

Gender Differences in Transport Behaviour Patterns

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Abstract: Gender equality is a topical issue that also concerns the transport sector. Gender-neutral transport systems may not be equally suitable for each gender and thus fail to meet their mobility requirements. Therefore, there is a need to study the transport behaviour of men and women and use the findings to further develop transport systems. This article focuses on gender differences in transport behaviour patterns. To obtain the necessary data, a survey was conducted through a structured personal questionnaire. The results were then processed using selected statistical methods. The results of the survey show that the differences are mainly in the means of transport used or the purposes of the trips. On the other hand, as for the criteria that influence the selection of a mode of travel, time is equally important for both women and men, followed by the purpose of the journey and the availability of transport. The survey thus confirmed that there are significant differences in the transport behaviour of men and women.

Keywords: Gender differences, transport, mobility, transport behaviour

1. Introduction

The issue of gender equality has been discussed with more or less success, in many areas of human activity. Transport is one of the areas where women are still quite often disadvantaged and there are thus many opportunities for improvement. It is true that there have been many studies conducted on this topic. However, the results of these studies are not always conclusive, and the findings are rarely applied in practice. Transport research and transport planning were "gender-blind" in the past, and even after feminist criticism, research has focused only on a small part of the problems, and to a limited extent only [1]. In urban transport, gender issues began to be researched and

discussed roughly in the 1980s, both theoretically and practically [2]. Despite this, urban transport planning still does not take gender differences sufficiently into account and focuses primarily on economic and, at present, mainly environmental aspects [3].

Transport systems are designed predominantly by men, so they are mostly suitable for men [4]. Even current transport policy does not systematically help to address gender differences. However, the community of women is significant, and their needs should also be taken into account. This is because women use quite different and more complex travel models and behave differently compared to men, which is caused by patriarchal influences that place women in a caring role, primarily satisfying the needs of family and the household, shopping, or transporting children [5]. Women and girls also tend to spend more time at home than men and boys [6]. In addition to caring for children, women are often also responsible for elderly, sick, or disabled relatives, which, together with household management, has an influence on the journeys women take, which differ from those of men in terms of the mode of travel methods, time of the day, type of destination, and the distances travelled [4].

Research shows that the main issues related to women's mobility are safety, feeling of security, availability, and reliability of transport, with the need to increase women's trust in transport systems and above all create an environment in which women can feel safe (safe and secure) during the entire journey [7]. This is because women feel insecure and vulnerable more often than men, or to be at risk of various attacks, which may limit their travel at certain times, for example at night [4]. If women wish to have a level of night-time mobility comparable to men, in terms of distance travelled, it can only be achieved with a greater economic burden, resulting, for example, from higher costs of taxi use combined with generally lower incomes, and in overcoming more significant constraints resulting from insufficient security [8].

Similar problems, which are relevant in terms of the equal use of transport by women, also occur in public transport. These include the physical accessibility of the transport system (e.g., stops, stations, vehicle equipment, or greater travel comfort for people travelling with small children), the quality of services provided within the transport system (e.g., comfort, frequency, timetables), the spatial distribution of facilities and services and, above all, issues of safety and security, including perceived personal safety [9]. In some cases, safety and comfort may be a more important factor than travel time or transport expenses [10].

It should also be taken into account that the age of passengers is increasing, which may limit their travel options in some way. Research suggests that older people are more likely to choose public transport over driving, especially women [11]. On the other hand, other research shows that the proportion of female drivers is increasing and although older women are less likely to drive

alone, such journeys are expected to increase [12]. This is mainly due to the increasing average life expectancy of women and the lower average age of women in the case of couples [12].

