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## Ways Residents of Large Cities in Poland, Commute before and during the Covid-19 Pandemic

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Anna E. Wolnowska<sup>1</sup>, Lech Kasyk<sup>2</sup>

**Abstract:**

**Purpose:** The article concerns the issues related to the methods of movement of people in urban areas by means of cars, trams, buses, bicycles, e-scooters, electric scooters and on foot. Its purpose is to present selected factors determining this choice.

**Design/Methodology/Approach:** The authors, using the proprietary questionnaire, conducted a survey among the inhabitants of one of the largest cities in Poland - Szczecin to determine their current preferences related to the way of movement before and during the pandemic caused by the Covid-19 virus. Non-parametric dual and multiple comparison tests, the Mann-Whitney U test and the Kruskal-Wallis rank ANOVA were performed. The Cronbach's  $\alpha$  coefficient was used to assess the reliability of the measuring scale.

**Findings:** The conducted analyzes allowed to determine the most common ways of traveling, the level of their safety and accessibility for residents. Statistically significant differences were found in respondents' opinions, depending on age, gender, industry, and education. The impact of the Covid-19 pandemic on opinions on the frequency of use, safety, and availability of means of transport in Szczecin was verified. The analysis showed a slight decrease in the declared frequency of using the analyzed means of transport and no decrease in the safety assessment of the analyzed means of transport during the application of the restrictions related to Covid-19.

**Practical Implications:** The presented analysis and assessment of the ways in which the inhabitants of Szczecin move could be used in rational actions of the local authorities aimed at improving the quality of life of the inhabitants and friendly to the inhabitants of the city in the context of public and individual transport.

**Originality/Value:** The authors compared the preferences of the ways of movement and the implemented solutions with the parameters of their effectiveness, based on the experimental results and foreign literature.

**Keywords:** Quality life, municipal transport, pandemic Covid, mobility in cities.

**JEL codes:** R40, R41.

**Paper type:** Research article.

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<sup>1</sup>Corresponding author, Faculty of Economics and Transport Engineering, Maritime University of Szczecin, Poland. E-mail: [a.wolnowska@am.szczecin.pl](mailto:a.wolnowska@am.szczecin.pl)

<sup>2</sup> Department of Mathematics, Maritime University of Szczecin, Poland, E-mail: [l.kasyk@am.szczecin.pl](mailto:l.kasyk@am.szczecin.pl)

## **1. Introduction**

Each person, depending on what does daily or where works, looks for the most appropriate way of moving (Redman *et al.*, 2013). She/He makes her/his choice dependent on accessibility (Stępniań *et al.*, 2019), economic conditions, often on the speed of a given mode of movement and her/his own comfort (Hjorthol *et al.*, 2010; Bjørnarå *et al.*, 2019), recently with one thing as a limitation, that is the Covid-19 pandemic (Glavic *et al.*, 2021). In addition to comfort, travel time, environmental friendliness, and reliability of the means of transport, city residents pay much more attention to safety (Chu *et al.*, 2020; Betkier, 2020). They choose, if possible, to travel on foot. It is not always possible due to the size of a large city and the location of the workplace, study, medical assistance, and recreation. This is a challenge for local authorities, which create the quality of life in the city also through the availability of various means of transport, considering the principles of sustainable development (Lozzi, 2021; Oleśków-Szłapka *et al.*, 2020; Mensah, 2019). Hence, currently, in most large Polish cities, residents can use buses, trams, e-scooters, electric scooters, bicycles, and taxis (Pogodzińska, 2018). Others, such as metro, water tram, trolleybus, may be characteristic of a relevant city (Zawieska, 2017).

The epidemic continues throughout Poland from March 20, 2020. During this period, the provisions of the Act of March 2, 2020, on special solutions related to the prevention, counteracting, and combating of COVID-19, other infectious diseases and crisis situations caused by them (Dz. U. poz. 374, 2020) and as modified by the amendment to March 31, 2020, (Dz. U. poz. 568, 2020). For the public collective transport industry, this entailed several changes, including limiting the number of passengers in the period from March 25, 2020, to April 11, 2020, to no more than half of the seats (Dz. U. poz. 491, 2020). Subsequent amendments introduced new changes depending on the current epidemiological situation:

- From May 14, 2021, public transport will be able to carry, at the same time, no more than 50% of the number of seats or 30% of all seats and standing places, while leaving at least 30% of the seats unoccupied in the vehicle (currently this is at least 50% of unoccupied seats).
- From May 15, 2021, to June 5 this year, relevant means of public transport will be able to carry, at the same time, no more than 100% of passengers than the number of seats or 50 percent of the number of all sitting and standing places, while leaving at least 50% unoccupied seats in the vehicle. Regulation of the Council of Ministers of May 6, 2021, on the establishment of certain restrictions, orders and bans in connection with an epidemic (Dz. U. 2021 r. poz. 861).

In public transport, there are also certain rules of safe travel issued by the Chief Sanitary Inspectorate, Ministry of Health, Ministry of Infrastructure, on August 24, 2020, during the SARS-CoV-2 epidemic in Poland. They concern the obligation to keep a safe distance from other passengers (at least 1.5 m) and cover the mouth and nose, as well as closing the door by the driver. Furthermore, ozone the vehicle or disinfect it by using an alternative method at the end of each day's journey. Regular cleaning and disinfection of touch surfaces in the vehicle during breaks in vehicle operation, but not less than 2 times a day. Ensuring air exchange in means of transport by leaving windows and roof vents open. (GIS, 2020). The introduced rules and restrictions in the use of public collective transport resulted in interest of other ways of traveling (Wielechowski, *et al.*, 2020). Thus, the need to capture changes in the preferences of travelers around the city, to determine the frequency, availability, and safety of using them.

