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MOBILITY OF EMPLOYEES AND STUDENTS IN A UNIVERSITY TOWN IN A POST-COMMUNIST COUNTRY

Summary. Transportation is undergoing its most significant transformation since the inception of road transport. This transformation is fueled by concerns about climate change and technological advancements. Understanding the current situation in medium-sized cities across Europe is crucial to developing transportation concepts for urban areas within the EU. This study offers insights into the current state of urban mobility in post-communist countries and depicts the current spatial mobility in a medium-sized city. The aim of this study is to evaluate the influence of selected socioeconomic factors on the mobility of employees and students. This study, conducted in 2019, employed quantitative research methods, including a questionnaire survey. In total, 545 employees and students participated in the survey, representing a significant indicator of mobility in the city of Zlín. Data analysis was performed using nonparametric methods. The results indicate a relationship between respondents' job classification, age group, transportation time, and choice of means of transport. These findings can be applied to countries with similar historical and cultural development backgrounds, such as Poland, Hungary, and Slovakia.

1. INTRODUCTION

The current state of urban mobility in the Czech Republic, as well as in Poland, Slovakia, and Hungary, is characterized by a significant scale and proportion of car traffic in urban passenger transportation [12]. This reality is one of the primary causes of traffic congestion, accidents, extensive pollution in cities, and adverse impacts on public health. It also necessitates demanding requirements for communication networks, urban areas, and landscape preservation [15]. Urban mobility and transportation are among the 10 fundamental themes for creating long-term sustainable urban development in line with Europe 2030 objectives. This initiative emphasizes the promotion of public transport and alternative means of transportation (namely walking, cycling, and car sharing), reducing reliance on individual car transport (ICT), adopting low-emission public transport vehicles, implementing road safety measures, and mitigating the environmental and public health impacts of transportation.

The requirements for the development of urban mobility are determined by the current state and structure of the transportation system in each city, as well as the anticipated trends in social, economic, and ecological conditions for future urban development. The evolution of mobility should take into account changes in city sharing and urban structures, and it should be based on the processes of suburbanization and an evaluation of the impact of mobility on the residents' quality of life.

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Additionally, the continuous growth in the use of ICT in urban passenger transportation is a significant factor to consider [33, 39].

The effective management and organization of urban transport systems, as well as their application in facilitating people's mobility, require a suitable set of indicators and data to describe, quantify, and evaluate the state, structure, and level of urban mobility. Indicators commonly used to report urban mobility include the average number of trips made by city residents on a typical working day, the purpose of the journey, the distance traveled, and the means of transport used [11, 32].

Having a correct understanding of the current development and distribution of transportation routes in post-communist countries like the Czech Republic can aid in determining appropriate concepts for future development and implementing measures to foster sustainable growth. For this study, Tomas Bata University (TBU) in Zlín was selected as the research institution. With its diverse range of respondents, the university environment provides a suitable representative group for conducting a questionnaire survey, encompassing both local and commuting individuals across various age groups. The city of Zlín, a regional city in the Zlín Region with a population of 75,000 inhabitants, serves as an ideal area for implementing the research plan. The aim of this study is to assess the impact of selected factors on the choice of transportation for the initial morning commute to a university for educational or employment purposes. The data for analysis were derived from the results of a questionnaire survey on the spatial mobility of students and employees of Tomas Bata University in Zlín.

2. THEORETICAL FRAMING

2.1. Transport and behavior

Transportation serves as the fundamental driving force behind entire economies, as well as society as a whole. It plays a pivotal role in promoting economic growth and enhancing the overall quality of life. However, transport also gives rise to various externalities, including noise, accidents, infrastructure damage, vibrations, and congestion [31].

Numerous cities are confronted with an increasing demand for transportation. However, this demand is constrained by the limited space and capacity of transport routes. Consequently, there is a strong impetus for the rapid development of public transport. Research conducted by Bamberg [2] and Steg [36] presents several motives that influence travel behavior, including instrumental motivation, effectiveness (comfort, safety, time efficiency), symbolic motivation (prestige associated with the means of transport), and pro-social motivations (aimed at reducing the carbon footprint).

