Keywords: urban public transport; individual car use; modal split; the urban public transport tendencies; Kendall's rank correlation coefficient τ

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STATISTICAL ASSESSMENT OF INDICATORS MEASURING PUBLIC TRANSPORT USE IN CITIES

Summary. Urban mobility is a major challenge for cities worldwide, with a significant portion of transportation relying on individual car use (ICU). Efforts are increasingly focused on reducing ICU in favor of more sustainable, eco-friendly modes of transport. Reducing ICU involves shifting routine travel for individuals aged 15-64 towards urban public transport, facilitated by the widespread adoption of time-based fare systems. To effectively develop urban mobility strategies, it is essential to measure the current baseline, set clear objectives, and evaluate outcomes. This paper proposes two key indicators to address these needs. The first is Tendency to Urban Public Transport 1, which represents the ratio of the total number of time-based fare passes to the population aged 15-64. The second is the Tendency to Urban Public Transport 2, which reflects the extent to which regular urban public transport trips by time-based fare pass holders contribute to total transport performance. We also examined and verified statistically significant relationships between these indicators and factors such as population size, city area, and other relevant variables.

1. INTRODUCTION

Urban mobility is a major challenge for cities worldwide. A substantial share of everyday trips is still realized by individual car use, which contributes to congestion, air pollution, and unsustainable mobility patterns. Therefore, shifting these trips towards public transport is a long-term goal of transport policy at the local and national levels. Achieving this shift requires the development of infrastructure and services, along with a reliable measurement of how public transport is used.

Despite the importance of this issue, systematic data on urban mobility are often limited. Household travel surveys are costly and irregular, while modal split statistics are not always comparable across cities. For many municipalities, readily available data consist mainly of operational statistics from transport operators. These provide useful insights but are not designed to directly measure changes in individual mobility behavior.

The problem addressed in this paper is the lack of standardized indicators that would allow researchers and policymakers to assess the extent to which regular public transport is used as an alternative to individual car use. Focus of this paper is on the working-age population (15-64 years), which accounts for the majority of routine trips to work and education.

This study proposes and tests new indicators that capture people's tendency to use urban public transport based on time-based fare passes and transport operator data. Two indicators are introduced: The first is Tendency to Urban Public Transport 1, defined as the ratio of recalculated annual time-based passes to the population aged 15-64. The second is Tendency to Urban Public Transport 2, defined as the ratio of transported persons using time-based passes to the total number of transported persons.

Correlation analysis was applied (Kendall's τ) to data from a selected set of Czech cities to evaluate the robustness of these indicators. Their relationships were tested with factors such as city population, territorial size, transport performance, and infrastructure.

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2. REVIEW OF RELATED WORK

Urban mobility and transport are among the 10 key themes considered when establishing sustainable urban development, as outlined by the international Aalborg commitments. This initiative aims to promote public transport, alternative modes of transport, walking, and cycling over the long term, with the goal of reducing individual car use and mitigating the negative impacts of car traffic on both the environment and public health. [1]

A number of empirical studies have investigated the structure of daily mobility in European cities. Becker et al. [2] analyzed German surveys conducted between 1972 and 2003 and found that residents typically made about three journeys per day on working days. Similar results were reported in Austria, where the Austrian Traffic Forecast (Verkehrsprognose Österreich 2025+ 2009, [3]) noted an average of 3.16 journeys per person per day in 2002 [3]. The Tabellenbericht zum Forschungsprojekt' Mobilität in Städten SrV 2013' (2014) [4], based on data from a 2013 questionnaire survey involving 15,600 participants from over 300 German cities and municipalities, found that the number of transport journeys varied by age and gender. The average number of transport journeys was 3.5 per person per day, with women aged 25-45 making the most journeys (4.1 per day). The lowest number of journeys (3.1 per day) was recorded for women aged 65 and older, as well as children under six years old. The Sustainable Mobility Plan for Prague and its Environs [5] reported that residents of Prague made an average of 3.57 journeys per day. The most recent data from the EU [6] shows that the average number of trips per day is 2.7. According to this study, a very sharp decline in the number of trips, experienced by 82% of the respondents, was associated with the COVID-19 pandemic.