The aim of the publication is to assess the ways in which the inhabitants of Szczecin travel before and during the pandemic caused by the Covid-19 virus. The following research hypotheses were adopted:

*H1: the survey conducted on the basis of the prepared questionnaire allows to determine preferences in moving around the city of Szczecin;*

*H2: the analysis of the obtained results allows to determine the frequency of choices of the ways of movement of respondents, taking into account their sex, age and professional activity, both before and during the pandemic;*

*H3: the analysis of the obtained results, provides information about which of the respondents consider the safest modes of movement both before and during the pandemic;*

*H4: the analysis of the obtained results allows to determine the level of availability of various means of transport for respondents, considering their gender, age and professional activity, both before and during the Covid-19 pandemic.*

## **2. Literature Review**

The preferences and transport needs of residents of large cities in Poland have changed quite dynamically over the last decade (Kruszyna, 2017; Zdanowska and Bojke, 2017). This happened due to the implementation of new ways of movement, more ecological, consistent with the policy of sustainable development, reduction of CO<sub>2</sub> emissions and noise, which was to lead to an improvement in the quality of life of the inhabitants (Wolnowska *et al.*, 2015a; 2014; 2015b). However, the last year has shown that preferences in the ways of moving around the city also depend on the epidemiological situation in a relevant city or even country (Nian *et al.*, 2020; Vannoni, 2020). The mobility of residents of many cities around the world has been disrupted (Barbarossa, 2020; Barbieri,

2020; Bucsky, 2020; Ceder, 2020). The need to travel to work or school has also taken a different dimension through the implementation of distance learning and the increase in distance work (Rubin *et al.*, 2020). The complacency in public transport was disturbed, which resulted in a reduction in the number of people traveling by bus, tram, or metro (Harrington and Hadjiconstantinou, 2020; Kubalák, *et al.*, 2021; Orłowski, 2020). A decrease in people using collective public transport was recorded in many cities, regardless of the continent (Thomas *et al.*, 2021).

In Baltimore, passenger numbers began to decline from March 2020, while in Washington, Detroit, Seattle, Minneapolis and several others, passenger numbers were recorded as early as April 2020 (Ahangari *et al.*, 2020). This phenomenon has also been observed in India. About 41% of commuters stopped traveling during the transition to the closure phase, 51.3% used the same mode of transport, and 5.3% of commuters switched from public to private transport (Pawar *et al.*, 2020). Resignation of residents from public transport and a significant reduction in the number of passengers in public transport also influenced decisions changing the traffic organization in favour of ecological individual transport, temporarily transforming their car lanes into pavements and bicycle lanes, thus allocating more space for pedestrians and cyclists (e.g., parking lots) in Berlin, Bogota, Philadelphia (Laker, 2020). In Great Britain, the pandemic has affected all forms of travel. Car travel, pedestrian and bicycle traffic decreased by around three-quarters. Public and bus transport decreased to 60% (Carrington, 2020).

Trieste is an Italian city badly affected by coronavirus. The mortality rate per 100,000 inhabitants by September 2020 was 88, 29 in Friuli Venezia Giulia, 169 in Lombardy and 59 in Italy. Before the pandemic, the most preferred mode of transport was the bus 35.7%, now it is only 9.2%. Most likely, it was replaced by pedestrian means of transport, which gained from 33.3% to 52.5% of supporters. A noticeable increase is observed for the car from 16.7% to 22.8% and a slight increase for the bicycle from 7.2% to 9.3% (Scorrano and Danielis, 2021). When undertaking the study of preferences for the manner of movement at the local level, in the city of Szczecin, it is worth looking at the results of the research in a city of Gdańsk, which is comparable in terms of size and location.

Most of the research conducted among the inhabitants of Gdańsk showed that before the pandemic, 57% of respondents declared using public transport every day, and 24% used it several times a week. Such a voice of the respondents indicated the scale of the frequency of using public transport in Gdańsk. According to the researchers, 70% of respondents used at least two means of transport in Gdańsk, which means the availability of many means of transport, and it gives users the opportunity to reach their destination more conveniently. About

64% of people confirmed that they use public transport due to the lack of a private vehicle. After the announcement of the pandemic and the implementation of restrictions on public transport, almost 90% of Gdańsk residents declared to resign from this form of moving around the city. 75% showed a willingness to return to this form of transport when the situation stabilized in the epidemic, and they would feel safe and comfortable (Przybyłowski *et al.*, 2021).

Among the large Polish cities, Warsaw, Kraków and Łódź are the leaders. Szczecin is in 7th place, right behind Gdańsk and Poznań with a population of less than 404,000 inhabitants (Karmowska and Sobczyk, 2020), on the area of just over 300 km<sup>2</sup>. It is the largest city in the western-northern part of Poland, located at the mouth of the Odra River and the Szczecin Lagoon, which connects with the Baltic Sea.

### 3. Methods and Empirical results

Research on the ways of movement of residents of one of the large cities in Poland was carried out in the city of Szczecin in the period from 17/05/2019 to 01/04/2021. 322 respondents aged 16 to 80 participated in the survey by means of a questionnaire made electronically available.

The study used a convenient sampling method, also known as random, as one of the groups of non-random methods (Szreder, 2003). Most of the respondents were women 62.7%. The respondents represented all levels of education, higher 54%, secondary 42.5%, vocational 2.2% and primary 1.3%. 71.4% of the respondents declared that they live in Szczecin, 13.7% in the vicinity of Szczecin, and 11.2% in the West Pomeranian Voivodeship. A significant part, as much as 58.4%, are students, 38.2% of the respondents working professionally, the rest were schoolchildren, pensioners and the unemployed. The respondents represented various professional sectors, the most numerous of which were services 32.5%, education 23% and administration 20.1%. Trade and production were similar.