Researchers also focus on women and bicycle transport. Research carried out in the countries of the European Union [13] shows that the traditional division of roles in households makes it difficult for women to use bicycle transport and increases the probability that women prefer to use a car for travel. This research also shows that the lower proportion of women who use bicycles is related to their limited time options, which again results from the need to take care of family and household. The results of this research also confirmed that women are very sensitive to safety and security. Australian research [14], in turn, focused on gender differences in recreational cycling and bicycle use for travelling. In both cases, women turned out to use this mode of transport less often and for shorter time. Bicycle use for transport was mainly used for commuting to work, with the number of women using this mode of transport for this purpose being lower as well. Furthermore, women preferred off-road cycling, for example on cycle paths, and mentioned a higher number of constraints for both purposes of using bicycle transport. As for the constraints, both men and women mention heavy traffic on the roads, including driver aggression, and related safety concerns. Norwegian research [15] deals with the issue of bike sharing, where gender differences are also evident. The research found that bicycle sharing is mainly used by men, even in combination with public transport, and that women are not comfortable with the restrictions associated with bicycle rental, both in terms of their preferences and women's daily activities, which are time and space consuming.

Another possible mode of transport is walking. Research [16] shows that more women than men walk in their free time, but there are differences in different age groups. At younger age, the number of women using this mode of transport is higher compared to men; however, the gender gap decreases as people get older and even reverses for elderly people. The results of the research also suggest outside leisure time, there are no significant differences between men and women in terms of walking as a mode of transport, except for running errands, for which women prefer walking. Gender differences in the use of walking can also be due to the environment in which people live [17].

Since women are more willing to use environmentally friendly modes of transport, their transport needs should be included in transport technologies aimed at low-emission mobility [18]. The fact that innovative technologies and increased automation are not always gender neutral and that women are less willing to use them should also be included, although transport safety and security are decisive factors for their mobility [18,19].

Transport and mobility are essential to modern society. The development of transport has always been linked to the need for mobility. Transport facilitates access to work, education, health

services, and other services necessary to improve the lives of individuals or households. Therefore, transport systems have always been designed to be user-neutral in order to provide the same benefits to all. However, it is currently becoming apparent that what is designed to benefit all may not be beneficial to every individual.

This article focuses on differences in transport behaviour between men and women during their normal journeys. These may cause a user-neutral, i.e., gender-neutral, transport system to fail to meet the mobility requirements of all users, including the genders, to the same extent.

First, the null hypothesis H_0 was formulated: "There are no differences in the transport behaviour of men and women." In case the null hypothesis is confirmed, the conclusion is that there are no gender differences in the behaviour patterns, and a gender-neutral transport system can thus suit both men and women. Research specified below is thus conducted to either confirm or reject this hypothesis.

2. Data and Methods

Primary marketing research was conducted in the form of a structured personal questionnaire compiled on the basis of a literature search and analysis of the issue; the appropriateness of the formulated research questions was validated through a pilot survey. A statistical approach based on relevant literature was used to determine the sample size. Based on performed calculations, Hague [20] suggests that for a basic sample size of 100,000 units, 384 respondents is sufficient to ensure 95% confidence and a maximum error of 5%. The actual survey was conducted using an electronic form of the questionnaire, in both Czech and English versions, to reach a larger number of respondents. A total of 394 respondents from EU countries, 182 men (53.8 %) and 212 women (46.2 %) at the age of 18+ took part in the survey. The gender composition of the respondents corresponds to the proportion of men and women in the total EU population over 18 (53 % women, 47 % men) [21]. The main objective of the research was to gain initial insight into gender issues in relation to transport behaviour and to understand the underlying context. This was primarily to determine whether gender is a factor that influences transport behaviour. Therefore, gender was also a fundamental criterion of the research.

ANOVA and chi-square test were used to evaluate the results of the questionnaire survey and assess the correlations.

The ANOVA test allows more than two groups to be compared at the same time to identify a possible relationship between them and to determine the degree of variability in the data set.

To test the statistical hypothesis, i.e. to verify that all samples come from the same base population,

the following formula is used.

$$F = \frac{\frac{S_{y,m}}{k-1}}{\frac{S_{y,v}}{n-k}}, \quad [-] \quad (1)$$

where: F is ANOVA coefficient [-]; $S_{y,m}$ is the sum of squares due to treatment or between-group sum of squares [-]; $S_{y,v}$ is the sum of squares due to error or within-group sum of squares [-]; k is the total number of populations [-]; n is the total number of observations [-].