Based on this data, people living in cities typically make between 2.5 and 3.5 transport journeys on a normal working day. Therefore, in a city of 100,000 inhabitants, the total number of transport journeys per day would range from 250,000 to 350,000. The literature consistently describes the distribution of these journeys across transport modes by the concept of the modal split [7, 8].

Individual car use remains a dominant factor in this distribution. This is due to the degree of motorization, the low occupancy rate of passenger cars, and the use of passenger cars by persons aged 18-64.

Previous studies have consistently shown a steady increase in the degree of motorization. The Sustainable Mobility Plan for Prague and its Environs [5] reports that the number of passenger cars per thousand inhabitants in Prague reached 655 in 2017, with projections indicating a further increase to 714 by 2030. Comparable trends were observed in the Comprehensive Transport Project of the City of Zlín [9], which recorded 405.4 passenger cars per thousand inhabitants in 2015 and forecasted growth to 435.1 by 2025 and 446.6 by 2030. At the European level, Eurostat [10] indicates a 5.9% increase in the number of registered passenger cars across the EU between 2019 and 2024. The same source notes that no EU member state experienced a decline in motorization during this period (of note, a decline was recorded in Iceland, which is not part of the EU, though it is located in Europe).

Another well-documented issue is the persistently low occupancy rate of passenger cars. The Tabellenbericht zum Forschungsprojekt "Mobilität in Städten SrV 2013" [4] and the Sustainable Mobility Plan for Prague and its Environs [5] both report an average of 1.3 persons per journey. A slightly lower value is presented in the Comprehensive Transport Project of the City of Zlín [9], where the average occupancy is 1.2 persons per journey. Broader European-level findings are provided by the European Study on New Mobility Patterns in European Cities [6], which indicates an average occupancy rate of 1.4 passengers, with limited variability across member states. Although occupancy tends to increase during non-working days, it is consistently well below two persons per vehicle. In the United States, long-term trends show a decline in average vehicle occupancy, from 1.87 persons per car in 1977 to 1.5 in 2019. [11]

The working-age population plays a decisive role in shaping individual car use. According to the Austrian Traffic Forecast (Verkehrsprognose Österreich 2025+ 2009, [3]), individuals aged 18-64 who own passenger cars account for 71.6% of individual car use as drivers in urban transport. This group represents only 36% of the country's total population. Among working and non-working individuals aged 18-64 who own passenger cars, 95% use their cars as drivers. This group constitutes 57.3% of the total population.

The data indicate that the high share of individual car use in the overall transport mix is a general and long-term trend, supported by the continuously increasing degree of motorization. The occupancy of passenger cars in urban transport remains low, with their use predominantly concentrated among individuals aged 18-64. This pattern is also evident in the Czech Republic, where the proportion of this age group in the total population of large cities and agglomerations ranges from 61-65%.

Insights into the purposes of transport journeys across different age groups of urban residents are also valuable (Table 1).

Table 1

Model of distribution of urban transport according to the purpose of the journey
Source: Verkehrprognose Österreich 2025+ [3]

Group of passengers	Age category	Share of the total population	The journey related to work	The journey to education	Shopping and personal handling	Leisure
Children	6-14	11.2%	Not applicable	70-75%	5-10%	20-25%
Youth	15-17	3.8%	10-25%	45-55%	10%	20-25%
Employed persons	18-64	47.0%	40-65%*	1%	20-25%	15-20%
Non-working persons	More than 18	38.0%	Not applicable	5-10%	60-65%	30-35%

* This range depends on whether individual car use for commercial transport is included in the calculation.

The goals of increasing the share of urban public transportation in the overall transport sector are directly tied to reducing individual car usage. Specifically, this refers to limiting car use among individuals aged 18-64 and encouraging their shift towards urban public transport, particularly for regular commutes to work and school. This shift may be either partial or complete. The impact of such a transition will be seen in a rise in the number of people using urban public transport, an increase in the adoption of time-based travel passes, and a larger proportion of regular journeys in the overall transport performance of urban carriers [12, 13].

The objectives for the future of urban mobility must be measurable, meaning they must rely on the availability and accuracy of the necessary statistical data. However, there is a lack of consistent and reliable data on the use of passenger cars and individual car use. In contrast, data on the performance and infrastructure of urban public transport is accessible and useful. This information is available from both public sources and internal databases of urban transport companies. The data is collected using a standardized methodology, making it suitable for comparing different entities within the same time period, as well as for analyzing the historical development of a specific entity [14, 15].