The questionnaire consisted of 8 basic questions and a record characterizing the respondent, including age, professional activity, industry, education, and gender. Using the method of induction and deduction, only a few of the questions asked, were used to assess the modes of movement of the respondents. Among them: How often do you use a relevant mode of transport? How do you rate the level of safety in moving with the means of transport? How do you rate the level of accessibility to means of transport?

Such a selection of data for analysis was dictated by the achievement of better transparency and coherence of conclusions in two planes, taking into account the period before and during the COVID-19 pandemic. The following forms of travel

were considered for the assessment, on foot (F), by car (C), e-scooter (S), electric scooter (E), bicycle (B), bus (BUS), tram (TRAM), taxi (T) and other (O), e.g., seasonally available water tram, applications for finding / sharing rides / sharing a vehicle. The study did not consider the subway, city railways and trolleybuses, as these means of transport are not available in Szczecin.

When asking respondents about the frequency of use, safety, and availability, a 7-point Likert scale was used to analyze the reliability with the use of the Statistica program. The Cronbach's  $\alpha$  coefficient was 0.774, which proves the correct selection of the measuring scale used by the authors of the article in the questionnaire. A detailed description of the scales used to assess the frequency, safety, and availability of the studied modes of movement is presented in Table 1. Non-parametric tests of dual and multiple comparisons, the Mann-Whitney U test and Kruskal-Wallis rank ANOVA were used to develop the obtained results (Montgomery and Runger, 1994).

*Table 1. Description of the measurement scales used in the research*

Scale	Incidence	Safety	Availability
1	I do not exploit.	Very dangerous	Inaccessible
2	On occasion (once for a couple of years)	Dangerous	Very hard-to-reach
3	Very rarely (once a year)	Moderately dangerous	Hard-to-reach
4	Seldom (once a month)	Moderately safe	Moderately accessible
5	Often (once a week)	Averagely safe	Averagely accessible
6	Very often (once a day)	Safe	Well-accessible
7	Notoriously (several times per day)	Very safe	Very accessible

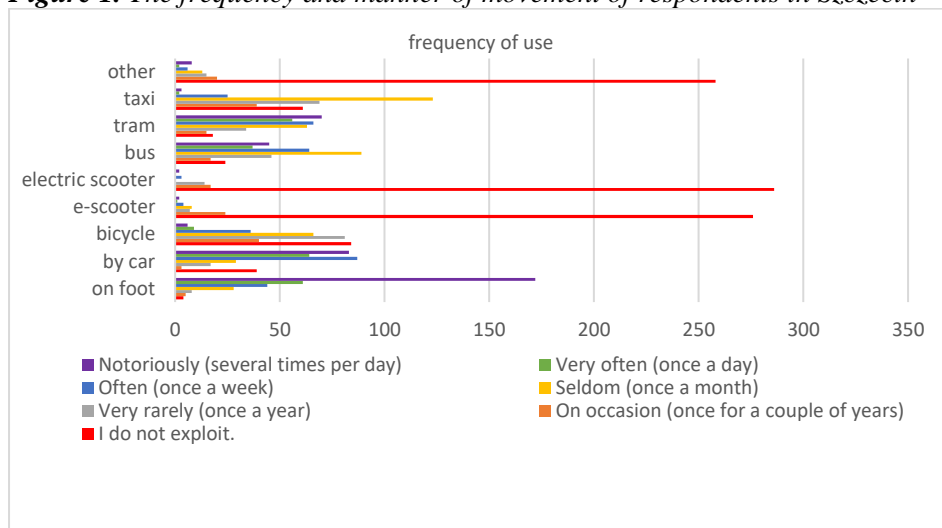
Source: Own creation.

## 4. Data Analysis and Discussions

### 4.1 General Study Description

The collected research results make it possible to preliminarily determine not only the frequency of using various means of transport in urban areas, but also in general the ways of moving around the city of Szczecin. In the analyzed period, the respondents most often, i.e., notoriously, walked 172 people, the following were very popular, car 83 people, tram 70 people, bus 45 people. The rest of the respondents, broken down by several people, traveled by other means of transport. The most frequently declared means of transport which the respondents did not use were e-scooters, electric scooters, and others. The general distribution of the ways of movement of the respondents is presented in Figure 1.

**Figure 1.** The frequency and manner of movement of respondents in Szczecin



**Source:** Own creation.

The opinion of the respondents on the safety level of moving around the city of Szczecin is also worth noting. They consider a tram 37 people and a bus 28 people, to be a very safe way. They rate the bus, tram, foot, and taxi as safe. Some respondents consider car, taxi and on foot to be a moderately safe way to travel around the city. The most dangerous means of transport were other modes of movement not mentioned in the survey, as well as e-scooters and electric scooters. A comparison of the safety level of the methods of movement used, is shown in Figure 2.