Formula for between-group sum of squares:

$$S_{y,m} = \sum_i n_i (\bar{y}_i - \bar{y})^2, \quad [-] \quad (2)$$

Formula for within-group sum of squares:

$$S_{y,v} = \sum_i \sum_j (y_{ij} - \bar{y}_i)^2, \quad [-] \quad (3)$$

where: n_i is the number of observations in each group [-]; y_{ij} is the single score for an individual i within a particular group j [-]; \bar{y} is the mean of the whole sample [-]; \bar{y}_i is the mean of the group [-].

If $F > F_{1-\alpha} (k-1, n-k)$, the null hypothesis can be rejected, which means that there are significant differences between the samples.

The chi-square test is used primarily to evaluate discrete random variables. It tests the null hypothesis stating there is no significant difference between two groups of samples.

The following formula is used to test this hypothesis:

$$\chi^2 = \sum_i \frac{(n_i - e_i)^2}{e_i}, \quad [-] \quad (4)$$

where: n_i are the real values [-]; e_i are the expected values [-].

The null hypothesis is rejected if the results of the test statistic exceed the appropriate quantile chi-square of the distribution, i.e., if $\chi^2 \geq \chi_{(r-1)(1-\alpha)}^2$.

For both tests a p -value can also be used, which shows the lowest level of significance for rejecting the null hypothesis. If the p -value is less than 0.05, the alternative hypothesis can be confirmed.

3. Results

As part of the research, the respondents were first asked *what mode of transport they use* (at least once a week).

It is clear from the processed results that at the 5% confidence level (which is usually used), there is a significant difference between men and women in the use of specific means of transport: the p -value of the chi-square test is 0.017. Compared to women, men use more often:

- car as its drivers,
- train,
- bus,

- bicycle.

Women tend to use cars rather as passengers; they also use public urban transport and walking more often compared to men. The results are shown in Fig. 1.

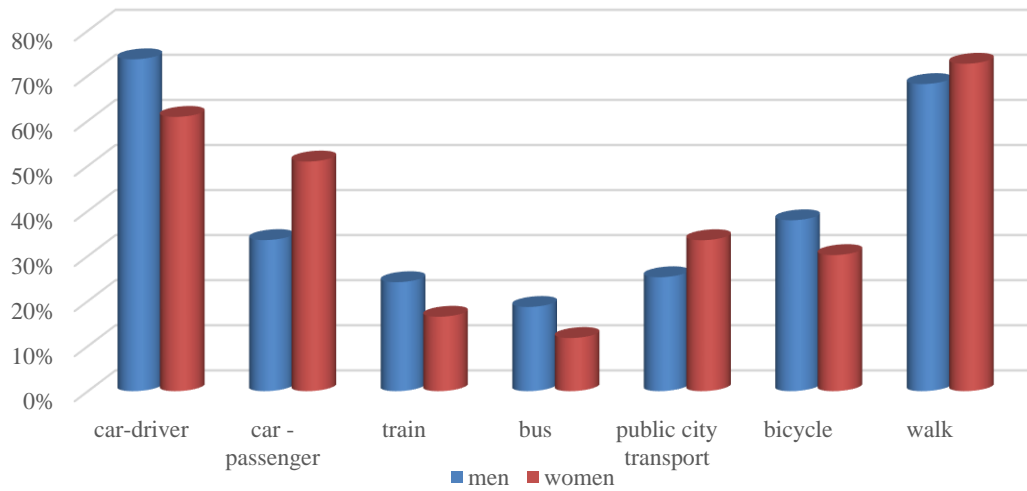


Fig. 1 Means of transport. Source: authors

Another question the respondents were asked concerned *the purpose of their trips made for their own use*.

As shown in Fig. 2, men most often mentioned work and shopping, while for women, shopping is slightly more often mentioned than work as the purpose of their trip. Women travel more often to offices and to doctors. On the contrary, men travel more frequently for sports. The chi-square test showed that the purposes of the trip (their frequency) differ significantly between men and women. The calculated p -value is 0.006.