3. METHODOLOGY

This paper is based on the assumption that there is a correlation between journeys made via urban public transport and those made by individual car use.

- The number of transport journeys made by city residents on a typical working day remains stable over the long term.
- Urban residents generally travel distances greater than one kilometer using either individual car use or urban public transport.
- Urban public transport serves as an alternative to individual car use, meaning a reduction in car usage results in an increase in public transport use.
- The transport capacity of urban public transport, in terms of the number of passengers, has stagnated for a prolonged period.

− Growth in public transport usage is linked to an increase in regular commutes to work and school via urban public transport.
− A rise in regular urban public transport journeys leads to a higher adoption of time-based travel passes.
− Changes in the reduction of individual car use and the growth of public transport usage primarily affect urban residents aged 15-64.

This paper is based on the assupmtions outlined above and investigates the extent to which the residents of selected Czech cities use urban public transport for regular journeys to work and school. The analysis also explores statistically significant relationships between public transport usage rates and factors such as population size, geographic area, and other potential influences.

3.1. The aim of this paper

This paper aims to determine the frequency of regular urban public transport use among residents aged 15-64 in selected Czech cities and to assess the impact of various factors on this reported usage level.

3.2. Data used

The analysis utilizes data from three sources:

a) Data on total transport performance, traffic performance, and transport infrastructure.

Transport performance refers to the number of passengers transported annually, while traffic performance represents the total distance traveled by the transport company's vehicles in the respective city. Transport infrastructure is characterized by the number and types of vehicles, as well as the length and number of urban public transport lines. This analysis is based on data from the year 2023. [16]

b) Time coupons and urban public transport tickets

A survey conducted with transport companies provided data on the number of tickets and time coupons sold in 2023. Weekly, monthly, multi-month, and annual time coupons are primarily used by individuals aged 15-64 for regular commutes to work and school.

c) Population and city area

Data on the population and the city's cadastral area were obtained from the regional statistics of the Czech Statistical Office (2024). [17] Regarding the cadastral area, data on plots classified as built-up and other zones were used. These plots include areas designated for housing, education, employment, shopping and services, sports facilities, various types of infrastructure, and more.

3.3. Definition of the research question

In this paper, it is assumed that an increase in the share of urban public transport within overall urban passenger transport is linked to a rise in the number of regular journeys made using time-based travel passes. The primary group regularly using these passes (monthly, multi-month, and annual) consists of residents aged 15-64.

In the first part of the analysis, two indicators were calculated using data on time coupons sold and the number of residents aged 15-64 in the selected cities to assess the level of regular urban public transport use in the monitored cities.

In the second part, the existence of statistically significant relationships between these two indicators and factors such as population size, transport infrastructure, or the transport performance of urban public transport systems was investigated.

a) Involvement of city residents aged 15-64 in the use of urban public transport

The use of urban public transport is quantified using two indicators: Tendency to Urban Public Transport 1 and Tendency to Urban Public Transport 2.

Tendency to Urban Public Transport 1 is a ratio-based indicator. The numerator is the total number of time-based travel coupons sold, converted into annual equivalents. The denominator is the population of the city aged 15-64. The resulting value represents the number of urban public transport coupons per

1,000 residents in this age group. This indicator reflects the level of interest among people aged 15-64 in regularly using urban public transport for their mobility needs.

$$\text{Tendency to Urban Public Transport 1} = \frac{\text{time−based travel coupons (annual equivalents)}}{\text{population of the city aged 15−64}} \quad (1)$$

Tendency to Urban Public Transport 2 is also a ratio-based indicator. The numerator is the total number of journeys made using urban public transport coupons, and the denominator is the total number of passengers transported by urban public transport in a calendar year. This value represents the proportion of journeys made with time coupons relative to the total transport performance. This indicator reflects the extent to which regular journeys contribute to the overall transport performance.

$$\text{Tendency to Urban Public Transport 2} = \frac{\text{journeys made using urban public transport coupons}}{\text{passengers transported by public transport in a year}} \quad (2)$$

b) Verification of statistically significant relationships between the population aged 15-64 using urban public transport and selected factors

The following factors that influence the decision of residents to use urban public transport for regular journeys were selected:

− The size of the city, measured by its population,

− The territorial size of the city, based on the built-up area and other areas registered in the real estate cadaster,

− The total length of urban public transport lines within the city,

− The density of the transport infrastructure, calculated as the length of urban public transport lines per hectare of built-up and other areas,

− The transport performance of urban public transport on a typical working day, expressed in vehicle kilometers and seat-kilometers.

