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Development of modal split in the Czech Republic according to national census

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ABSTRACT:

One of the key parameters during the analysis of traffic in the cities is the modal split, which shows how is the role of different modes of transport in the city. Every 10 years in the Czech Republic, the Czech Statistical Office makes a census of houses, people and flats and a regular commute to work and school (or modal split). However, this data is not using for the further needs of city traffic planning, while small towns (15-60,000 inhabitants) have not another source of data for planning of traffic behaviour. This paper follows the final report from the CYCLE21 project, which analysed data from 2001. This paper examines the development of data between 2001 and 2011 (when the last census took place in the Czech Republic) and analyses the trend of change of traffic behaviour. Concurrently, this paper introduces methodological documents created by the authors of the paper for the future census in 2021 so that it is possible to make prediction of modal split in individual cities in the Czech Republic.

KEY WORDS: the prognosis of data, modal split, Czech Statistical Office, commute, SUMP

1. Introduction

The United Nations points to two fundamental trends. The first is the growing population on Earth, which currently stands at over 7 billion people and, according to medium estimates, will reach 10 billion people by 2050 (United Nations, 2019). The second of these trends is the increasing urban population and depopulating countryside. Cities are a magnet and at the same time a sustainable structure and must provide the place where the world's population will live, as according to the European Commission (2012) more and more people are moving to cities – 74 % of the European population live in them and is estimated to grow by 2050 at 82 %. By comparison, in 1950, only 30 % of the world's population lived in cities; in 2005, 40 % of the world's population was already in cities (United Nations, 2005).

Empirical research (Banister 2008) has concluded that the key parameters of a sustainable city are that it should have more than 25,000 inhabitants (preferably over 50,000), with a medium population density of over 40 people per hectare. It should be a city with the support of mixed land use, which would allow the proximity of everyday travel destinations (a city of short distances).

Studies on the principles of sustainable transport systems (Branister and Stead, 2004; LyonsaKenyon, 2003; BanisteraHickman, 2006) have already identified four key principles in the first decade of the 21st century, but they have not yet been able to implement urban planning. These are the following principles.

1. Reducing the need for travel - substitution - there will be a reduction of some trips and reasons for market change (e.g. online shopping).
2. Transport policy measures - change in the distribution of the modal split.
3. Spatial planning measures - shortening distances (urban decentralization).
4. Technological innovations - increasing the efficiency of the transport system.

It is therefore clear from the above that more and more people will live in cities, which will result in an increasing demand for transport to work, school facilities, medical facilities, etc., not only within cities but within the whole network. . These predictions are further supported by the fact that the number of category B driving licenses (passenger car up to 3.5 t) in the population continues to grow, as evidenced by Figure 1, which presents the cumulative development of driving licenses in the United States, Germany and the Czech Republic (Kraftfahrt-Bundesamt , 2020; Worldometers.info, 2020; US Department of Transportation, 2014; Hedges & Company, 2020; Ministry of Transport of the Czech Republic, 2020).

The development of driving licenses itself is not so authoritative, but it can also be supported by the development of the cumulative number of passenger cars up to 3.5 t in relation to the number of inhabitants. Figure 2 shows the number of vehicles per person in a given country (European Automobile Manufacturers' Association, 2019; Statista Research Department, 2020).