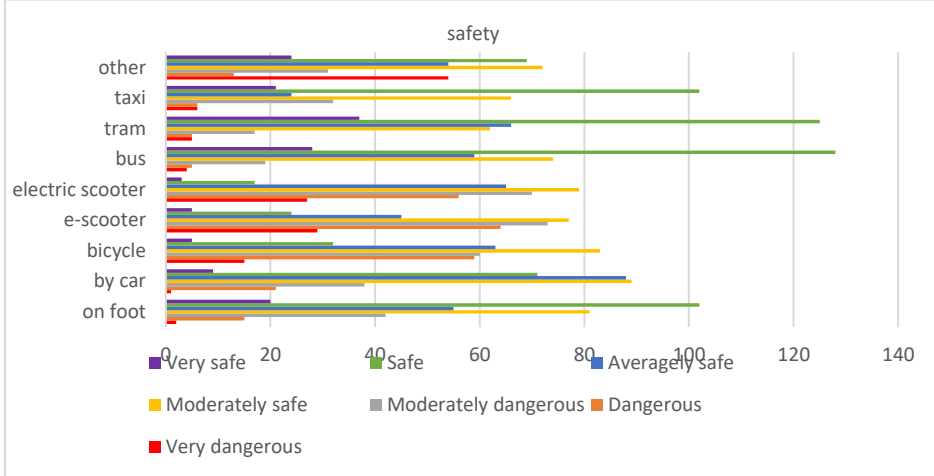
In densely populated cities, the availability of transport and mobility are diverse. In the case of the city of Szczecin, the respondents considered walking 229 people, taxi 114 people and tram 93 people - the most accessible way of traveling. The taxi 152 people, the bus 150 people, the car 139 people and the tram 137 people were well accessible. The respondents considered a e-scooter, bicycle, and electric scooter as medium and moderately accessible. On the other hand, a small number of respondents to e-scooters 21 people considered it very difficult to access. Details of the analysis are presented in Figure 3.

#### 4.2 The Impact of Covid-19 on the Change in the Assessment of the Frequency, Safety and Availability of Individual Means of Transport

Comparative analysis of the survey results regarding the frequency of using various means of transport depending on the covid situation, showed a general

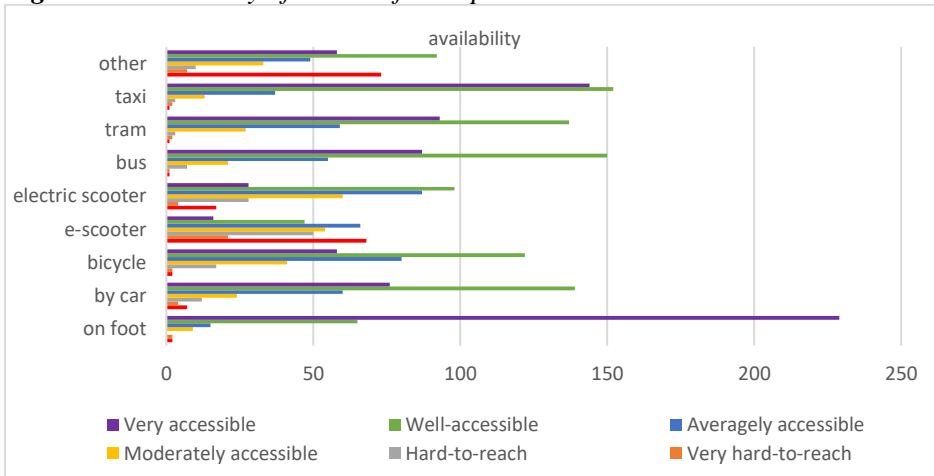
trend of a slight decrease in the frequency of use. The only means of transport where the frequency of use increased, was the car (Figure 4).

**Figure 2.** The level of security of the methods of movement used by respondents



Source: Own creation.

**Figure 3.** Availability of means of transport

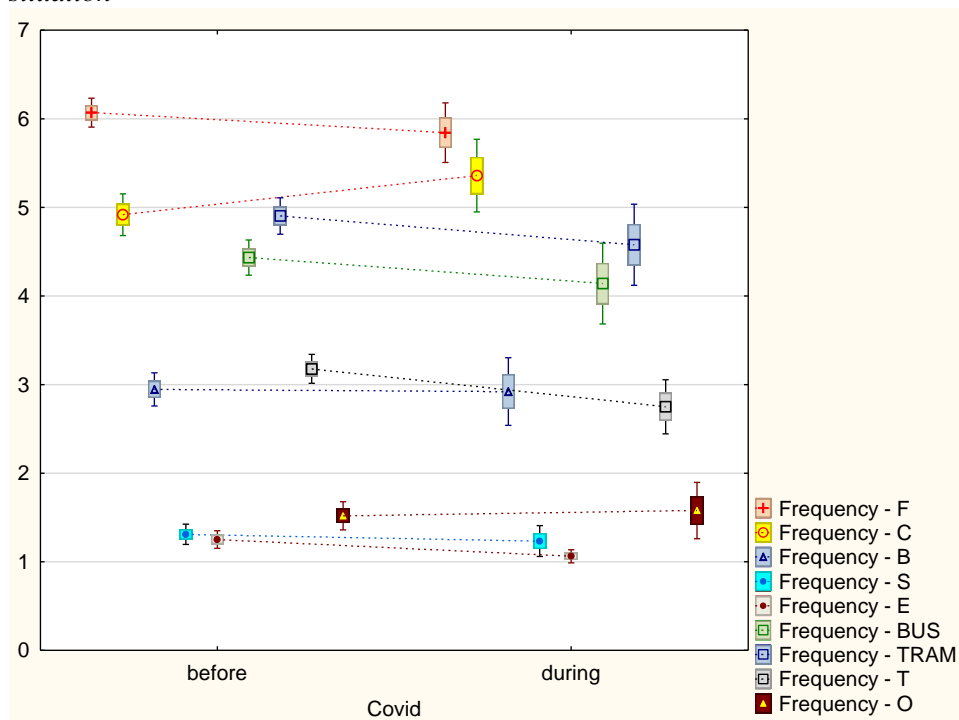


Source: Own creation.

However, the Mann-Whitney U test showed a statistically significant difference in the average frequency of use before and during covid only in the case of Taxi (Table 2).



**Figure 4.** The frequency of using means of transport depending on the covid situation



Source: Own creation.