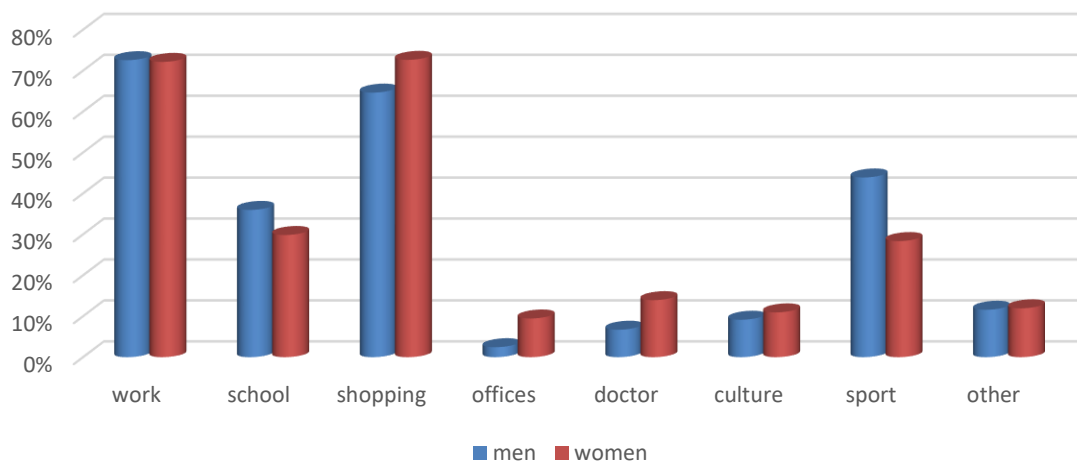


Fig. 2 Purpose of travelling. Source: authors

The next question concerned *the most common purpose of respondents' day trips (to meet the needs of people in their care)*.

According to the results, the most common purpose is for shopping (see Fig. 3). The second most common purpose mentioned by men was work. Going to the doctor with persons in their care was more commonly mentioned by women, while men spoke about going to various offices to arrange affairs of people in their care. They also more often drive others to sports. The chi-square test showed that the purposes of the trip (their frequency) differ between men and women. The *p*-value is 0.016.

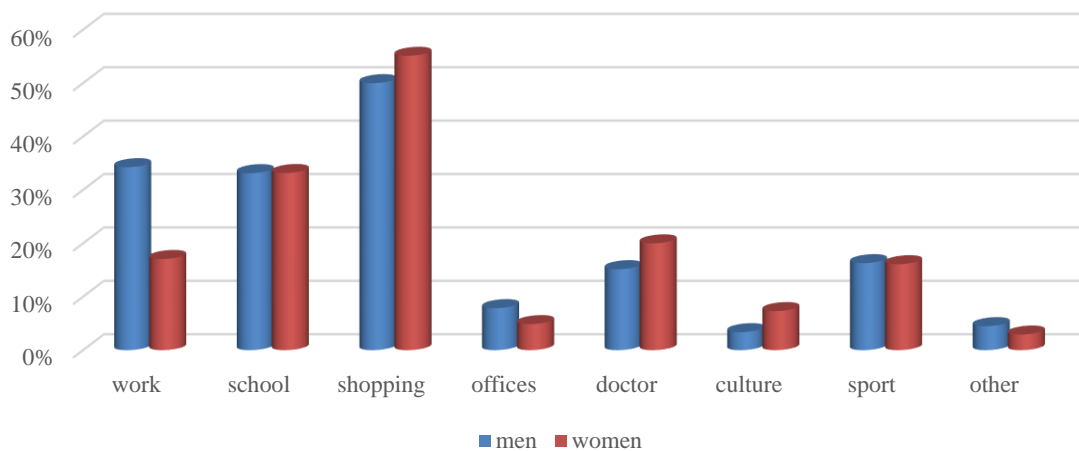


Fig. 3 Purpose of travelling for others. Source: authors

Another question was interested in *distance and time of travel related to the respondents' regular (daily or weekly) trips using usual modes of transport*.

The results were entered in a boxplot, where both outliers and extreme values were discarded. Men travel a longer distance (16 km on average; in the case of women, it is only 10 km). This result was confirmed by the ANOVA test (*F* test value: 15.24, *p*-value: 0.0001). The travel time to work is equal for men and women, approximately 20 minutes. The analysis of variance did not reject the null hypothesis (*F* test 1.97, *p*-value 0.162).