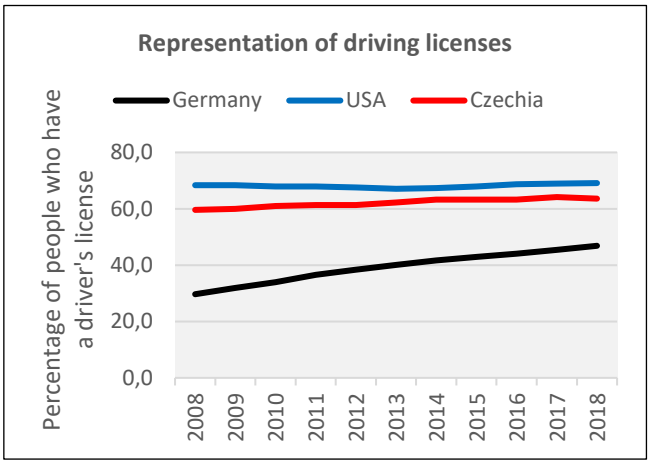

Figure 1: Percentage of driving licenses in the population

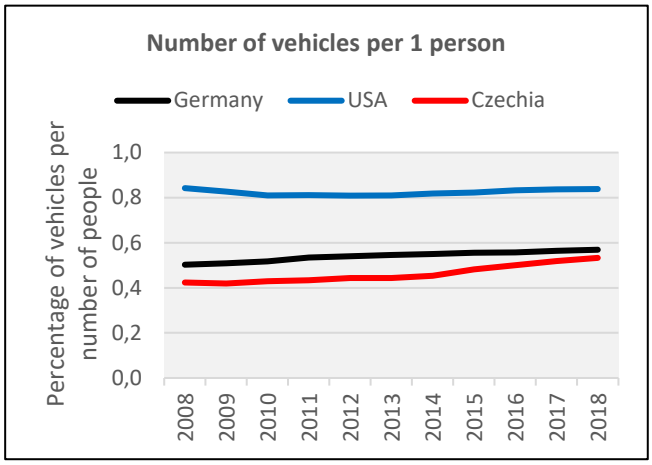

Figure 2: Number of vehicles per 1 person

From the above, it is clear that the situation on the roads will deteriorate and the currently set system is unsustainable and it will be necessary to approach a comprehensive system solution at the level of cities with less than 100 thousand inhabitants.

2. Traffic behaviour

The key challenges faced by urban planners in the past are underestimated in traffic behaviour (Banister, 2005; Balaker and Stayl, 2006; Wickham, 2006). Nevertheless, it is remarkable that transport planning "survived" all these crises, which appeared almost intact, perhaps with minor changes. Two basic principles are still enshrined in the transport planning approach used.

- Travel is a derived demand, not an activity that people want to do for themselves. Travel only leads to the value of the activity that is at the destination (therefore transport is just a tool of implementation).
- People minimize their travel costs, especially because of the combination of travel costs and travel time.

These two basic principles have important implications because they are embedded in most analyzes and evaluation studies. They help explain the predominance of transport solutions in urban problems and the huge increase in faster and longer distance travel, as increased cruising speed outweighs increased travel costs. **Although travel times may have remained constant as cities spread, distances and speeds increased significantly** (Banister, 2006; Deakin, 2006; Duranton, 2006; Kahn, 2006). Local public transport, cycling and walking have become less attractive, which in turn has led to greater use of the car. Car dependency and increased decentralization of cities are difficult processes that are not easy to reverse.

Travel time is important for commuting, but as travel patterns change and leisure travel increases, travel time may become a more positively valued activity (Loo and Chow, 2006; Schlich et al., 2004; Mokhtarian et al. al., 2006). Escape theory (Heinze, 2000) assumes that mobility at leisure is an attempt to compensate for the declining quality of life in cities. Travel opportunities are required to escape away from the everyday environment of something completely different. Much of the free time is devoted to the need for travel, and travel activity is valued.

There is a need to change traffic behaviour so that more people use means of transport other than cars. However, this has not been successful in the Czech Republic for a long time. As early as 1999, Dekoster and Schollaert noted that almost 50% of car journeys in the city are shorter than 8 km and 30% of journeys are shorter than 3 km. If we look at the data from Prague, this still does not change, according to a survey of traffic behaviour (Marešová 2019), in Prague, 21% of journeys shorter than 2 km are made by car.

3. Open data for traffic planning

The Czech Republic has two types of data that are collected at regular intervals and are publicly available for traffic analysis. Every 5 years, the Road and Motorway Directorate of the Czech Republic (RSD) performs a census of traffic intensities on motorways, roads and selected local roads. The data can be used for basic evaluation of traffic intensities in cities. It is also possible to perform analyzes of the composition of traffic flows, determination of peak hours or load of the entire traffic network. The RSD only counts vehicles that pass through a given road profile. (Horník et al. 2019) It is not possible to further determine the modal split from these data, which is a basic indicator of the quality of traffic in cities (nor the direction of traffic flows - OD matrix). Modal split can be determined as a nationwide Population Censuses, which is collected by the Czech Statistical Office.