According to Chen and Li [20], the selection of transportation modes is influenced by both observable variables (such as time and means of transport) and unobservable variables (including quality and safety). In areas where various transportation options are available, two variables consistently impact the choice of transportation. The first variable is the availability of transport at a specific time. The second variable is the time needed to transport the individual to the intended destination using the selected mean of transportation.

RQ1: Is the choice of means of transport dependent on the job classification of the respondent and the type of means of transport?

Based on data from the Czech Statistical Office, the share of passengers using public transport is continuously declining and the proportion of passengers relying on ICT is increasing. Dargay and Hanly [10] concluded that the choice of means of transport is influenced by factors such as fuel prices and the cost of owning a car. This suggests a connection between an individual's income and their choice of transportation. However, income is not the sole determining factor in mode selection. Li et al.'s study [25] also highlights the significance of route length as a key factor. Research by Islam et al. [22] also mentions the availability of park-and-ride services when their appropriate availability can reduce capacity requirements. Given the limited capacity of transport routes, it is crucial to establish favorable conditions for a modal split.

RQ2: Is the choice of means of transport dependent on the gender of the respondent and the type of means of transport?

Gossen and Purvis [16] highlight the influence of gender and the nature of work on the selection of transportation modes. The authors discovered that women tend to choose different means of transport than men.

RQ3: Is the choice of means of transport dependent on the age category of respondents and the type of means of transport?

Haustein [17] emphasizes the significance of age in considering the choice of transportation. Simons et al. [34] focused on the mobility of adolescents, who are influenced by different factors compared to adults. When an individual owns a car, there tends to be an increase in the frequency of car trips and a corresponding decrease in the utilization of public transport. [19]. Furthermore, a study conducted by Berg et al. [4] highlights how social status, as indicated, for example, by job classification and wages, shapes transportation preferences and decisions. Also, the safety and comfort of a particular means of transport also play a role in determining the preferred option [18]. Fishman [13] notes a higher prevalence of bicycle use as a means of transport among the younger generation.

RQ4: Is the choice of means of transport dependent on the duration of the journey and the type of means of transport?

According to Tian and Huang [37], time constraints primarily stem from traffic congestion in urban areas. Ashmore et al. [1] examined national cultural differences among other factors influencing transportation modes. Şimşekoğlu et al.'s research [35] in Norway offers insights into the selection of transportation modes. The authors discovered that a strong emphasis on punctuality increases the likelihood of using private cars, while individuals who prioritize health or belong to older age groups predominantly utilize public transport.

2.2. Modal split

Research conducted by Basarić and Jović [3] and Chuen et al. [21] demonstrates that user costs associated with transportation activities, such as parking fees and public transport fares, significantly affect the choice of means of transport. The extent of these individual components within user mobility plays a crucial role. Basarić and Jović [3] also note that an excessive fee can lead to an economic decline in areas with high fees and result in reduced services and accessibility. Vinckery's model introduces the trade-off between waiting and delay costs and the cost of arriving later when considering the choice of transportation. Tian and Huang [37] emphasize the role of uncertainty in transportation mode choice, particularly the risk (uncertainty) that a user is willing to accept in terms of time. Jong et al. [23] highlight the interest of governmental authorities in the modal split as a means of future environmental protection through the distribution of traffic among various modes of transportation.

Cycling has a positive impact on the environment, and extensive research has been conducted to understand its role in transportation. However, according to research by Buehler and Pucher [7], recreational cycling still prevails over utilitarian cycling in daily activities. The study by Carse et al. [8] highlights the substitution of cycling with short-term car rentals in certain areas and cities. Molin et al. [27] attribute the low proportion of bicycle transportation in the modal split to participants' consideration of time frames when comparing transportation options. Nonetheless, Kuhnimhof [24] notes that cycling significantly contributes to expanding the modal split. The study by Bovy and Hoogendoorn-Lanser [6] emphasizes that transport distances also influence the choice of transportation mode.

