indicate high congestion (42.7%). However, men in the 45-56 years group more often evaluate the filling of vehicles as low (advantage of communication 17.6%) than as high (disadvantage of communication 8.8%). At the same time, a higher percentage assesses the cleanliness of the vehicles as low than high (an advantage of transport) and indicates the price as too high in relation to the quality of service (23.8%, while only less than 6% assess the price as an advantage)<sup>26</sup>. What is surprising is the assessment of the amount of charges for communication services. In most

groups, more respondents consider it an advantage than a disadvantage. For men the difference reaches 16 percentage points. However, when asked directly (see Figure 5) almost twice as many respondents (in each group) consider the ticket price as too high in relation to the services provided. Also nearly twice as many respondents considered the price as relatively low in relation to the quality of services (in case of men 3 times less).

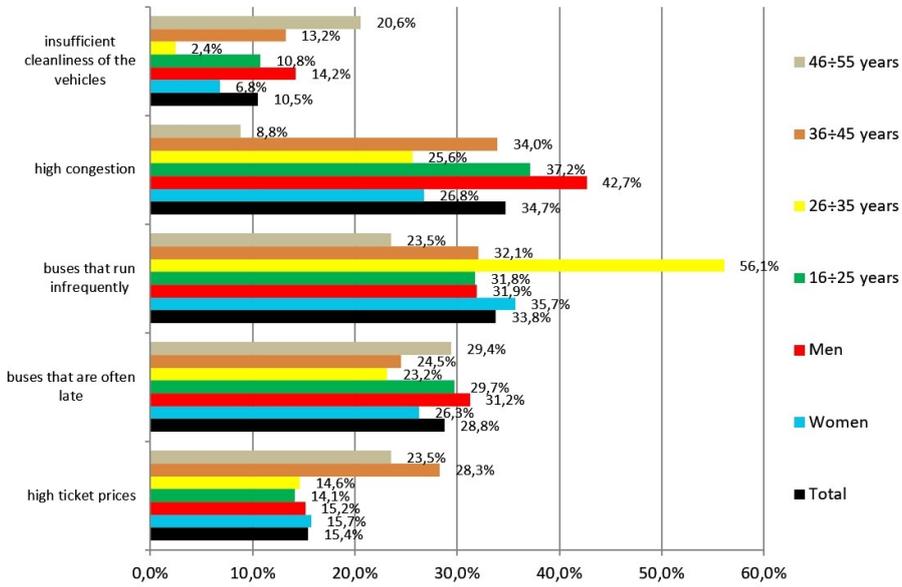
From the point of view of the organisation of transport, the following are of interest: the mode of transport (mode, Figure 17), the purposes of transport (Figure 18) and the motivations for choosing the modes of transport (Figure 19). The most frequently chosen modes of transport are the car and public transport. The car is chosen more often by respondents in all groups except men aged 46-55. Men aged 26-35 are the most likely to choose a car. The frequency of car choice decreases with age. The survey shows that men, compared to women, are more likely to choose car, public transport and walking, but much less likely to choose bicycle<sup>27</sup>.

<sup>25</sup> On a contradictory basis. The options were chosen on the basis of literature research.

<sup>26</sup> Only for men aged 26-35 the percentage is higher at 28.3%. They consider 22.6% to be suitable.

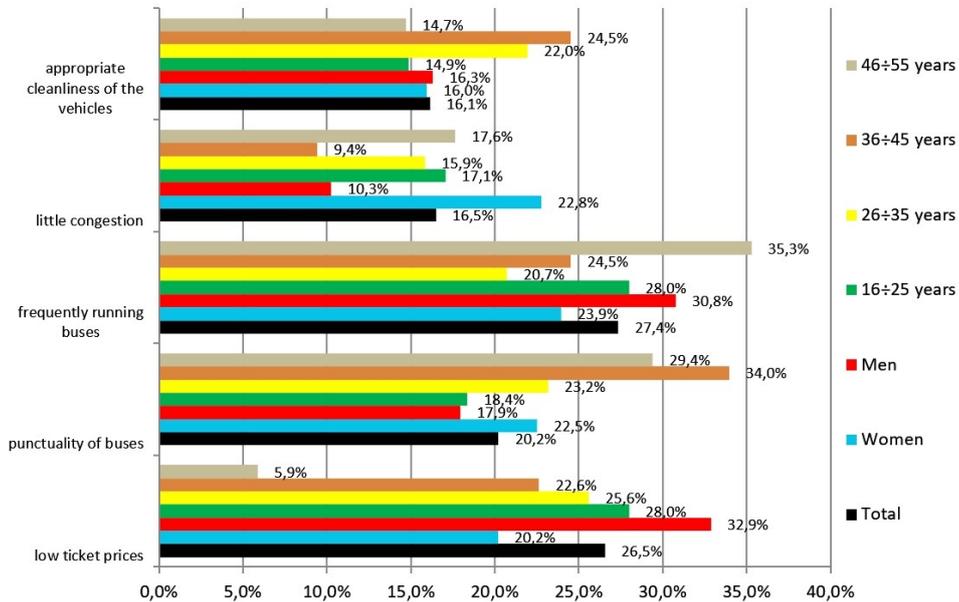
<sup>27</sup> The lowest percentage of all respondent groups. However, this is somewhat of a surprise.