The Population Censuses in 2011 was a nationwide census in the Czech Republic. It took place at midnight from Friday 25 to Saturday 26 March 2011. Regulation No. 763/2008 of the European Parliament and of the Council of the European Union provided that the census was to take place in all European Union (EU) member states every ten years, starting in 2011, with further reference years to be determined by the European Commission as the executive body of EU.

The data that is suitable for use in traffic analysis are as follows:

- Total regular commuting.
- Commuting to work.
- Commuting to schools.

Based on these data, it is possible to determine in detail the modal split, which tells about the behaviour of residents in the city. The project CYCLE21 – Analysis of the needs for building cycling infrastructure in the Czech Republic, which was implemented within the National Research Program 2004–2009 of the Ministry of Transport of the Czech Republic (Brůhová-Foltýnová 2008), dealt with this determination. The authors of the project identified a modal split, which served as a basis for the analysis of urban traffic (Figure 3). The project was beneficial especially for cities with 10 to 60 thousand inhabitants, for which it can be too financially demanding to have an extensive transport analysis, including the modal split.

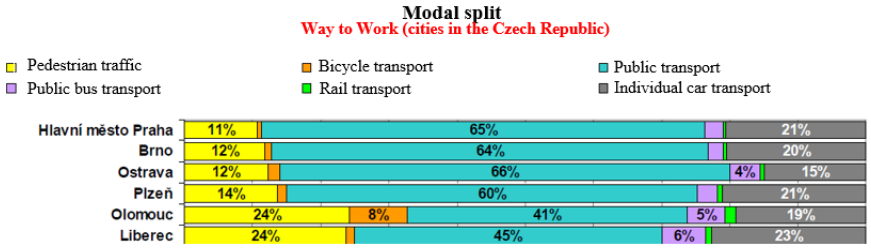

Figure 3: Results of the CYCLE21 project (Brůhová-Foltýnová, 2008)

The authors of the CYCLE21 project evaluated the data of the Population Censuses in 2001, but they did not continue in 2011. It was not possible to compare how the modal split of individual cities changed. At the same time, there was enormous interest in these data in the Czech Republic. In 2017, Dr. Jirsa also drew on the CYCLE21 project during the elaboration of the Nymburk City Communication Network Concept (Jirsa et al. 2017), where he presented this data as one of the key inputs.

The authors of the article therefore follow the work of the authors of the CYCLE21 project so that it is possible to further evaluate the data according to the same methodology. This continuous evaluation is more than desirable, because in the Czech Republic at present (2020) there are no more comprehensive data for the whole country. It should also be mentioned that the study of the Prague Institute of Planning and Development (IPR) tried to follow the CYCLE21 project (Jaroš et al. 2018). However, this study only worked for the capital city of Prague. **The authors of both projects** (Brůhová-Foltýnová et al. 2008, Jaroš et al. 2018) **did not publish a methodological procedure in their projects, so that it was possible to follow up on the projects.**

4. Methodical data separation

As part of the Population Censuses in the Czech Republic in 2001, commuting to all cities in the Czech Republic was determined. It was further divided into gender, total commuting time, modal split and what type of employment commuting is made up of. These data were then created for individual districts. The problem arises with the Population Censuses from 2011, the modal split for individual cities is missing. Although there are data for individual districts, they are unusable or only to a limited extent applicable to the cities themselves. The task is therefore to separate the individual values of detours within the districts for the cities themselves, which could further use them for urban infrastructure planning.

For the separation of data, the values from the Population Censuses from 2001 will be used for the individual division of transport work both within districts and individual cities, as well as the values from the 2011 census of population, houses and dwellings for districts and population in 2001 and 2011, and the following relation no.1.

$$m_{A2011} = \frac{p_{A2001}}{p_{A2011}} \cdot \frac{m_{A2001} \cdot o_{X2011}}{o_{X2001}} \qquad (1)$$

Where: m_{A2011} is a commute to the city *A in 2011 within a specific transport segment*, p_{A2001} is the population of city *A* in 2001, p_{A2011} is the population of city *A* in 2001, m_{A2001} is a commute to the city *A in 2001 within a specific transport segment*, o_{x2011} is commuting to district *X* in 2011, o_{x2001} is commuting to district *X* in 2001.