3. AIMS AND METHODS

The aim of this study is to evaluate the dependence between the choice of transportation mode and the mobility profile of the respondents, specifically regarding their transportation from their place of

residence to their educational or occupational institution, with selected socio-demographic characteristics taken into account.

3.1. Participants

The participants in this quantitative research were employees and students of Tomas Bata University in Zlín, Czech Republic, which constitutes a significant portion of the urban population in the city, where more than 75,000 citizens reside. These participants were categorized into students and employees based on their affiliation with the university as a public institution. Table 1 shows the composition of the participants.

Table 1

Descriptive statistics of participants

Measure	Items	Employees		Students	
		Responses	%	Responses	%
Number of participants	545	215	39.4	330	60.6
Gender	Male	81	14.9	111	20.4
	Female	134	24.6	219	40.2
Age	Less than 20	0	0	12	2.2
	20–24	1	0.2	229	42.0
	25–30	18	3.3	64	11.7
	31–40	91	16.7	6	1.1
	41–50	41	7.5	15	2.8
	51–60	43	7.9	4	0.7
	61 and more	21	3.9	0	0

The collected data form the database and serve as the foundation for our subsequent research. However, for the purposes of this study, data from students in the part-time study segment were excluded. This decision was made considering that a significant portion of their academic activities and associated transportation routes occur on non-working days.

3.2. Measures

The present research was conducted using a questionnaire survey. The questionnaire consisted of three parts containing 32 questions in total. The first section focused on the respondent's characteristics (six questions), the second section was devoted to the spatial characteristics of the respondent (six questions), and the third section was focused on the daily spatial activities of these respondents (18 questions, with the option to repeat six of these questions up to 10 times). The questionnaire consisted of closed-ended questions.

In the first part, respondents were asked about their general characteristics, including their gender, age, and job classification. The second part focused on transportation-related questions, such as the means of transport used, permanent and temporary residence locations, and the typical duration of the journey to work or study. The third part of the survey focused on the daily activities of the respondents.

They were asked to specify the starting and ending points of their activities, the type of activity performed, the means of transport used, and the area to which they were transported. This section included six questions related to spatial activities, which could be repeated up to 10 times. The maximum number of recorded activities per respondent was 10.

The purpose of this third part was to capture the respondent's commuting patterns and activities in the vicinity of their institution. It aimed to identify specific areas where respondents spent their time.

At the end of their daily activities, respondents were requested to describe how do they return to the starting point of their activities.

The mobility of individuals is determined by the physical distance between their current location and the place where they intend to engage in various regular or irregular activities. Santos et al. [32] identified several types of activities that contribute to mobility, including employment, education and study, service provision, handling of affairs, shopping, and leisure activities, among others. These activities play a significant role in shaping people's travel patterns and transportation choices.

In this research, the place of residence serves as the typical starting point for people's daily mobility, and it is the most frequent destination for their return trips. Throughout the day, individuals typically undertake at least two transportation journeys, either on foot or by using different means of transport like bicycles, motorcycles, cars, buses, trains, or a combination of these, as mentioned in the study by Santos et al. [32]. Mobility in an urban environment presents a distinct challenge due to its scale, complexity, and diverse impacts on the city and its residents. Urban mobility involves navigating through a multitude of transportation options and considering the various effects it has on both the urban infrastructure and the people who live within it.

3.3. Procedure

For the statistical analysis of the collected data, pivot tables were created to organize the respondents' answers. Pearson's goodness of fit test was originally considered to evaluate individual dependencies. However, not all the necessary conditions guaranteeing the strength of the test were met, and the modification of the data would have represented the merging of some categories within the investigated factors, which would have eliminated the monitored details. In a specific case, it would not have been possible to deal with a detailed expression of preferences for the choice of individual means of transport. Therefore, instead of the considered test, the chi-square test of independence and Fisher's exact test was used to claim statistically significant dependency. Then, Cramer's V was calculated to show the strength of dependency. Finally, if a dependency was found, Pearson's residuals were calculated and significant residuals were marked in pivot tables.