**What, in your opinion, are the drawbacks in the services offered by public transport?**



**Fig. 15. Disadvantages of public transport services**

**What do you think are the advantages of the services offered by public transport?**



**Fig. 16. Advantages of public transport services**

Rating of road infrastructure and public transport in Radom according to respondents' sex and age

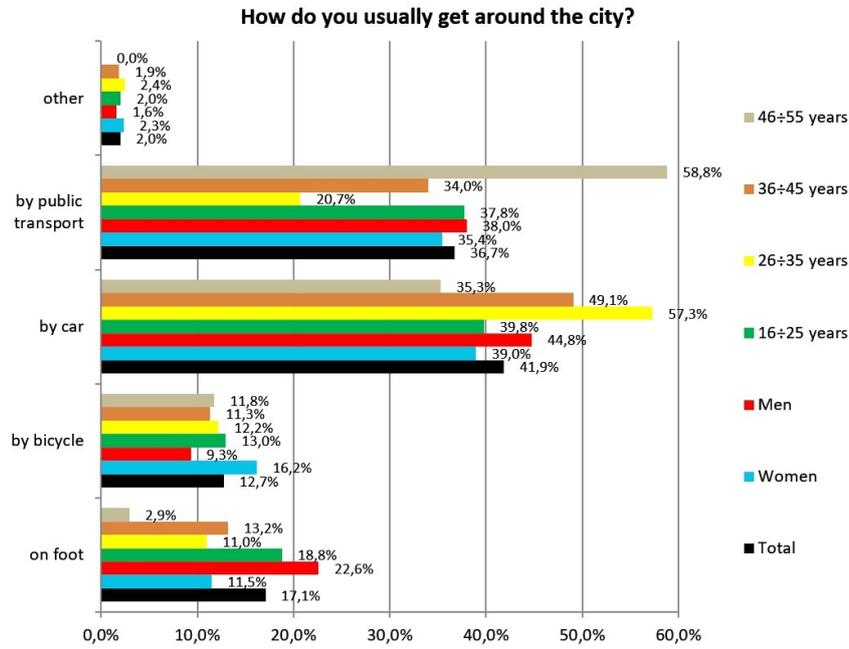


Fig. 17. Way of getting around the city

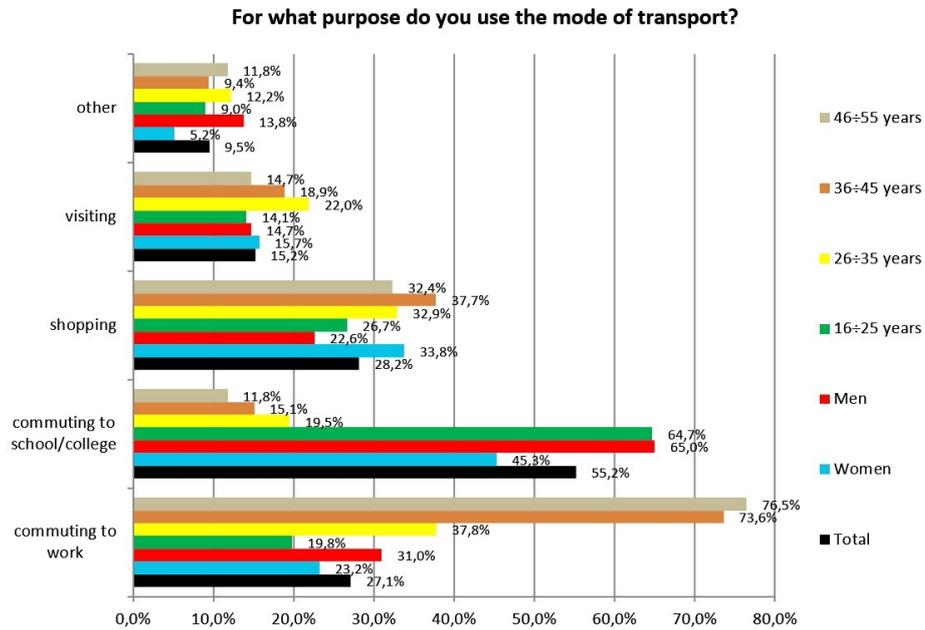
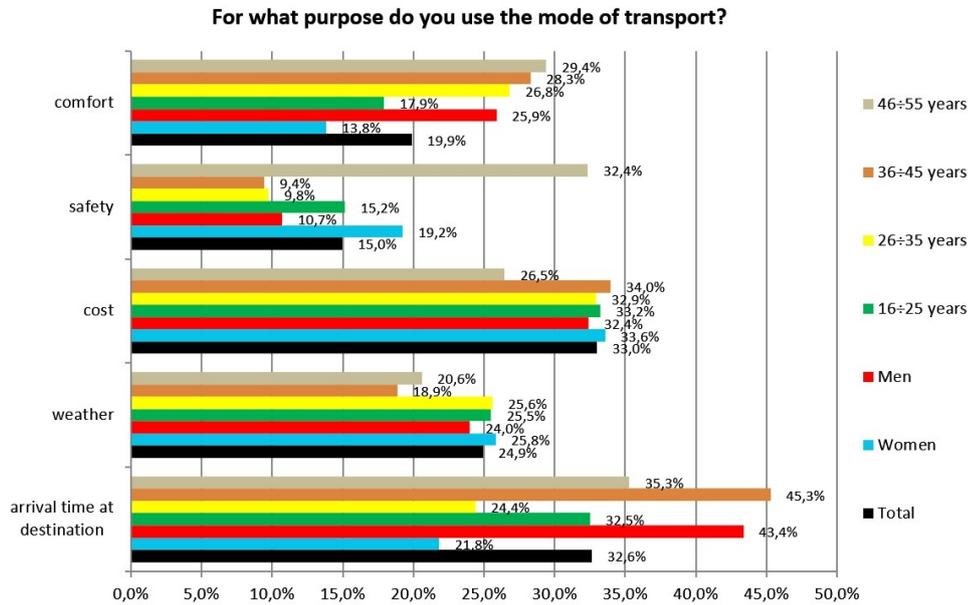
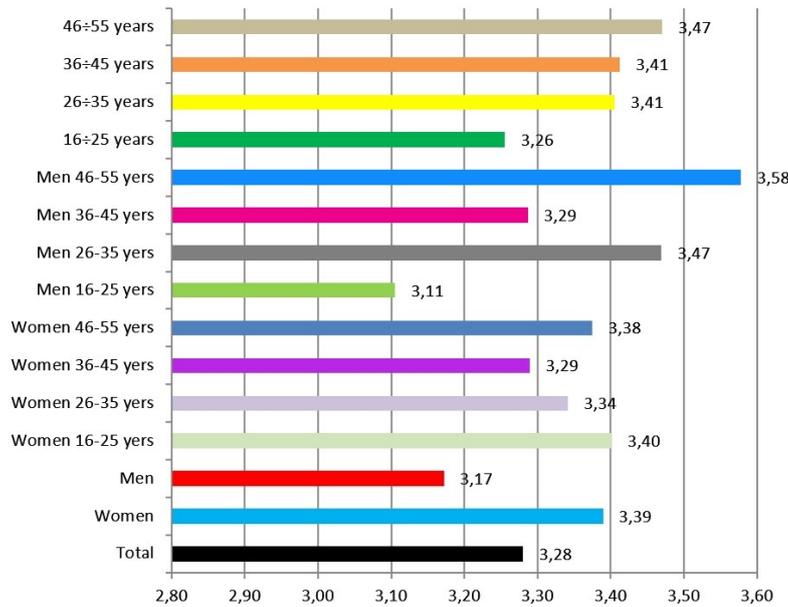


Fig. 18. Destinations of travel by public transport



**Fig. 19. Motivations for choosing the mode of transport**



**Fig. 20. Assessment of road infrastructure and public transport in Radom according to the chosen groups of respondents**

What is surprising is the high declared percentage of walking as the primary way of getting around the city. Much higher than in other surveys, also

concerning other cities. Clearly, the purposes of travel are strongly influenced by the age of respondents. Older people tend to work (hence

### Rating of road infrastructure and public transport in Radom according to respondents' sex and age

over 73% of respondents aged over 46 indicated this purpose), younger people tend to study (nearly 65%). However, some surprise is the relatively low percentage of choosing work as a destination among 36-35 year olds - 37.8%. This is not "compensated" by studying – 19.5%<sup>28</sup>. More interesting are the gender differences. Men were much more likely to indicate work, school (nearly 20 percentage points difference) and "other" (two and a half times), women "shopping". The factor determining the choice of mode of transport much more often for men than for women was the duration of the journey (twice as often) and its comfort (also twice as often). A specific group is the oldest people, for whom the duration of the trip, safety and comfort are important. This indication of motivation could suggest that the car is the primary mode of transport. However, the primary mode of transport in this group is public transport (58.8%), with the car coming second (35.3%).