**Table 2.** Results of the Mann-Whitney U test for the frequency of using means of transport depending on the covid situation

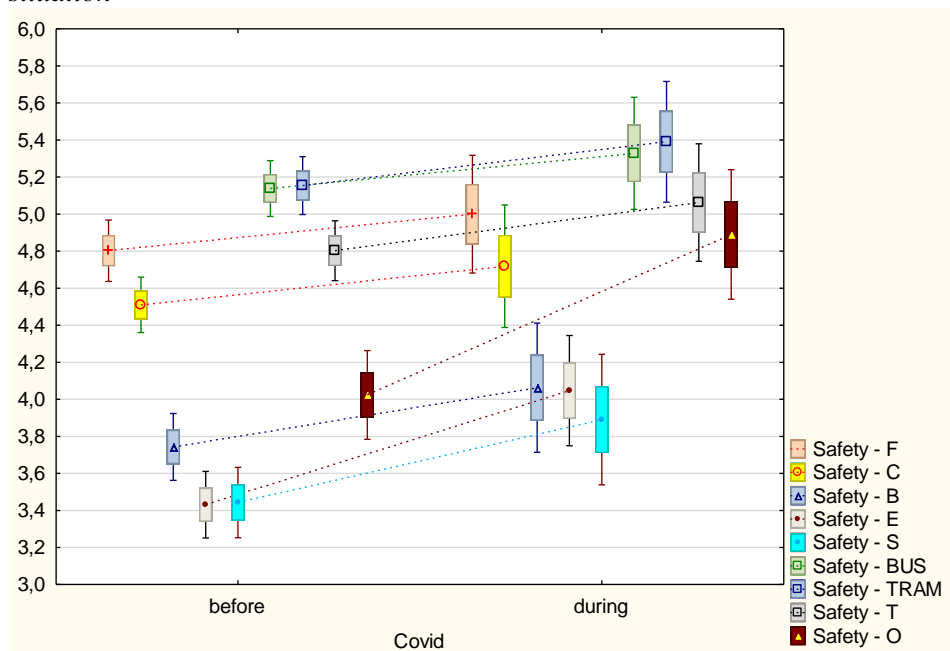
Variable	The value of the U Mann-Whitney test	Significance level for the designated test value
Frequency - F	1.417736	0.156268
Frequency - C	-1.571396	0.116091
Frequency - B	0.027637	0.977951
Frequency - S	0.133194	0.894039
Frequency - E	1.869240	0.061590
Frequency - BUS	1.001027	0.316814
Frequency - TRAM	1.170771	0.241691
Frequency - T	2.381820	0.017227
Frequency - O	-0.4640684	0.642598

Source: Own creation.

Therefore, it can be concluded that Covid did not significantly affect the frequency of using means of transport, apart from Taxi. While assessing the preferences of the respondents as to the manner of moving around the city of Szczecin, they were

asked to assess the level of safety of these possibilities. During the Covid-19 pandemic, an increase in the safety assessment of all means of transport was observed, as shown in Figure 5.

**Figure 5.** Safety assessment of means of transport depending on the covid situation



**Source:** Own creation.

The Mann-Whitney U test showed that in the case of (S), (E), (O), there is a statistically significant difference between the average safety assessment before and during Covid, (Table 3).

**Table 3.** The results of the Mann-Whitney U test for the evaluation of the safety of means of transport depending on the covid situation

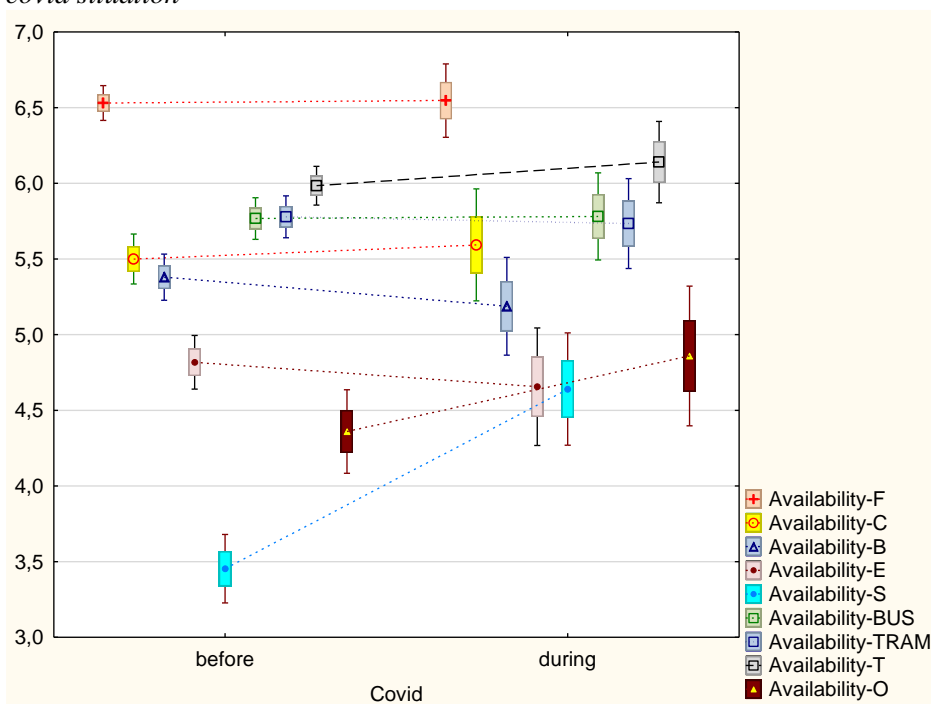
Variable	The value of the U Mann-Whitney test	Significance level for the designated test value
Safety - F	-1.043560	0,296689
Safety - C	-1.155337	0,247952
Safety - B	-1.487313	0,136933
Safety - S	<b>-3.039296</b>	<b>0,002372</b>
Safety - E	-2.137167	0,032585
Safety - BUS	-1.11052	0,266774
Safety - TRAM	-1.379586	0,167715

Safety - T	-1.171322	0,241470
Safety - O	-2.949376	0,003184

Source: Own creation.