As for commuting to schools, in terms of distance, it turned out that men and women travel almost the same distance on average, about 12 km. This was confirmed by analysis of variance (*F* test value: 0.25, *p*-value: 0.62). Also, the travel time to school is similar for both men and women (about 24 minutes). The ANOVA test proved this statement (*F* test value: 0.23, *p*-value: 0.63).

In the case of travelling for shopping, in terms of distance, it turned out that men travel a longer distance. This was confirmed by analysis of variance (*F* test value: 9.1, *p*-value: 0.003). In the case

of travelling for shopping in terms of time, it turned out that men spend about the same amount of time travelling as women (F test value: 1.56, p -value: 0.21).

The results of the survey did not confirm the existence of any significant difference in the travel of men and women for the purposes of culture, both in terms of distance and time. In the case of travel for sports, there is no significant difference in distance either, but a difference was identified in terms of travel time, specifically, women spend more time travelling for the purpose of sports. The results of the survey concerning travel distance and travel time are summarized in Table 1 and Table 2.

Table 1 Travel distance [km]. Source: authors

	Work	School	Shopping	Culture	Sport
Men	15.9	12.8	5.3	10.2	6.3
Women	9.9	11.6	3.9	10.8	6.3
p -value	< 0.001	0.62	0.003	0.62	0.99
Significant difference	yes	no	yes	no	no

Table 2 Travel time [min]. Source: authors

	Work	School	Shopping	Culture	Sport
Men	23.6	24.8	11.1	20.0	12.7
Women	21.1	23.3	10.3	22.3	18.5
p -value	0.162	0.63	0.21	0.19	< 0.001
Significant difference	no	no	no	no	yes

Interestingly, although men have been shown to travel a longer distance in several cases, they report the same travel time as women. How is this possible? There is probably a correlation between this result and the fact that most men drive a car.

One of the important questions within the research was whether there is a gender difference in *the use of the synergistic effect, and thus the combination of multiple purposes into one trip*. Most men and women combine multiple purposes in one trip, namely 93 % of women and 87% of men.

The chi-square test did not show that men and women differed significantly in this respect. The p -value was 0.062, which indicates there is no significant difference.

The research also focused on *which criteria affect the mode of transport selected by the respondents*.

14 responses from men and 24 responses from women were discarded because they chose more than the maximum allowed 3 criteria.

The research results (Fig. 4) showed that the most important factor in decision both for men and women is time. Another important factor is the purpose of the trip and the availability of the mode of transport. Convenience is important for roughly 40 % of the respondents, and price is even less important.

Here, no significant differences were identified between men and women, as indicated by the p -value of the chi-square test (0.29).

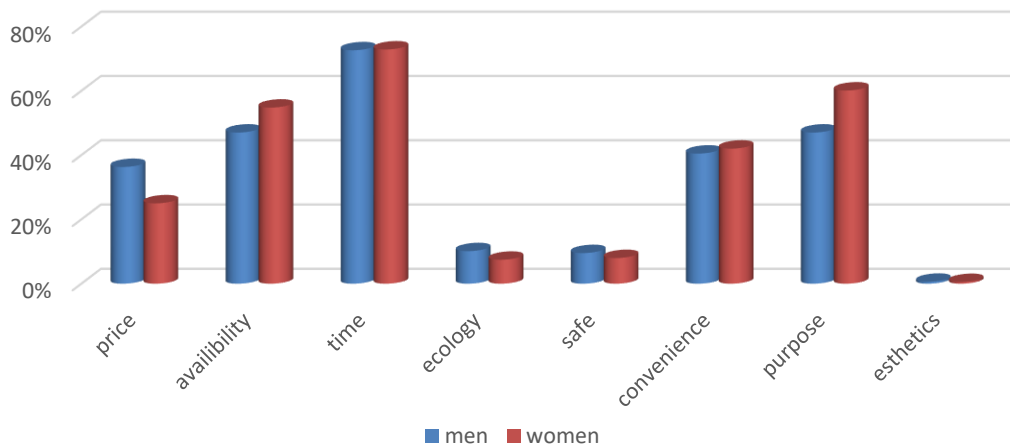


Fig. 4 Criteria for choosing mode of transport. Source: authors

Another important aspect to examine was the perception of safety. The respondents were asked *which part of the journey they perceive as least safe*.