The general rating of Radom's road infrastructure and public transport based on questions 6-13 is quite good – it is 3.28<sup>29</sup> (Figure 20). The highest rating was given by men aged 46-55 years, women in this group much lower<sup>30</sup>. The youngest respondents gave the lowest ratings. It should be noted that men, except for the group of the youngest respondents, gave higher ratings than women. However, due to the clear predominance of 16-25 year olds among the survey participants, the overall rating given by women is higher than that given by men. Among people aged 46 and above, we observe a very large variation in the ratings measured by the range<sup>31</sup> – 1.78 for women and 1.31 for men – in the remaining six age groups (including gender) it does not exceed 1 (for men it is higher than for women). The overall rating is the resultant of partial ratings – individual questions (infrastructure and public transport components). Ratings vary widely (Table 1). The highest rating was given to the readability of timetables (3.52), and the lowest to the accessibility and distribution

of parking spaces in the city (2.91). Also when evaluating individual questions, there is a large variation in ratings between groups of respondents. The range is [0.46; 0.97]. Taking gender and age into account, accessibility of public transport was rated highest (4.28), accessibility and distribution of parking spaces in the city was rated lowest (2.50)<sup>32</sup>. In order to assess whether the assessment of the components of road infrastructure and public transport of Radom is statistically significantly different in particular groups of respondents, statistical tests were carried out<sup>33</sup>. In the vast majority of cases the hypothesis of equality of mean values (so that the difference in grades in the compared groups is statistically insignificant) should be rejected. In 19 cases (Table 2) the test does not give reasons to reject the null hypothesis<sup>34</sup>, including 11 cases where evaluations were compared taking into account only the age of respondents<sup>35</sup>. Note that the rating of public transport accessibility (Figure 8, question 8 Table 1 and 2) is significantly different for each of the distinguished groups.

The standardised coefficient of the  $\alpha$ -Cronbach's scale reliability (Table 3) in most cases takes values in the range of 0.7-0.8<sup>36</sup>. Thus, it can be assumed that it is satisfactory. Only for groups aged 46-55 it takes values below 0.7, with 0.598 for women. It can be assumed that one of the reasons is the relatively small sample size for these categories of respondents.

Comparison of the survey results with other surveys is difficult due to significant differences in the content of the questions asked and a different rating scale. In relation to the survey [15], a significantly higher percentage of respondents declared to travel on foot (by 10.6 percentage points) and by public transport (by 8.5 percentage points), a lower percentage by car (by 8.7 percentage points) and by bicycle (by 1.5 percentage points). The structure of purposes and motives of travel differs quite significantly. In the present survey, the

<sup>28</sup> For this the highest percentage in the "visiting" category.

<sup>29</sup> A scale of 1 to 5 was adopted, where 3 was defined as "satisfactory".

<sup>30</sup> So those most likely to indicate (in percentage terms) public transport as their main mode of transport. Overall, the 46+ group had the highest rating.

<sup>31</sup> Between the mean scores for each question.

<sup>32</sup> In both cases, women aged 46-55 years.

<sup>33</sup> Test of significance of means. For each of the 8 questions and total scores, 17 tests were conducted comparing female and male scores with the total score, between each other by age groups and between age groups. A total of 153 tests were carried out.

<sup>34</sup> In the remaining 134 cases, the hypothesis had to be rejected; the p-value in 126 cases was less than 0.001, in 6 cases with a range of (0.01;0.001), in 2 cases with a range of (0.05;0.01).

<sup>35</sup> In addition, there were 3 cases where the overall rating was compared with the rating from the highlighted age group.

<sup>36</sup> For the group of women aged 36-45, even more than 0.91 and in general for respondents aged 36-45 almost 0.85.

proportion of respondents travelling to school (by 43.9 percentage points) and for other purposes (by 6 percentage points) increased, while the proportion travelling for shopping decreased (by 14.5 percentage points)<sup>37</sup>. A significantly higher proportion of respondents attach more importance to the duration of the trip (12.5 percentage points) and comfort (11.5 percentage points), a smaller proportion to weather and safety (by about 4.5 percentage points). The rating of the price for services also varies considerably. The percentage of respondents believing the price to be too high has increased by 8.3 percentage points, to be adequate for the services provided has decreased by 16.6 percentage points, and too low by 4.9 percentage points. At the same time respondents with no

opinion has increased by 13.3 percentage points. The condition of bus stops has improved. Although the percentage of answers "at least satisfactory" (= satisfactory + good + very good) has not changed significantly (+2 percentage points), but "satisfactory" has decreased by 17.6 percentage points. Rating of the readability of timetables has improved slightly (5 percentage points less ratings of "bad" and "very bad"). Ratings for road infrastructure have worsened considerably - the percentage of "bad" and "very bad" has risen by 12 percentage points. Also worsening were ratings for the accessibility and layout of car parks (15 points more for "bad" and "very bad") and the condition and layout of cycle lanes (13 points more)<sup>38</sup>.