The following statistical hypotheses were formulated for this analysis:

HA1: Tendency to Urban Public Transport 1 has a statistically significant effect on the length of urban public transport lines in the city.

HA2: Tendency to Urban Public Transport 2 has a statistically significant effect on the length of urban public transport lines in the city.

3.4. Applied statistical methods

The hypotheses were tested using correlation analysis. The analysis focused on whether Tendency to Urban Public Transport 1 and Tendency to Urban Public Transport 2 are statistically significantly related to the length of transport lines. It also explored whether these tendencies are significantly influenced by factors such as population size, the city’s transport infrastructure, the size of the built-up and other areas within the city’s cadastral territory, and transport performance - measured in vehicle kilometers and seat-kilometers, on a typical working day.

The hypotheses were tested using correlation analysis. The analysis examined whether *Tendency to Urban Public Transport 1* and *Tendency to Urban Public Transport 2* are statistically significantly related to the length of transport lines. It also explored whether these tendencies are influenced by factors such as population size, the city’s transport infrastructure, the size of built-up and other areas within the city’s cadastral territory, and transport performance—measured in vehicle kilometers and seat-kilometers on a typical working day.

Kendall’s rank correlation coefficient (τ) was used to determine the existence of statistically significant relationships between these variables. The primary reason for choosing this method was that the data were not normally distributed, contained outliers, and lacked a clear monotonic relationship between the variables. Kendall’s τ does not strictly require a monotonic relationship, making it well-suited for the analysis.

4. RESULTS AND DISCUSSION

Table 2 presents the calculated Tendency to Urban Public Transport 1, expressed as a percentage. Several conclusions can be drawn from the data and calculations presented in Table 2.

Tendency to Urban Public Transport 1, which reflects the ratio of recalculated annual coupons to the number of residents aged 15-64, shows a clear relationship with the total population of the city. Larger cities such as Prague, Brno, and Pilsen exhibit tendencies above 55%, with the exception of Ostrava, which reports only 33%.

Cities with populations around 100,000 show tendencies ranging between 24% and 45%, highlighting differences among cities of a similar size. In contrast, cities with populations of around 50,000 exhibit tendencies below 20%.

These findings are closely related to individual car use. Across all cities, the data indicate challenges with passenger car transport, including issues with private vehicle operation and parking, as well as the availability and comfort of urban public transport. The disparities among cities and agglomerations with populations around 100,000 can be attributed to factors such as social preferences, long-established habits, economic conditions of the urban population, and the specific territorial characteristics that influence the use of alternative transport options.

Tendency to Urban Public Transport 2—which is the ratio of passengers using time coupons to the total number of transported persons—ranges between 41% and 78%. This measure shows a greater balance between cities compared to Tendency to Urban Public Transport 1. In eight cities, more than 53% of passengers use time coupons, while in five cities, this proportion falls between 41% and 49%.

Table 2

Tendency to urban public transport 1. Source: A survey conducted with transport companies, the Czech Statistical Office [17], Equation (1)

City	Annual coupons recalculated	Population of city	Population 15-64	Tendency to Urban Public Transport 1 (%)
Prague	710,848	1,384,732	899,807	79
Brno	174,326	400,566	256,362	68
Pilsen	67,706	185,599	118,783	57
Olomouc	27,702	101,825	64,425	43
Zlín + Otrokovice	24,201	91,825	57,623	42
Hradec Králové	21,220	93,506	57,354	37
České Budějovice	22,004	96,417	61,124	36
Ústí nad Labem	19,805	91,963	58,250	34
Ostrava	60,899	283,504	184,542	33
Liberec + Jablonec	27,114	253,229	96,835	28
Pardubice	14,041	92,149	58,506	24
Opava	7,174	55,512	37,756	19
Děčín	3,831	47,180	29,473	13

Table 3 shows the calculated Tendencies to Urban Public Transport 2, expressed in percentages.