4. RESULTS

One of the main outcomes of the questionnaire survey was that an overview was obtained of the share of means of transport on the first morning trip to the place of employment or study. The obtained data were compared with the data reported for the entire city of Zlín, as presented in Table 2.

Table 2

Descriptive statistics of participants

	Means of transport	Student	Employee	Total of TBU	City of Zlín*
		%	%	%	%
1	Walking	46.2	26.5	36.8	25.2
2	Cycling	0	2.3	1.1	1.6
3	Public transport	40.7	31.2	36.1	24.1
3.1	Urban public transport	24.2	18.6	21.5	-
3.2	Bus	12.3	6.1	9.3	-
3.3	Train	4.2	6.5	5.3	-
4	ICT	13.1	40.0	26.0	45.2
5	Combined transport	-	-	-	3.9

* Generel dopravy města Zlína [14]

The data clearly indicate that the modal split of employees and students at TBU (Tomas Bata University) is significantly more favorable than the modal split data for the entire city of Zlín. The modal split results for TBU are primarily influenced by the segment of full-time students, where the share of environmentally friendly means of transportation, such as walking, cycling, and public transport, accounts for nearly 87% of the total volume of transport routes. This high percentage reflects a positive trend towards sustainable and eco-friendly transportation choices among TBU students, contributing to a more favorable modal split for the university community as a whole.

In the next part of the paper, we will proceed to the statistical evaluation of the research questions.

RQ1: Is the choice of means of transport dependent on the job classification of the respondent and the type of means of transport?

Using a random sample of 545 people, we examined whether the choice of means of transport (the explained variable) was statistically significantly influenced by the job classification of the respondents and the type of means of transport (Table 3).

For the purposes of Fisher's exact test, the following null hypothesis (H_0) and alternative hypothesis (H_A) were identified:

H_0 : The choice of means of transport does not depend on the job classification of respondents and the type of means of transport.

H_A : The choice of means of transport depends on the job classification of respondents and the type of means of transport.

Table 3
Pivot table for the position of respondents and means of transport

<i>Travel mode</i>	<i>Position</i>		<i>Total</i>
	Employee	Student	
Bicycle	5	1	6
	2	4	6
Bus (outside urban public transport)	13	34	47
	19	28	47
Car (co-driver)	13	12	25
	10	15	25
Car (driver)	73	70	143
	56	87	143
Train	14	15	29
	11	18	29
Urban public transport	40	72	112
	44	68	112
Walking	57	126	183
	72	111	183
Total	215	330	545
	215	330	545

$$\chi^2 = 24.156 \cdot df = 6 \cdot \text{Cramer's } V = 0.211 \cdot \text{Fisher's } p = 0.000$$

The influence of factor (respondents' job classification) is described as follows: the test criterion $\chi^2(6, N = 545) = 24.156, p < 0.05$. Thus, H_0 is rejected. Cramer's V was $V(df = 6) = 0.21, w = 0.08$,

which shows a small statistically significant dependency (Cohen 88). Pearson’s residuals were calculated and are shown in the pivot table. As can be seen, there is only one discrepancy between observed and expected frequencies.

RQ2: Is the choice of means of transport dependent on the gender of the respondent and the type of means of transport?

Using a random sample of 545 people, we examined whether the choice of means of transport (the explained variable) was statistically significantly influenced by the gender of the respondents and the type of means of transport (Table 4).

For the purposes of Fisher’s exact test, the following null hypothesis (H₀) and alternative hypothesis (H_A) were identified:

H₀: The choice of means of transport does not depend on the gender of respondents and the type of means of transport.

H_A: The choice of means of transport depends on the gender of respondents and the type of means of transport.