**Table 1. Scoring of particular elements of road infrastructure and public transport in Radom depending on selected groups of respondents**

Group of respondents	Survey question																		min	max	range	c
	6		7		8		9		10		11		12		13		Total					
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b				
Total	3.43	0.92	3.52	0.94	3.48	0.88	3.11	1.02	3.31	0.97	2.91	1.01	3.08	1.03	3.40	0.98	3.28	0.60	2.91	3.52	0.61	855
Women	3.61	0.93	3.54	0.99	3.56	0.92	3.24	1.06	3.35	1.08	3.15	1.07	3.18	1.12	3.47	1.07	3.39	0.63	3.15	3.61	0.45	426
Men	3.25	0.87	3.50	0.89	3.41	0.84	2.97	0.97	3.27	0.86	2.67	0.88	2.99	0.94	3.33	0.89	3.17	0.55	2.67	3.50	0.83	429
Women 16-25 years	3.59	0.96	3.57	1.02	3.54	0.91	3.26	1.08	3.34	1.09	3.22	1.07	3.19	1.15	3.50	1.09	3.40	0.64	3.19	3.59	0.40	348
Women 26-35 years	3.63	0.73	3.59	0.74	3.39	0.97	3.17	0.95	3.29	1.05	3.12	1.08	3.15	1.06	3.39	0.89	3.34	0.55	3.12	3.63	0.51	41
Women 36-45 years	3.63	1.01	3.21	0.98	3.47	0.96	3.53	0.90	3.47	1.17	2.68	0.95	2.89	0.94	3.42	1.22	3.29	0.81	2.68	3.63	0.95	19
Women 46-55 years	3.89	0.76	3.22	0.88	4.28	0.83	2.78	1.00	3.61	0.70	2.50	1.04	3.50	0.62	3.22	0.73	3.38	0.42	2.50	4.28	1.78	18
Men 16-25 years	3.14	0.86	3.43	0.88	3.31	0.83	2.89	0.97	3.23	0.84	2.62	0.85	2.96	0.96	3.27	0.90	3.11	0.54	2.62	3.43	0.81	338
Men 26-35 years	3.56	0.84	3.85	0.82	3.85	0.73	3.17	0.95	3.44	0.90	3.02	0.88	3.29	0.93	3.56	0.90	3.47	0.52	3.02	3.85	0.83	41
Men 36-45 years	3.62	0.78	3.62	0.85	3.50	0.71	3.24	0.85	3.32	0.88	2.65	0.95	2.91	0.75	3.44	0.75	3.29	0.50	2.65	3.62	0.97	34
Men 46-55 years	3.88	0.72	3.88	0.89	4.13	0.81	3.56	1.03	3.69	0.95	2.81	1.11	2.94	0.77	3.75	0.77	3.58	0.51	2.81	4.13	1.31	16
16+25 years	3.37	0.94	3.50	0.96	3.43	0.88	3.08	1.04	3.28	0.98	2.92	1.01	3.07	1.07	3.38	1.01	3.26	0.61	2.92	3.50	0.58	686
26+35 years	3.60	0.78	3.72	0.79	3.62	0.88	3.17	0.94	3.37	0.98	3.07	0.98	3.22	0.99	3.48	0.89	3.41	0.54	3.07	3.72	0.65	82
36+45 years	3.58	0.89	3.65	0.92	3.73	0.82	3.28	0.94	3.45	0.98	2.92	0.91	3.17	0.94	3.52	1.00	3.41	0.62	2.92	3.73	0.82	53
46+55 years	3.88	0.73	3.53	0.93	4.21	0.81	3.15	1.08	3.65	0.81	2.65	1.07	3.24	0.74	3.47	0.79	3.47	0.47	2.65	4.21	1.56	34
min	3.14	0.72	3.21	0.74	3.31	0.71	2.78	0.85	3.23	0.70	2.50	0.85	2.89	0.62	3.22	0.73	3.11	0.42	2.50	3.31	0.81	
max	3.89	1.01	3.88	1.02	4.28	0.97	3.56	1.08	3.69	1.17	3.22	1.11	3.50	1.15	3.75	1.22	3.58	0.81	3.22	4.28	1.06	
range	0.75	0.29	0.66	0.28	0.97	0.26	0.78	0.22	0.46	0.47	0.72	0.26	0.61	0.53	0.53	0.48	0.47	0.40	0.46	0.97	0.51	

a – mean, b – standard deviation, 6, 7, ..., 13 – questions according to figures numbering, c – group size

<sup>37</sup> It should be taken into account that in the current survey it was possible to indicate several purposes.