5. Interpretation of results

Within the comparison of cities with 15 - 60,000 inhabitants, 102 cities were compared. The following figures interpret the partial results.

The total regular commuting based on data from the Population Censueses has a declining trend between 2001 and 2011 (except for the municipality of Brandýs nad Labem). This difference is mainly due to the geographical location of cities, or the proximity of larger, more dominant centers (cities around 100,000 inhabitants). The results of total commuting and its comparison are, of course, also dependent on the change in the number of inhabitants during the observed period. The population of Brandýs nad Labem increased by 2,200. It could be said here that this is a direct relationship between the growth of the population and the growth of total commuting.

If we deal with the total commuting in whole districts, the trend is, as with cities, declining between 2001 and 2011. Although the number of inhabitants in the number of monitored districts increased significantly, the total value of commuting to the given district decreased in all cases. For example, in the district of Prague-East, the population increased by more than 60,000, and yet commuting to this district decreased by more than 1,000 inhabitants. Here, however, the result of the research is understandable due to the geographical location, which is close to the center of Prague. Directly proportional to the decrease in the number of inhabitants and at the same time commuting is, for example, the Karviná district, where the number of inhabitants decreased by more than 20,000 between the monitored years, as well as the size of commuting. The population also increased in the Benešov, Kladno, Beroun, Mladá Boleslav and Nymburk districts. However, this did not change commuting, the reason for the increase in population is mainly more economically affordable housing near the metropolis, which is the dominant destination for commuting to work and school.

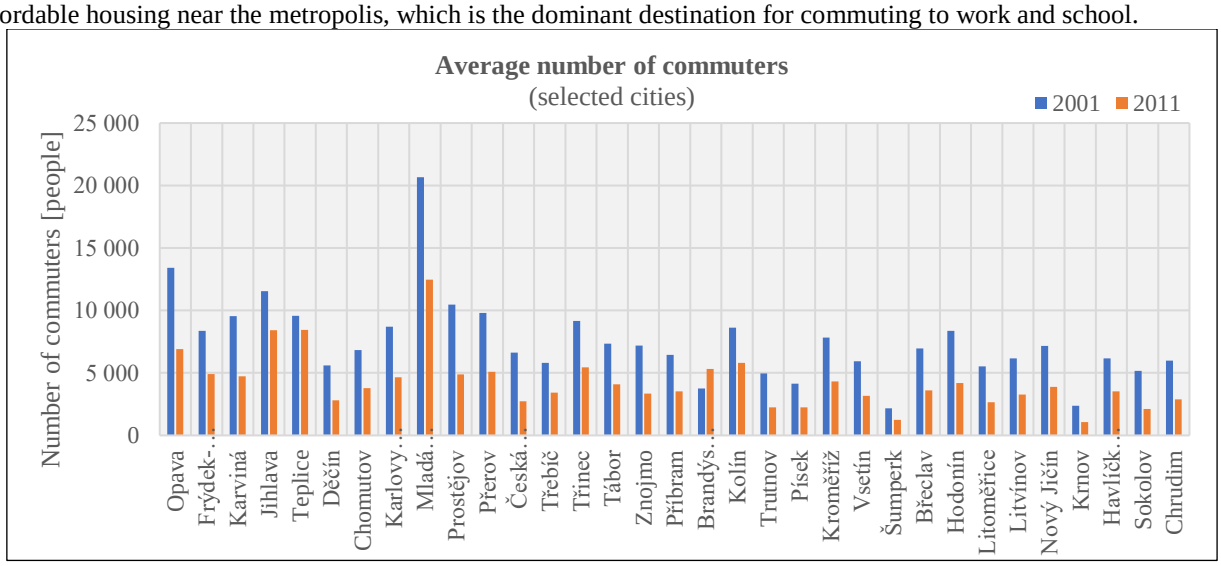

Figure 4: Comparison of commuting between 2001 and 2011 (selected cities)

Modal split data was divided commuting in cities by public bus transport, train, private motor vehicle, public transport, cycling and pedestrian mode of transport.