Table 4
Pivot table for the gender of respondents and means of transport

<i>Travel mode</i>	<i>Gender</i>		<i>Total</i>
	Female	Male	
Bicycle	1 4	5 2	6 6
Bus (outside urban public transport)	35 30	12 17	47 47
Car (co-driver)	20 16	5 9	25 25
Car (driver)	87 93	56 50	143 143
Train	17 19	12 10	29 29
Urban public transport	75 73	37 39	112 112
Walking	118 119	65 64	183 183
<i>Total</i>	353 353	192 192	545 545

$$\chi^2 = 12.255 \cdot df = 6 \cdot \text{Cramer's } V = 0.150 \cdot \text{Fisher's } p = 0.067$$

The influence of factor (gender) is described as follows: the test criterion $\chi^2(6, N = 545) = 12.255$, $p > 0.05$. Thus, H₀ is not rejected.

RQ3: Is the choice of means of transport dependent on the age category of respondents and the type of means of transport?

Using a random sample of 545 people, we examined whether the choice of means of transport (the explained variable) was statistically significantly influenced by the age category of the respondents and the type of means of transport (Table 5).

To answer this research question, we created a pivot table showing the age categories of the respondents and the type of means of transport. For the purposes of the chi-square test of independence or Fisher's exact test, the following null hypothesis (H_0) and alternative hypothesis (H_A) were identified:

H_0 : The choice of means of transport does not depend on the age category of respondents and the type of means of transport.

H_A : The choice of means of transport depends on the age category of respondents and the type of means of transport.

The influence of factor (age) is described as follows: the test criterion $\chi^2(36, N = 545) = 84.510$, $p < 0.05$. Thus, H_0 is rejected. Cramer's V was $V(df = 36) = 0.161$, $w = 0.026$, which shows a small statistically significant dependency (Cohen 88). Pearson's residuals were calculated and are shown in the pivot table.

Table 5

Pivot table for age categories of respondents and means of transport

Travel mode	Age							Total
	19 and less	20–24	25–30	31–40	41–50	51–60	61 and more	
Bicycle	0 0	0 3	1 1	2 1	2 1	1 1	0 0	6 6
Bus (outside urban public transport)	1 1	26 20	7 7	4 8	6 5	3 4	0 2	47 47
Car (co-driver)	1 1	5 11	4 4	5 4	4 3	6 2	0 1	25 25
Car (driver)	0 3	35 60	24 22	40 25	16 15	16 12	12 6	143 143
Train	0 1	9 12	8 4	6 5	3 3	2 3	1 1	29 29
Urban public transport	3 2	57 47	10 17	16 20	14 12	9 10	3 4	112 112
Walking	7 4	98 77	28 28	24 33	11 19	10 16	5 7	183 183
Total	12 12	230 230	82 82	97 97	56 56	47 47	21 21	545 545

$$\chi^2 = 84.510 \cdot df = 36 \cdot \text{Cramer's } V = 0.161 \cdot \text{Fisher's } p = 0.000$$

RQ4: Is the choice of means of transport dependent on the duration of the journey and the type of means of transport?

Using a random sample of 545 people, we examined whether the choice of means of transport (the explained variable) was statistically significantly influenced by the duration of the journey and the type of means of transport (Table 6).

For the purposes of the chi-square test of independence or Fisher's exact test, the following null hypothesis (H_0) and alternative hypothesis (H_A) were identified:

H_0 : The choice of means of transport does not depend on the duration of the journey and the type of means of transport.

H_A : The choice of means of transport depends on the duration of the journey and the type of means of transport.

5. DISCUSSION

The average respondent made three trips as part of their daily activities during the working day. Chen and Li [20] highlight time as one of the criteria influencing the choice of means of transport. According to Tian and Huang [37], people are typically influenced by time constraints when determining their mode of transport to ensure they arrive at their destination on schedule. Börjesson and Eliasson [5] note that social status, along with time, plays a role in one's choice of transportation methods. Ciommo and Shiftan's research [9] indicates that both time and age are factors that influence traffic behavior. Our study further confirms a significant correlation between the choice of means of transport and journey duration.