<sup>38</sup> It should be noted that in the study [15] there was a different structure of respondents, which probably influences the results. In that study, men predominated (62.8%), with 16-25 year olds accounting for 38.3%.

Rating of road infrastructure and public transport in Radom according to respondents' sex and age

Table 2. Groups of respondents and components of road infrastructure and public transport in Radom with statistically insignificant scores

Survey question	Group of respondents	p-value
6	26÷35 years-36÷45 years	0.525
	Women 26-35 years-Men 16-25 years	0.155
	Women 36-45 years-Men 16-25 years	0.164
7	16÷25 years-46÷55 years	0.321
	Total-46÷55 years	0.803
	Women 36-45 years-Men 16-25 years	0,061
9	Total-46÷55 years	0.237
	26÷35 years-46÷55 years	0.598
	16÷25 years-46÷55 years	0.050
	Women 36-45 years-Men 16-25 years	0.291
10	Women 36-45 years-Men 16-25 years	0.596
11	Total-36÷45 years	0.740
	16÷25 years-36÷45 years	0.658
12	26÷35 years-36÷45 years	0.066
	26÷35 years-46÷55 years	0.576
13	26÷35 years-36÷45 years	0.151
	26÷35 years-46÷55 years	0.857
	36÷45 years-46÷55 years	0.214
TOTAL	26÷35 years-36÷45 years	0.519

Table 3. Values of standardised coefficient of the  $\alpha_{st.c}$  scale reliability

Group of respondents	$\alpha_{st.c}$	Group of respondents	$\alpha_{st.c}$
Total	0.769658	Women 16-35 years	0.764363
Women	0.764745	Women 26-35 years	0.724623
Men	0.763177	Women 36-45 years	0.914615
16-35 years	0,770811	Women 46-55 years	0.598155
26-35 years	0,727027	Men 16-35 years	0.751295
36-45 years	0,849559	Men 26-35 years	0.734416
46-55 years	0,613068	Men 36-45 years	0.767752
		Men 46-55 years	0.656729

Table 4. Comparison of ratings of selected elements of public transport and transport infrastructure in two surveys

Element assessed	Rating in survey [14]	Rating in current survey
Rating of public transport accessibility	0,59	0,61
Accessibility and readability of information	0,62	0,63
Condition and distribution of bicycle paths	0,43	0,52
Condition of road infrastructure	0,42	0,52

In the case of study [14], four items were compared<sup>39</sup> – the results are presented in Table 4. Since in that study the rating scale was from 1 to 10 and in the current study from 1 to 5, the results were reduced to a scale between [0;1]<sup>40</sup>. The survey [14] took into account the responses of respondents aged 18-25 years, for the current survey the respondents aged 16-25 years. The rating of all four elements in the current survey is higher<sup>41</sup>. For accessibility of communication and accessibility and readability of information, the difference is very small. The difference is particularly marked in relation to road and cycle infrastructure.

### CONCLUSIONS

The research sample obtained is balanced by gender, not balanced (representative) by age. Respondents aged 16-25 make up approximately 80% of all respondents. This causes the total results to be decisively influenced by this group of respondents. The evaluation of people over 56 years old, so also in senior age, is not taken into account. The (total) results reflect the rating of public transport and infrastructure of Radom by young people. In case of comparing the results with other surveys, comparisons should be made in appropriate age groups (possibly including gender).

In the opinion of respondents:

- a) in public transport buses it is safe (51%, 11% have the opposite opinion),
- b) it is safe at public transport stops (45%, 12,6% have the opposite opinion),
- c) the price of the services is adequate to their quality (54% of the respondents having an opinion),
- d) the condition of public transport stops is at least satisfactory (nearly 87%),
- e) readability of timetables is at least satisfactory (nearly 87%),
- f) accessibility of public transport is at least satisfactory (nearly 90%),
- g) the condition of roads in the city is at least satisfactory (73.5%),
- h) the condition of transport solutions is at least satisfactory (almost 82%),
- i) the accessibility and distribution of parking spaces is at least satisfactory (65%),
- j) the condition and arrangement of bicycle paths are at least satisfactory (73%),

k) the condition and safety of pavements and pedestrian crossings in the city are at least satisfactory (nearly 85%).

Although the overall rating is positive in all aspects, items (a), (b), (c), and (i) need action to improve the performance of these elements due to the high percentage of negative ratings.

It is noteworthy that the overall rating of transport solutions is generally rated higher than its components (in individual groups of respondents).

Do the answers to the above questions depend on the gender and age of the respondents? The answer is not clear<sup>42</sup>:

- for 10 questions (except question c) it depends on gender,
- in case of questions a, b, c, d, f it depends on age,
- in the group of women the answer to questions a, b, c, e, f, g and i depends on age
- in the group of men the answer to questions c, d, f, g, h, i, k depends on the age of respondents.