Respondents also rated the availability of means of movement in the city of Szczecin both before and during the Covid-19 pandemic. Comparative analysis of the survey results showed only in one case a significant increase in the assessment of accessibility, (Figure 6). This concerned the availability of e-scooters, which were introduced to Szczecin on a larger scale in 2020. For the remaining means of transport, the identified changes did not turn out to be statistically significant (Table 4).

Figure 6. Assessment of the availability of means of transport depending on the covid situation



Source: Own creation.

Table 4. The results of the Mann-Whitney U test for the assessment of the availability of means of transport depending on the covid situation

Variable	The value of the U Mann-Whitney test	Significance level for the designated test value
Availability - F	-0.184914	0.853296
Availability - C	-0.941840	0.346274

Availability - B	1.044171	0.296406
Availability - E	0.643728	0.519752
Availability - S	-4.581961	0.000005
Availability - BUS	-0.144409	0.885177
Availability - TRAM	0.180245	0.856959
Availability - T	-1.351292	0.176602
Availability - O	-1.192920	0.232901

*Source: Own creation.*

### 4.3 Influence of Respondents' Characteristics on Research Results

The respondents who participated in the survey were also asked about their gender, age, education, and professional activity, with the specification of occupational groups. Such information allowed to define their needs in terms of movement in the city of Szczecin more precisely. Studies have shown that the Covid-19 pandemic did not have a major impact on the frequency of use of the proposed methods of travel. The only mode of transport that noticed a change is the e-scooter, where the average frequency of use has decreased and was the lowest compared to the others.

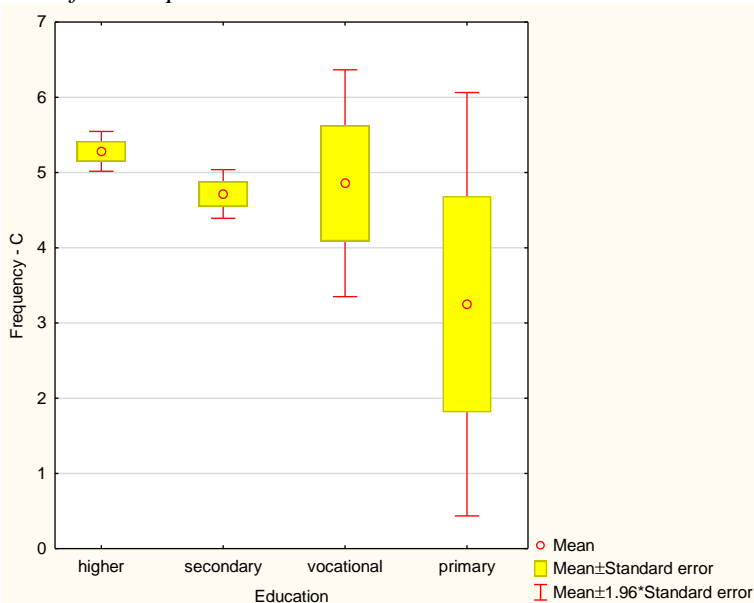
In addition, significantly more women than men use the bus. It is worth noting that people with higher education drive most often, which would suggest not so much having additional skills, but a better financial situation and no restrictions in the distance when looking for a job, Figure 7. The next few figures show the most statistically significant differences in opinions in the groups mentioned.

The Kruskal-Wallis ANOVA test confirmed the significance of the influence of education on the frequency of car use, the value of the H statistic was 9.63 with the test probability  $p = 0.022$ . The post-hoc test for the Kruskal-Wallis ANOVA showed the significance of the difference in the frequency of car use for two groups of respondents: with higher and secondary education,  $p = 0.043$ . The results of the research also indicate that there is a certain differentiation in the frequency and manner of movement of representatives of various industries, which is presented in detail in Figure 8 and Figure 9.

On foot, respondents working in services are the most frequent, while those working in production the least frequently. Buses are most often chosen by those working in trade, and least often in education. Trade representatives also use other methods of movement not mentioned in the survey.

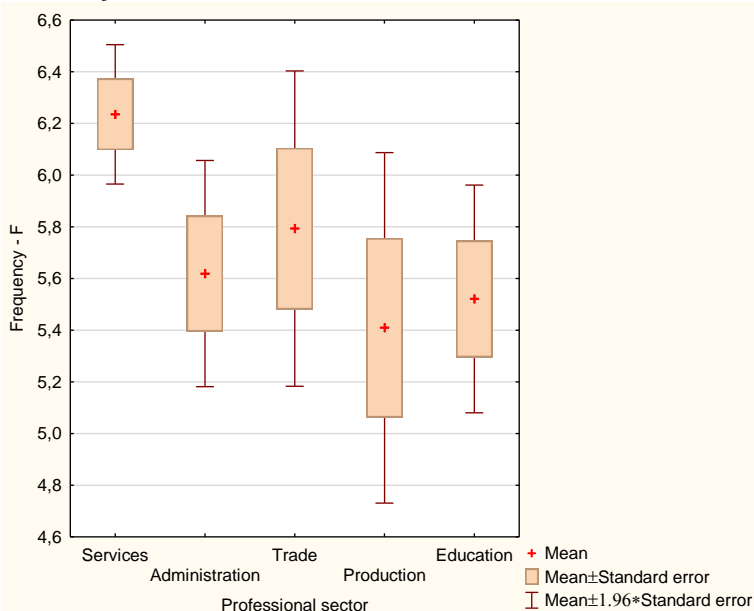
The Kruskal-Wallis rank ANOVA test confirmed the significance of the influence of the respondent's industry on the frequency of his walking. The value of the H statistic was 11.49 with the test probability  $p = 0.0216$ .