Table 6

Pivot table for transport time categories of respondents and means of transport

<i>Travel mode</i>	<i>Transport time [min]</i>									<i>Total</i>
	< 5	6–10	11–15	16–30	31–45	46–60	61–120	121–240	> 241	
Bicycle	0 0	2 1	2 1	0 2	0 1	2 1	0 0	0 0	0 0	6 6
Bus (outside urban public transport)	0 2	0 8	4 12	13 13	3 4	17 4	7 3	3 1	0 0	47 47
Car (co-driver)	1 1	1 4	7 6	9 7	3 2	2 2	1 1	1 1	0 0	25 25
Car (driver)	3 6	24 23	29 36	32 40	18 12	18 14	13 8	5 4	1 1	143 143
Train	1 1	0 5	0 7	5 8	1 2	9 3	7 2	6 1	0 0	29 29
Urban public transport	1 4	14 18	39 28	40 31	12 9	4 11	1 7	0 3	1 0	112 112
Walking	15 7	47 30	55 46	52 51	9 15	0 17	3 11	2 6	0 1	183 183
Total	21 21	88 88	136 136	151 151	46 46	52 52	32 32	17 17	2 2	545 545

$$\chi^2=228.352 \cdot df=48 \cdot \text{Cramer's } V=0.264 \cdot \text{Fisher's } p=0.000$$

The influence of the transport time is described as follows: the test criterion $\chi^2(48, N = 545) = 228.352$, $p < 0.05$. Thus, H_0 is rejected. Cramer's V was $V(df = 48) = 0.264$, $w = 0.006$, which shows a small statistically significant dependency (Cohen 88). Pearson's residuals were calculated and are shown in the pivot table.

Another one of the tested criteria was the age of respondents and its dependence on the choice of means of transport. This relationship was demonstrated by weak dependence. Young people aged 20 to 24 most often choose urban public transport or walking. People aged 31 to 40 tend to choose a car. Tyrinopoulos and Antoniou [38] concluded that the choice of means of transport is age dependent. They also found that people aged 35 to 45 most often choose a car as a means of transport. This correlates with the results of further research conducted by McCarthy et al. [26], showing that the decision of transportation means is influenced by whether or not the person moving has children accompanying them during the journey. Muro-Rodríguez [28] found similar results but also mentions the importance of other factors such as family status, transport costs, and the purpose of the trip. Our research reveals that the choice of means of transport has a weak dependence on the job classification of respondents. The relationship between the choice of means of transport and job classification is presented by the research by Polat [29]. According to a study by Berg et al. [4], social status, which is related to the work performed, significantly influences the choice of means of transport. High-income groups prefer to travel by car. Our research also shows a relationship by which employees, who are expected to have a higher income than students, choose to travel by car more often.

According to Gossen and Purvis [16], the choice of means of transport is influenced by job classification and gender. Also, Rivera's [30] study conducted in Southeast Asia shows that the choice of means of transport depends on gender and job classification. Our research did not confirm that the choice of means of transport has a statistically significant relationship with the gender of the respondent. This is in accordance with the findings of Li, Song, and Yu [25], who did not confirm that the choice of means of transport is influenced by gender.

6. CONCLUSIONS

This paper examined the spatial mobility of employees and students at Tomas Bata University in Zlín, focusing on four research questions. The first question explores the relationship between means of transport and job classification. Our findings indicate a weak dependence of the choice of means of transport on job classification.

The second question investigates the association between gender and choice of means of transport. However, we did not find evidence to support the influence of gender on the choice of means of transport.

The third question examines the interdependence of means of transport and the age categories of respondents. Our results suggest that the choice of means of transport has a weak dependence on age category.

The fourth question explores the connection between the choice of means of transport and journey duration. We found a weak relationship between journey duration and the choice of means of transport for both students and employees.

Our findings align with current research in this field. Considering the global trend of increasing individual car usage at the expense of public transport, future research will focus on enhancing the role of urban public transport in the Czech Republic. Specifically, we plan to compare the densities of the public transport networks in selected Czech cities.

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