Based on the answers to questions d-f, a point scale was created for the assessment of road infrastructure and public transport. The overall rating is fairly good at 3.28<sup>43</sup>. The highest rating was given by men aged 46-55 years, the lowest by the youngest respondents. Men, apart from the group of the youngest respondents, gave higher ratings than women. However, due to the overwhelming predominance of 16-25 year olds among survey participants, the overall rating given by women is higher than men. Among people aged 46 and above, we observe a very large variation in the ratings measured by the range – 1.78 for women and 1.31 for men – in the remaining six age groups (including gender) it does not exceed 1 (for men it is higher than for women). The variation in scores for individual questions is high. The highest rating was given to the readability of timetables (3.52), the lowest to the accessibility and distribution of parking spaces in the city (2.91). Statistical tests were carried out to assess whether ratings were statistically insignificant across respondent groups. In 134 cases the hypothesis had to be rejected; p- value

- in 126 cases was less than 0.001,
- in 6 cases from the interval (0.01;0.001],
- in 2 cases between (0.05;0.01].

<sup>39</sup> Other items could not be compared due to differences in survey design.

<sup>40</sup> From the result, 1 was subtracted and divided by the range (9 for study [14] and 4 for the current study).

<sup>41</sup> May not be statistically significant. Significance tests of mean values were not performed.

<sup>42</sup> A significance level of  $\alpha = 0.05$  was assumed.

<sup>43</sup> A scale from 1 to 5 was adopted, where 3 was defined as "satisfactory".

## Rating of road infrastructure and public transport in Radom according to respondents' sex and age

In 19 cases, the test does not give reasons for rejecting the null hypothesis, including 11 cases where ratings were compared taking into account only the age of respondents.

The standardised reliability coefficient of  $\alpha$ -Cronbach's scale in most cases exceeds 0.7, so it is satisfactory. The obtained values are higher than those obtained in the study [15].

Among the permissible choices of variants of evaluations of the duration of the public transport bus service, the most frequently chosen option was "no service at night time". There is a clear differentiation in the choices of response options by age.

Indication of advantages and disadvantages of the public transport by respondents (defined answers, multiple choice) clearly depends on the age and gender of respondents. In case of people aged 26-35 the most often indicated disadvantage (56.1% of respondents in this group) is that the buses run too rarely. Men indicate high congestion (42.7%). Surprising is the evaluation of the amount of fees for transport services. In most groups more respondents consider it as an advantage than a disadvantage.

From the point of view of the organisation of transport, the mode of travel, the purposes of travel and the motivations for choosing the modes of transport are of interest. The most frequently chosen modes of travel are the car and public transport. Unexpectedly, the declared percentage of walking as the primary mode of movement in the city is high. It is much higher than in other studies, also concerning other cities. A specific group is the elderly, for whom travel time, safety and comfort are important. The primary mode of transport in this group is public transport (58.8%), with the car coming second (35.3%). Clearly, the purposes of travel are strongly dependent on the age of the respondents (work, school).

Comparison of the survey results with other surveys is difficult due to significant differences in the content of the questions and a different scale of evaluation. In comparison with the survey [14] (in which the representativeness of the sample was ensured), in the opinion of the respondents the condition of road and cycling infrastructure has significantly improved.

### OCENA INFRASTRUKTURY DROGOWEJ I KOMUNIKACJI MIEJSKIEJ RADOMIA W ZALEŻNOŚCI OD PŁCI I WIEKU

W artykule przedstawiono wyniki badań ankietowych dotyczących komunikacji miejskiej i infrastruktury drogowej Radomia. Uzyskano 855 ankiet. Wykorzystano 19 pytań

ankiety. Ankieta, poza pytaniami dotyczącymi wieku i płci, zawierała pytania z określonymi wariantami odpowiedzi z jednokrotnym lub wielokrotnym wyborem i pytania, w których respondent oceniał poszczególne elementy systemu transportowego. Z 8 pytań utworzono pięciostopniową punktową skalę Likerta stanowiącą ocenę komunikacji miejskiej i infrastruktury drogowej. Dokonano oceny rzetelności skali za pomocą standaryzowanego współczynnika Cronbacha. Analizę dokonano w wybranych grupach respondentów ze względu na wiek respondentów, płeć respondentów i z uwzględnieniem obu cech jednocześnie. Korzystając z testu niezależności chi-kwadrat zbadano zależność ocen od wieku i płci respondentów. Dla porównania istotności różnic ocen pomiędzy wyodrębnionymi grupami respondentów wykorzystano test istotności średnich. Wyniki ankiety wskazują, że choć ocena ogólna jest pozytywna, to ze względu na duży odsetek ocen negatywnych, konieczne jest podjęcie działań poprawiających m.in.: bezpieczeństwo na przystankach i pojazdach komunikacji miejskiej, dostępność i rozmieszczenie miejsc parkingowych. Wyniki badań porównano z wynikami wcześniejszych badań. W stosunku do badań z 2014 roku stwierdzono istotną poprawę stanu infrastruktury drogowej oraz stanu i rozmieszczenia ścieżek rowerowych.