**Figure 7.** The dependence of the frequency of choosing a car to travel on the level of education of the respondents



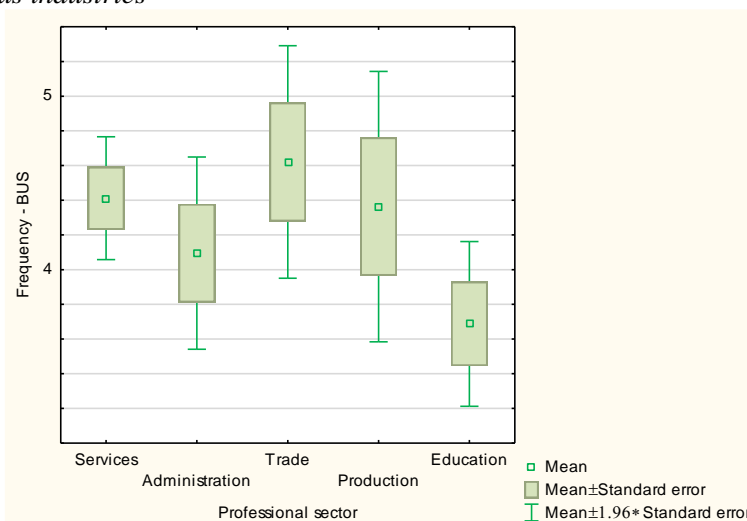
Source: Own creation.

**Figure 8.** The dependence of the frequency and walking method of movement of representatives of various industries



Source: Own creation.

**Figure 9.** The dependence of the frequency of traveling by bus for representatives of various industries



**Source:** Own creation.

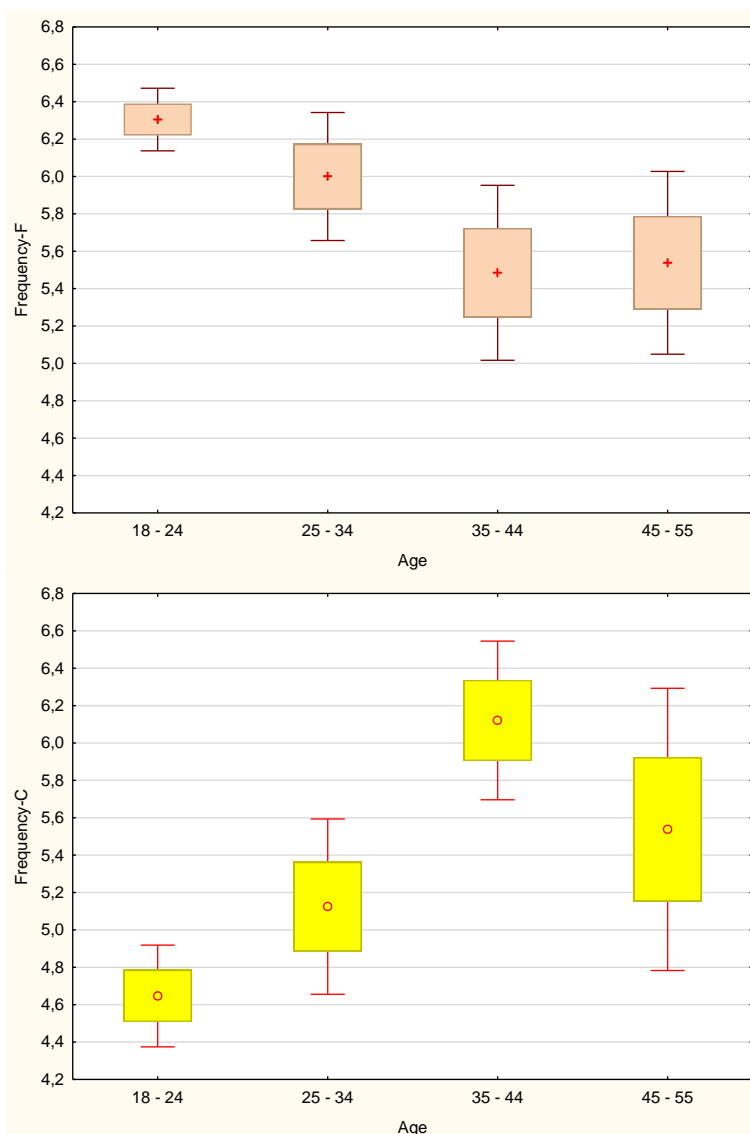
The Kruskal-Wallis rank ANOVA test confirmed the significant influence of the respondent's industry on the frequency of using city buses. The value of the H statistic was 10.76 with the test probability  $p = 0.0294$ .