Public bus transport

In almost all monitored cities, regular bus transport commuting decreased by 50-75%, in Tachov, Dvůr Králové nad Labem, Bílina and Teplice the value of the decrease was above 80%. The only town where the decline in commuting by regular bus was only 10% is Brandýs nad Labem. However, this figure is due to the fact that it is the only city where total commuting has increased between these years.

Train

Like regular bus transport, this type of means of transport has a declining trend in the number of people, in all monitored cities. In some cities, this information could not be ascertained mainly because the city does not have a train connection.

Private motor vehicle (PMV)

Compared to other modes of transport, commuting by private motor vehicle has a growing trend. The growing trend ranges from 0% to 62%. There is an extreme increase in PMV commuting in the already mentioned town of Brandýs nad Labem / Stará Boleslav, where the increase in commuting is 233%. The town of Kopřivnice, Zábřeh, Šternberk or Frenštát pod Radhoštěm also has a higher increase than the value of 50% within commuting with PMV. Commuting via OMV has a slightly declining trend in 35 out of 102 cities, but only in percentage units.

Public transport

From the point of view of commuting by public transport, the trend is again rather declining, the only town where there has been a growth is again the town of Brandýs nad Labem/Stará Boleslav. The difference between commuting by public transport in 2001 and 2011 remained virtually unchanged in Poděbrady or Nymburk. This figure was not available for many cities.

Cycling

The decline in commuting by bicycle to work or school is, as well as commuting by public line bus, worth 50-75%. As with other modes of transport, the value of the decline is in principle directly proportional to the trend in the development of total commuting to selected cities.

Walking

The last type of transport within the solved modal split of commuting is the pedestrian transfer of people to jobs and schools. There was a decrease in about 65% of selected cities, while in about 30% (31 cities out of 102) there was an increase in the number of people reaching the destination on foot. Cities with a higher increase in attendance above 50% include, for example, Třinec, Uherské Hradiště, Brandýs nad Labem / Stará Boleslav, Frýdek-Místek and Uherský Brod.

In summary, for all modes of transport, it can be said that commuting by most of the selected means of transport within the modal split depends on the trend of the development of total commuting in the monitored period. Commuting by public transport buses, public transport, trains and bicycles there was essentially a clear decrease in all monitored cities. For the selected type of transport by PMV or pedestrian transfer, there was a growth in selected cities. This can be influenced by several factors, such as higher economic availability of buying and operating your own car, or insufficient provision of the city by public transport and the related impossibility of choosing another more efficient form of transport to jobs and schools than PMV.

The issue of the average time spent in public transport depends on the value of total commuting and its trend within the observed period. Due to the fact that the value of total commuting has a declining trend in the observed period, the partial values of the number of commuters according to the time spent commuting are derived from this. These numbers of people logically also have a declining trend due to the total commute. The numbers of commuters were monitored according to the time spent in the vehicle according to the following minute intervals: up to 14 minutes, 15-29 minutes, 30-44 minutes, 45-59 minutes and more than 60 minutes.

The growth occurred only in the town of Brandýs nad Labem, in all time intervals. Another interesting feature is the increase in the number of commuters over 60 minutes to the cities of Svitavy and Jihlava. When it comes to the development of the average time spent in a vehicle commuting to work and schools, this value is lower in most cities in 2011 compared to 2001. The increase in the average time spent in a vehicle commuting is only in 6 cities where increase value only in percent units. The largest decrease in the value of the average time spent on commuting occurred in the towns of Chomutov and Teplice, where the decrease is about 16 %. These values are usually given by the general trend of accelerating public transport due to more efficient and more modern means of transport due to general technical progress.