Here, men and women equally stated that they consider the time spent on a means of transport to be the least safe (60 % of the respondents). There are no differences between men and women in this aspect, with the p -value of the chi square test being 0.92).

4. Discussion

The survey identified several significant differences in travel behaviour patterns between men and women, although in many cases, no differences were found. The null hypothesis was thus rejected.

The survey confirmed that the differences are mainly in the means of transport used, which is consistent with previous research [11,13-16]. Women are more likely to be passengers, use urban public transport and walk more often compared to men. Men, on the other hand, are more likely than women to drive, cycle, or take the train or bus. Differences between men and women were also identified in the purposes of trips, both for their own use and for the needs of the people they care for. This is consistent with the statement that women show different patterns of travel behaviour than men, resulting from the responsibility ensuring the running of their households and their caring role [4,5,22-25].

However, there were no major differences in the distance travelled or the time they spent travelling. Significant differences were found only in distance travelled to work and shopping (men travelled longer distances) and in the time travelled only for sporting activities (women travelled longer). Similarly, both genders are consistent in their efforts to rationalise travel and combine multiple purposes into one trip. No significant differences were found in the criteria influencing the way the respondents travel. For both women and men, time is the most important criterion, followed by purpose of travel and availability of transport. In literature, availability of transport is mentioned as one of the important criteria, especially for women, in the context of public transport [10,26].

Foreign sources also very often mention women's requirement for safety and security [7,9,10,13,18,23,26]. Surprisingly, this was not confirmed in this investigation. This is probably due to the fact that the survey was focused on normal daily trips, which usually take place during the day (i.e., not at night) and do not concern longer distance from the place of residence. Therefore, they are not perceived as problematic in terms of safety or security.

5. Conclusion

The objective of the research presented in this paper was to confirm or reject the null hypothesis, which was formulated as follows: "There are no differences in transport behaviour between men and women." The research questions focused on modes of transport used by the respondents, the purpose of their trips (both trips undertaken to meet their own needs and the needs of those in their care). Other questions focused on the distance and duration of trips, the combination of multiple purposes into one trip, criteria that influence the selection of a mode of travel, as well as safety.

Significant gender differences in transport behaviour were found in modes of transport used and the purposes of travel, either for meeting own needs or the needs of others. Regarding the purpose of travel, significant differences were confirmed only in certain cases, namely, when travelling to work, for shopping, or for sport. In the first two cases, men travelled longer distances than women, in the third case, time spent on the road was longer for women. In contrast, no significant differences were found in the case of combining multiple purposes into one trip, criteria influencing the mode of travel, or safety. Nevertheless, the above shows that there are differences in transport behaviour between men and women; therefore, the null hypothesis was rejected.

The above also implies the need for quality information, which is still insufficient. Traffic behaviour surveys should be carried out in such a way that the data obtained from them can be disaggregated by gender. Given the complexity of the issue, there is also a need to specify which questions to focus on to reliable results applicable in practice. For example, transport behaviour surveys can be used as a basis for transport models, which are an important part of transport planning, and which express the relationship between the demand and supply of transport services.

The aim of the survey, the results of which are described in this article, was not to cover the issue in its complexity, but to determine whether there are significant differences in transport behaviour between men and women, to compare the findings with other authors and to point out important aspects that should be focused on in detail. This is related to limitations of this survey specified below.

Patterns of transport behaviour can vary considerably from region to region, not only from the perspective of different areas of the world, but even within a particular country. Other aspects that may play an important role include age, financial situation of the respondents, as well as the time of day or year when the journey takes place, etc. The literature search also shows that it is very difficult to describe the whole range of issues within single research. Further research should thus focus on individual issues and examine them in more detail on a narrower scale.

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