**Słowa kluczowe:** badania ankietowe, dostępność transportowa, jakość transportu publicznego, transport publiczny

### REFERENCES

- [1] dell'Olio L., Ibeas A., de Oña J., de Oña R. (2017). Public transport quality of service. Elsevier, ISBN 9780081020807, eBook ISBN 9780081022795
- [2] Mouwen A. (2015). "Drivers of customer satisfaction with public transport services". *Transportation Research Part A: Policy and Practice*, 78, pp. 1–20. <https://doi.org/10.1016/j.tra.2015.05.005>
- [3] van Lierop D., Badami M. G., El-Geneidy, A. M. (2018). "What influences satisfaction and loyalty in public transport? A review of the literature". *Transport Reviews*, 38(1), pp. 52–72. <https://doi.org/10.1080/01441647.2017.1298683>
- [4] Redman L., Friman M., Gärling T., Hartig T. (2013). "Quality attributes of public transport that attract car users: A research review". *Transport Policy*, 25, pp. 119–127. <https://doi.org/10.1016/j.tranpol.2012.11.005>
- [5] Tyrinopoulos Y., Antoniou C. (2013). "Factors affecting modal choice in urban mobility". *European Transport Research Review*, 5, pp. 27–39 <https://doi.org/10.1007/s12544-012-0088-3>
- [6] Petrunoff N., Rissel C., Wen, L. M. (2016). "The effect of active travel interventions conducted in work settings on driving to work: A systematic review". *Journal of Transport&Health*, 3(1), pp. 61–76 <https://doi.org/10.1016/j.jth.2015.12.001>

- [7] Litman T. (2020). Evaluating Accessibility for Transport Planning. Measuring People's Ability to Reach Desired Goods and Activities. *Victoria Transport Policy Institute*. [www.vtpi.org](http://www.vtpi.org)
- [8] Hansson J., Pettersson F., Svensson H., Wretstrand A. (2019). "Preferences in regional public transport: a literature review, European Transport Research Review, vol.11, article number: 38. <https://doi.org/10.1186/s12544-019-0374-4>
- [9] CEN, European Committee for Standardisation. (2002). Transportation - Logistics and services - Public passenger transport - Service quality definition, targeting and measurement (EN 13816:2002). <https://tpbi.ro/file/2021/02/EN-13816-standard-Service-Quality-Definition-Targeting-and-Measurement-EU-2002.pdf>
- [10] Mohammed A. A., Shakir A. A. (2013). "Factors that affect transport mode preference for graduate students in the National University of Malaysia by logit method". *Journal of Engineering Science and Technology*, Vol. 8, No. 3, pp. 352 - 363
- [11] Fearnley N., Flügel S., Killi M. (2018). "Modal substitution in urban transport: a stated preference approach". *Proceedings of 7th Transport Research Arena TRA 2018*, April 16-19, Vienna, Austria
- [12] Schubert T. F., Henning E., Becker Lopes S. (2020). Analysis of the Possibility of Transport Mode Switch: A Case Study for Joinville Students". *Sustainability* 12, 5232; <https://doi.org/10.3390/su12135232>
- [13] van Lierop D., El-Geneidy, A. M. (2018). "Is having a positive image of public transit associated with travel satisfaction and continued transit usage? An exploratory study of bus transit". *Public Transportation*, 10(2), pp. 241–256. <https://doi.org/10.1007/s12469-018-0175-5>
- [14] Ciszewski T., Dębowska-Mróż M., Ferensztajn-Galardos E., Grad B., Krajewska R., Łukasik Z., Rogowski A., Wojciechowski W. (2014). "Analysis of transport movements and transport preferences in the area of ROF" (in Polish), developed by the team of UTH Radom (contract NR 1/KM4/2014 dated 21 May 2014 between SITK Branch in Kraków and UTH in Radom) within the project "Integrated planning of sustainable urban transport of the Radom Functional Area" (contract MPU-II/3302/4/2014 dated 22.04.2014 between Urban Planning Studio in Radom and SITK Branch in Kraków).
- [15] Dębowska-Mróż M., Rogowski A. (2019). "Selected problems of assessing transport accessibility in cities on the example of Radom" (in Polish), in Perzyński T. (ed.), *Selected problems of transport engineering*, Publishing House of the University of Technology and Humanities, Radom, Monograph Series No. 241, pp. 186-218, ISSN 1642-5278, ISBN 978-83-7351-891-9