With the exception of Prague and Brno, all cities show significantly higher values for Tendency to Urban Public Transport 2 compared to Tendency to Urban Public Transport 1. This reflects the intensity of time coupon usage for regular commutes via urban public transport. As Buehler et al. [18] suggested, public transport companies can boost their revenue through targeted strategies, such as fare increases for single tickets while maintaining deep discounts on monthly, semester, and annual passes. This approach, combined with enhanced service quality and fully coordinated timetables, fares, and services, could further encourage regular public transport use. According to Bull et al. [19], making public transport fare-free primarily resulted in a 12% increase in overall travel in Santiago, Chile.

Table 3

Tendencies of Urban Public Transport 2. Source: Association of Transport Companies of the Czech Republic. Annual report [16], Equation (2)

City	Transported persons with a time coupon in thousands per year	Transported persons in total in thousands per year	Tendency to Urban Public Transport 2 (%)
Prague	625,599	962,460	65
Brno	209,878	361,858	58
Pilsen	72,079	105,999	68
Olomouc	33,330	56,491	59
Zlín + Otrokovice	18,923	36,626	58
Hradec Králové	19,313	36,439	53
České Budějovice	21,618	52,728	41
Ústí nad Labem	16,791	37,314	45
Ostrava	70,271	90,091	78
Liberec + Jablonec	22,312	37,186	60
Pardubice	16,113	28,773	56
Opava	3,601	8,003	45
Děčín	2,755	5,622	49

The proposed indicators highlight the use of urban public transport for regular journeys to work and school, with the highest significance observed in the largest cities. As city populations decrease, interest in purchasing time coupons diminishes. However, the proportion of regular journeys remains significant in small and medium-sized cities despite the lower demand for time coupons. This suggests that urban public transport plays a key role in providing transportation for work and school commutes.

The analysis is supplemented by insights into the factors that influence city dwellers' decisions to use or avoid urban public transport in urban mobility. Matoušek [20] presented findings from a traffic-sociological survey of approximately 1,000 people in Hradec Králové and Liberec, which focused on the reasons for using or not using urban public transport. Of those surveyed, 46.3% reported that they use public transport for most of their journeys.

The reasons for not using urban public transport were as follows: negative perception of public transport (6.9%), preference for the comfort and privacy of individual car use (18.5%), longer travel times (10.4%), preference for walking or cycling (11.0%), and other reasons (1.4%). Overall, nearly 36% of respondents essentially excluded public transport from their travel choices.

4.1. Verification of statistically significant relationships between the variables

Table 4 presents the Kendall's rank correlation coefficient (τ) values for all factors that may influence Tendency to Urban Public Transport 1.

Table 4 indicates that Tendency to Urban Public Transport 1 is statistically significantly influenced by the number of urban inhabitants. The correlation between the population size and Tendency to Urban Public Transport 1 is substantial to very strong, with statistical significance confirmed at the 1% level. It can be concluded that as the population of a city grows, so does the tendency for its residents to regularly use urban public transport. A study by Santos et al. [21] also demonstrated this trend, showing that public transport use tends to increase as the population grows.

A statistically significant relationship was also confirmed between Tendency to Urban Public Transport 1 and factors such as the size of built-up and other areas; transport performance, measured by vehicle kilometers; transport performance, measured by seat kilometers; and transport performance, measured by vehicle kilometers on a typical working day. The correlation between Tendency to Urban Public Transport 1 and the size of built-up and other areas is substantial to very strong (0.513). Similarly, the correlation with transport performance, measured by vehicle kilometers, is substantial to very strong (0.513), though this relationship, unlike population size, is statistically significant at the 5% level.