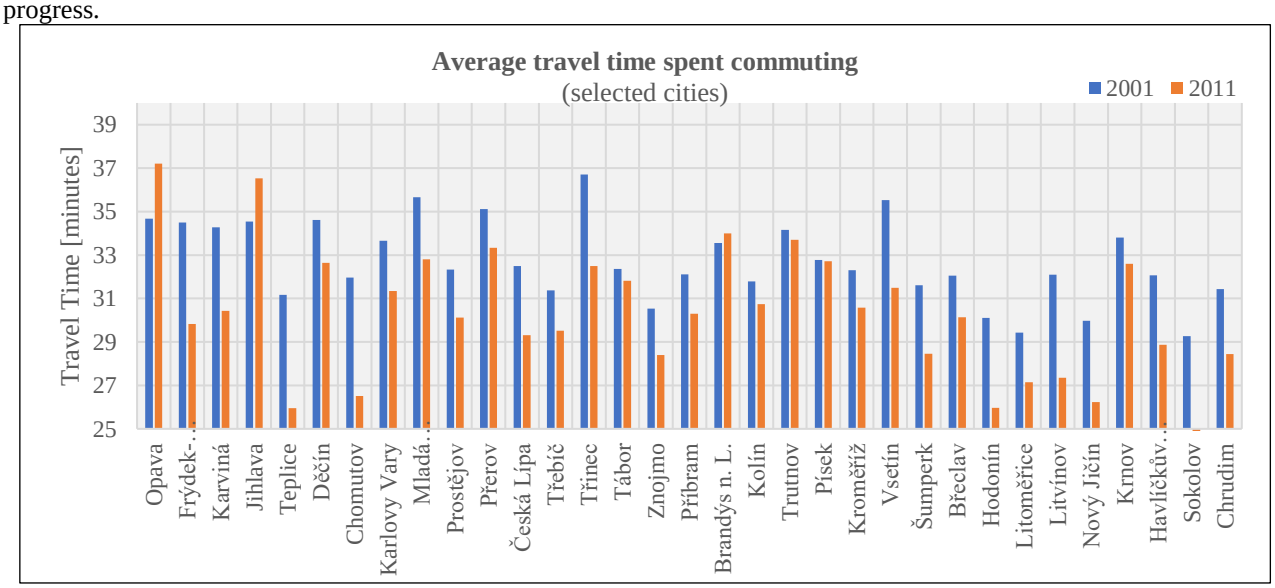

Figure 5: Average travel time spent commuting (selected cities).

6. Summary

The aim of the work was to follow up on the CYCLE 21 project (Brůhová-Foltýnová 2008) and to compare the development of basic urban indicators with a number of 15,000-60,000 inhabitants. The basic input was publicly available data from the Czech Statistical Office, the years 2001 and 2011 (following the future census in 2021). In the vast majority of cases, commuting has decreased in smaller cities. In some cities, the value of total commuting has dropped by up to half. The declining number of jobs is a major problem for these smaller cities. This is also influenced by the upward trend of people with higher education, which are no longer used in these cities. The data interpret the current trend in the Czech Republic - depopulation of the countryside and migration of inhabitants to large cities, or within driving distance. As predicted by the European Commission.

As part of the modal split, we are seeing a significant decline in the number of people commuting to cities using public transport, which is due to the fact that as these cities cease to be attractive for commuting, so does the number of public transport connections on offer. The trend in public transport is integrated transport systems, whose majority destinations end in metropolises or regional cities and "avoid" smaller cities, which are addressed in this work. Many of these trends have been warned at the beginning of the millennium by the work of foreign authors (Banister, 2006; Deakin, 2006; Duranton, 2006; Kahn, 2006, etc.).

In 2021, another census will take place in the Czech Republic. These data are the only permanent source of traffic data for cities of 15,000-60,000 inhabitants, so it is necessary to ensure their publication in an acceptable format, so that this data can be further worked on. In the case of traffic data (modal split and commuting), the authors recommend focusing not on individual administrative units (districts, regions), but directly on municipalities. The authors also recommend a thorough description of the methodological procedure for evaluating the data in the census and in subsequent research reports, so that it is possible to follow up on the work in the coming years.

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