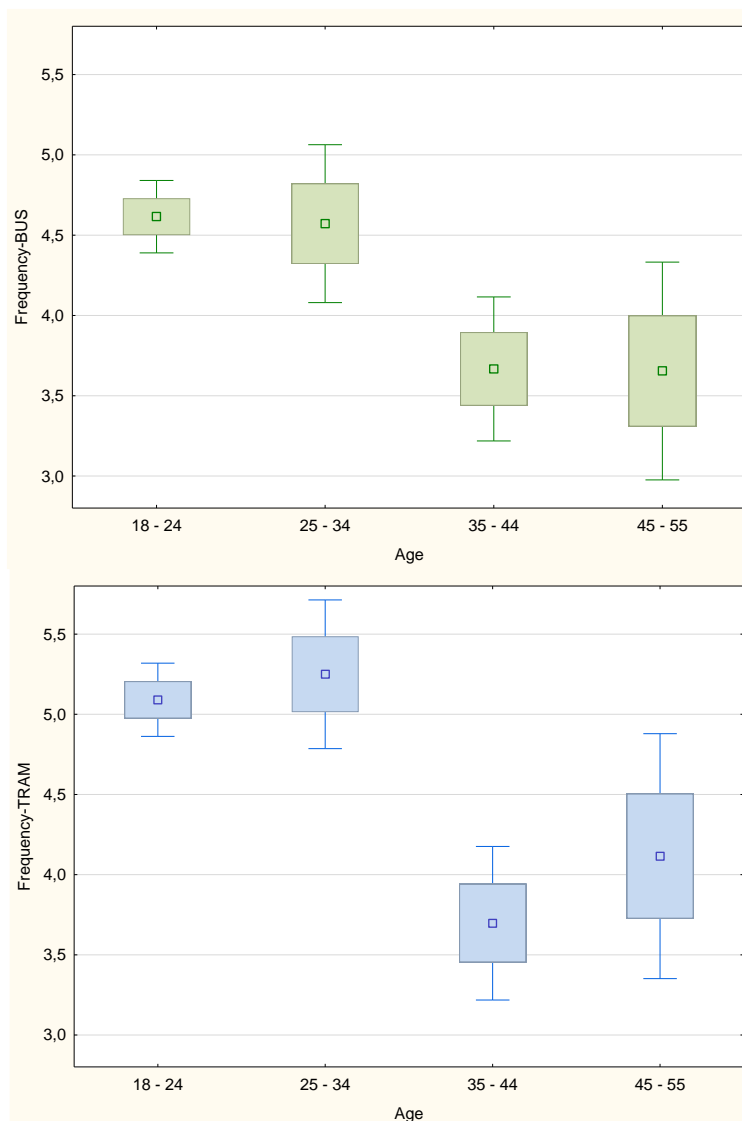
Considering the profession represented by the respondents, it can be noticed that walking is more often chosen by students than by working people, who prefer driving a car. It may be the result of the level of material pay of each of the occupational groups. When analyzing the dependence of the choice of the manner of respondents' movement on their age, a large variation in the frequency of using various means of transport in the city is noticeable.

The group that most frequently moves on foot is the youngest, i.e., up to 24 years of age. The car is mostly used by the group aged 35 to 44, but the least for those up to 24 years old. The respondents up to 34 years of age most frequently use buses and trams. The respondents over 65 and under 18 use the taxi least often, while others at a similar level. Research shows that e-scooters are not popular among respondents aged over 55, and young people under 18 do not declare using this means of transport. Only little interest among respondents aged 55-65 and 18-34 aroused moving by e-scooter. The remaining groups did not use this mode of transport at all. The respondents aged 25-34 most often use the e-scooter. Bicycle was the most popular in the age group over 65 and slightly less in the age group 35-44. More detailed analyzes are presented in Figure 10. For this purpose, the most numerous groups were selected, i.e., 4 age categories: 18-24, 25-34, 35-44

and 45-55 years old. In the case of modes of movement such as: on foot, by car, tram and bus, the Kruskal-Wallis rank ANOVA test confirmed the significance of the influence of the respondent's age on the frequency of their use ( $p \approx 0$ ). In the case of electric scooters, a significant age difference was also shown, with the test probability  $p = 0.0199$ .

**Figure 10.** Dependence of the way of movement on age





Source: Own creation.

## 5. Conclusions

The aim of the publication was to assess the ways in which the inhabitants of Szczecin travel before and during the pandemic caused by the Covid-19 virus. Even without a pandemic, the provision of appropriate and sufficient means of transport in a large city such as Szczecin is a challenge for the city authorities. Additional restrictions and orders increasing the level of security against infection



with the virus caused confusion and destabilization in the ways of moving around the city of all groups of respondents.

It should be emphasized that the presented analyzes of changes in the approach to urban transport, caused by the limitations of the Covid-19 pandemic, are based on the opinions of respondents about these changes, and not on statistical data from registrars of systems for providing means of transport. Hence, some discrepancies in the assessment of changes, e.g., the frequency of using collective forms of urban transport. In real terms, there was a significant drop in the number of passengers, and in the opinion of the inhabitants of Szczecin, it was only a slight reduction in the frequency of using these funds by them. This may indicate that after the restrictions are waived, the number of public transport passengers will return to the level from before the pandemic. This observation is extremely important for the city's transport policy, considering the principles of sustainable development. The safety and availability assessment can be interpreted in a similar way.

Higher assessment of the safety of all means of transport made by the respondents during the Covid-19 pandemic, compared to the time before the pandemic, means that the respondents positively assess the actions taken by the managers of individual means of transport.

Referring to the hypotheses presented in the article, it can be stated that the first two of them are true. The survey used by the authors of the article allowed to determine the preferences of residents in moving around the city of Szczecin. The respondents most often traveled their chosen routes on foot or by car. Subsequently, they chose the bus and the tram. In point 4.3 the relationship between the characteristics of the respondents and the frequency of their choice of methods of movement was shown, which is confirmed by H2. The analyzes of security and accessibility depending on the characteristics of the respondents did not confirm the differentiation of the security and accessibility assessment by different groups of respondents.

Changing the level of security depending on the pandemic caused by the Covid-19 virus has been confirmed for electric scooters, e-scooters, and others. However, the change in the level of accessibility only concerned the e-scooter. The interpretation that arises is that the respondents did not have time to get used to the possibility of using an e-scooter, because it appeared in Szczecin shortly before the pandemic, and during the pandemic, the available number of e-scooters was lower than that of electric scooters and bicycles. Bearing in mind the quality of life of the inhabitants, who are not indifferent to the development of sustainable public transport, both collective and individual, their needs and preferences should be carefully examined. Carefully observe and thoroughly analyze the availability

of means of transport proposed by local authorities and operators for all groups of residents.

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