Table 4
Calculated values of the Kendall's rank correlation coefficients τ. Source: the Czech Statistical Office [17], Association of Transport Companies of the Czech Republic. Annual report [16], Equation (1), Kendall's rank correlation coefficient (τ)

Variable	Variable	Kendall's rank correlation coefficient τ	P-value
Tendency to Urban Public Transport 1	Population	0.615	0.003**
Tendency to Urban Public Transport 1	Built-up and other areas	0.513	0.015*
Tendency to Urban Public Transport 1	Length of lines	0.359	0.088
Tendency to Urban Public Transport 1	Equipment with transport infrastructure	-0.168	0.427
Tendency to Urban Public Transport 1	Transport performance, measured by vehicle kilometers	0.513	0.015*
Tendency to Urban Public Transport 1	Transport performance, measured by seat kilometers	0.487	0.020*
Tendency to Urban Public Transport 1	Transport performance, measured by vehicle kilometers on a normal working day	0.487	0.020*

* Correlation coefficient τ is significant at the significance level of 5% (two-way test)
** Correlation coefficient τ is significant at the significance level of 1% (two-way test)

In summary, Tendency to Urban Public Transport 1 for people aged 15-64 increases with the larger size of built-up areas, as well as with higher transport performance, whether measured by vehicle kilometers, seat kilometers, or vehicle kilometers on a typical working day.

Kendall's rank correlation coefficient (τ) did not reveal a statistically significant relationship between Tendency to Urban Public Transport 1 and the length of transport lines or the city's infrastructure. However, Badia et al. [22] demonstrated that Barcelona's Nova Xarxa bus network, which is characterized by clear, direct routes, frequent service, and numerous transfer points, significantly boosted public transport usage. Contrary to the conventional belief that riders avoid transfers, their data show that transfer-friendly networks attract more passengers who view the system as a cohesive network rather than a set of separate lines.

As a result, the first statistical hypothesis regarding the relationship between Tendency to Urban Public Transport 1 and the length of transport lines was not supported. However, Tendency to Urban Public Transport 1 is significantly influenced by population size, the extent of built-up and other areas, and various measures of transport performance.

Table 5 presents the values of Kendall's rank correlation coefficient (τ) for all factors that may influence Tendency to Urban Public Transport 2.

The table indicates that Tendency to Urban Public Transport 2 is statistically significantly influenced by all factors, except the city's transport infrastructure. A substantial to very strong relationship was confirmed between the size of built-up and other areas and Tendency to Urban Public Transport 2 (0.564) at the 1% significance level. This suggests that Tendency to Urban Public Transport 2 increases as the size of built-up and surrounding areas grows.

Table 5

Calculated values of the Kendall's rank correlation coefficients τ. Source: the Czech Statistical Office [17], Association of Transport Companies of the Czech Republic. Annual report [16], Equation (1), Kendall's rank correlation coefficient (τ)

Variable	Variable	Kendall's rank correlation coefficient τ	P-value
Tendency to Urban Public Transport 2	Population	0.513	0.015*
Tendency to Urban Public Transport 2	Built-up and other areas	0.564	0.0072**
Tendency to Urban Public Transport 2	Length of lines	0.462	0.028*
Tendency to Urban Public Transport 2	Equipment with transport infrastructure	0.013	0.951
Tendency to Urban Public Transport 2	Transport performance, measured by vehicle kilometers	0.513	0.015*
Tendency to Urban Public Transport 2	Transport performance, measured by seat kilometers	0.436	0.038*
Tendency to Urban Public Transport 2	Transport performance, measured by vehicle kilometers on a normal working day	0.436	0.038*

* Correlation coefficient τ is significant at the significance level of 5% (two-way test)

** Correlation coefficient τ is significant at the significance level of 1% (two-way test)

Similar to Tendency to Urban Public Transport 1, Tendency to Urban Public Transport 2 is significantly influenced by the number of inhabitants, with a substantial to very strong correlation (0.513) at the 5% significance level. A substantial to very strong relationship (0.513) was also confirmed between Tendency to Urban Public Transport 2 and transport performance, measured by vehicle kilometers, which is statistically significant at the 5% level. In other words, Tendency to Urban Public Transport 2 increases with a growing urban population and higher transport performance, measured by vehicle kilometers.

The correlation between Tendency to Urban Public Transport 2 and transport performance, measured by seat kilometers, as well as transport performance, measured by vehicle kilometers on a normal working day, is moderate to substantial (0.436) and statistically significant at the 5% level. This means that Tendency to Urban Public Transport 2 increases with higher transport performance, measured by seat kilometers or vehicle kilometers on a typical working day.

Unlike Tendency to Urban Public Transport 1, a statistically significant relationship was confirmed between Tendency to Urban Public Transport 2 and the length of transport lines. The correlation is moderate to substantial (0.462) and statistically significant at the 5% level, indicating that Tendency to Urban Public Transport 2 increases as transport lines lengthen.

The second statistical hypothesis, which proposed that there is a significant relationship between Tendency to Urban Public Transport 2 and the length of transport lines, was confirmed. The findings, consistent with Badia et al. [22], suggest that the structure of public transport networks strongly influences demand. Networks designed to facilitate transfers increase usage and encourage time coupon holders to rely more strongly on public transport to make journeys.

Tendency to Urban Public Transport 2 is statistically significantly influenced by the number of inhabitants; the size of built-up and other areas; transport performance, measured by vehicle kilometers; transport performance, measured by seat kilometers; transport performance on a normal working day; and (especially) the length of transport lines. Similar to Tendency to Urban Public Transport 1, no statistically significant relationship was found between Tendency to Urban Public Transport 2 and the city's transport infrastructure.

5. CONCLUSIONS

Restricting individual car use in urban mobility has been a long-standing goal. One of the key solutions is promoting the wider use of urban public transport for journeys to work and schools. Regular travel, primarily involving people aged 15-64, is associated with the use of time coupons, which offer unrestricted travel and are economically more advantageous than individual tickets.

This paper proposed indicators that measure the level of regular journeys in urban public transport for a selected set of cities. Two indicators were introduced: Tendency to Urban Public Transport 1, which represents the ratio of recalculated annual time coupons to the population aged 15-64, and Tendency to Urban Public Transport 2, which represents the ratio of transported persons using time coupons to the total number of transported persons. This study contributes to the ongoing debate on sustainable urban mobility by introducing and testing two novel indicators for assessing the regular use of public transport. These indicators provide practical tools that researchers and policymakers can use to better evaluate, compare, and potentially improve public transport systems in medium-sized and large cities. The introduction of both indicators can be considered as the contribution of this paper, as the lack of suitable indicators for assessing regular public transport use has not yet been addressed in the literature and, therefore, was chosen as a new thematic area for research.

The calculations revealed that a city's size, measured by population or territorial area, plays a crucial role in determining the levels of these indicators. Substantial differences in the use of urban public transport were observed in cities with around 100,000 inhabitants, suggesting that the use of urban public transport can be increased in such cities. The novelty of this paper also lies in the attention given to cities with this population size. The Association of Transport Companies of the Czech Republic includes 20 urban agglomerations, with the existence of transport companies being relevant for approximately 50,000 inhabitants living in the given cities.

The strengthening of the importance of urban public transport and the possibilities of its use is supported not only by time coupons, which are, as already mentioned, cheaper than the sum of fares paid for individual rides, but also by fare payments via bank cards or the introduction of so-called bus lanes in individual cities. The modernization of the vehicle fleet of transport companies is also significant since new (especially ecological) technologies and increased passenger comfort make it possible to attract new customers through ticket prices and by reducing congestion in cities, which results from the use of a large number of private cars.

We examined statistically significant relationships between Tendency to Urban Public Transport 1 and 2 and various factors, including city population, territorial size, transport infrastructure, and transport performance. We confirmed statistically significant relationships between both indicators and the number of inhabitants; the size of built-up and surrounding areas; and transport performance, measured by vehicle kilometers, seat kilometers, and vehicle kilometers on a normal working day. However, we found no statistically significant relationship between the city's transport infrastructure and either indicator. Only Tendency to Urban Public Transport 1 was statistically significantly affected by the length of transport lines.

Performing quantitative analyses in the field of transport comes with certain methodological limitations. In the present study, we worked only with selected factors that may or may not significantly affect the tendency to use urban public transport. Other potentially more significant factors were not considered, which is why partial correlation analysis was not applied. Nonlinear models could also be explored to provide more relevant results, although they may not necessarily do so.

It is well-known that correlation does not imply causation. The existence of a correlation does not prove a causal relationship between the studied phenomena. Thus, we cannot definitively state that the analyzed factors (such as urban population, size of built-up areas, transport infrastructure, transport performance, or length of lines) have a factual or causal connection with Tendency to Urban Public

Transport 1 and 2. The correlations identified in this paper do not clarify which phenomenon is the cause and which is the effect.

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