

The efficiency of providing public services in transport

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Abstract: *Today's dynamic environment, which is developing at a rapid pace, places high demands not only on transport, but also on efficiency, speed, safety, quality and, in particular, questions about the efficiency of spending funds from city budgets, all with a strong emphasis on the environmental friendliness of urban public transport. Given that the public sector is undergoing changes, the main goal of which is to increase the efficiency and effectiveness of financial management in the public sector, cities must really always place a strong emphasis on ensuring maximum efficiency of services provided and the use of public resources in all expenditure areas of the budget. In the vast majority of cases, the financing of urban public transport currently represents the greatest burden on urban public budgets not only in the Czech Republic but also in cities in the EU.*

The article presents the outputs that emerged within the project "Methodological - application tools for efficiency financial management of territorial structured statutory city". The outputs of the article are focused on the area of transport, as it is one of the key areas of the city budget and in terms of expenditure sections, transport expenditures represent the highest amount in the budget of the Statutory City of Ostrava. Geographic information systems (GIS) can be successfully used to analyse efficiency, demand and urban public transport planning. For the purpose of effective presentation of information on the state and drawing of the budget and on the effectiveness of funds spent from the budget of the statutory city and individual city districts, the R-Point web map application was created. An interactive map showing statistical indicators in the area, there are also graphs that serve the user for a better comparison of data between individual city districts and the City of Ostrava.

Keywords: Public Services, Geographic Information Systems, Urban Public Transport

JEL: H72, R42, R12, R53

DOI: 10.24818/amp/2021.37-04

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Introduction

Mobility and its accessibility in the territory are the main factors for economic development, cohesion and social integration. Urban public transport is part of every modern metropolis and serves to satisfy the transport requirements of the population, while its function is given by the characteristics in relation to managing the needs of population transport, the environment, and the investment intensity of the transport system. To ensure these needs, a perfect organisation within the integrated transport system and synchronisation of technical development is necessary, as well as all management, organisational, tariff, planning, and investment activities. The current dynamic environment places high demands on the efficiency, speed, safety and quality of the urban transport system, but also on evaluating the efficiency of spending funds.

In the vast majority of cases, the financing of urban public transport currently represents the greatest burden on urban public budgets not only in the Czech Republic but also in cities in the EU (Androniceanu et al., 2019). Due to the extent of urban transport, the cost of its operation, fares and discounts provided, the operation of urban public transport will always be a loss-making activity and cities will always be forced to subsidise it from their budgets. City budgets contribute to the compensation depending on their size (Eveeva *et al.*, 2019). With the growing size and technological sophistication of urban public transport, the pressure for higher subsidies from the city will usually increase.

The pressure to ensure the maximum efficiency of the services provided and the use of public resources not only at the level of individual countries but also at the level of individual cities is constantly increasing (Ardielli, 2020). This need is also very noticeable in statutory cities, which carry out budgeting (solves the budget process) not only at the city level but also at the level of city districts.

City districts often point to the low volume of these budgeted resources, and in connection with this, centrifugal tendencies, i.e. pressures to separate city districts from the statutory city, may arise (and they are often very strong). The effort of cities is to submit methodological proposals for improving budgeting (budget process) and transparency at the level of cities and city districts, which also includes the definition of appropriate financial and technical performance indicators of city districts and cities and proposals for modelling measurement and evaluation of the efficiency of allocation processes according to technical and financial parameters (inputs and outputs), especially in the areas of education, transport, culture, and social services (e.g. Čepel, 2019; Androniceanu, 2021). One of the ways to clearly evaluate and present the obtained information on the state and execution of the budget and on the effectiveness of funds spent from the budget of the statutory city and individual city districts through selected indicators is to create a web map application that allows a wide range of users to assess the execution of the budget and services comprehensively from different perspectives

based on a large set of data, including their time evolution. The processed outputs of the performed analyses formed the necessary basis for creating the R-Point web map application (the ArcGIS Online environment was used to create network analyses), which aims to clearly evaluate and present information on the state and drawing of the budget (and its individual areas) from 2017-2019 and the effectiveness of funds from the budget of the Statutory City of Ostrava and city districts through selected indicators.

1. Literature review

In the last few decades, the public sector has undergone significant changes in many OECD countries, the main goal of which is to increase the efficiency and effectiveness of public sector financial management (Gavurova *et al.*, 2020). Researchers focus on measuring the efficiency of public service delivery using a variety of methods and conduct comparative tests of the performance of governments in different countries (Ranasinghe, 2019; Fusco & Allegrini, 2020).

In the vast majority of cases, the financing of urban public transport currently represents the greatest burden on urban public budgets not only in the Czech Republic but also in the cities of the European Union. Urban public transport can be defined as a system of passenger public transport lines designed to provide transport services in the territory of the city by means of public transport. A specific public transport system can be ensured by bus, tram or trolleybus transport. In cities with a population of over one million, it is the metro or overhead railways served by trains (Jaśkiewicz & Parlińska, 2016).

Every year, municipal budgets have to deal with the financing of a demonstrable loss and a reasonable profit for their own transport companies, or for contract carriers. Therefore, a number of professional works deal with the issue of comparing prices in public transport (e.g., determining the socially optimal price), setting the frequency and subsidies, evaluating the efficiency of road infrastructure, evaluating urban public transport, or evaluating investments in transport infrastructure capacity development (Pavón *et al.*, 2019; Vatankhah *et al.*, 2019; Hörcher *et al.*, 2020). The latter becomes an important direction of public budgets planning (Kostiukevych *et al.*, 2020; Nugraha *et al.*, 2020) within the public distributive policy in order to ensure social needs and high quality of life (Mishchuk *et al.*, 2019). Mitigation of transport issues positively influences population mobility and has a substantial impact on territorial disparities overcoming (Černevičiūtė *et al.*, 2019; Sivalai & Rojniruttikul, 2018) which in turn can determine the economic growth peculiarities (Oliinyk *et al.*, 2021).

Recently, the phenomenon of free travel for residents has appeared in urban transport. Many research works show that the mode of travel preferred by urban dwellers (residents) has a fundamental influence on the structuring of available modes of travel in metropolitan areas and the formulation of transport policy at the city level (Luan *et al.*, 2020; Khan *et al.*, 2016).

The effort of large metropolises, in particular, is to reduce the environmental burden of transport or to minimise its negative impact.

The energy crisis, the growing number of means of transport and the related accumulation of negative effects, which mainly affect the quality of the environment, have made the development of low-fuel and high-fuel-efficient vehicles the main research goal of many scientists and companies (Aslam *et al.*, 2006). As part of the provision of transport in cities, the optimisation of the transport system in relation to environmental and cost sustainability has been addressed for a long time (Martins *et al.*, 2019; Haseeb *et al.*, 2019).

Geographic information systems (GIS) can be used very successfully for demand analysis and effective urban public transport planning. A number of professional papers deal with this issue (Kujala *et al.*, 2018).

For the provision of public transport, and especially the transport service of the area, it is very important to design the route of the line and the location of stops and interchanges, including their markings and equipment. These nodes belong to important points of the transport network because they are places of origin and termination of transport relations. In the case of public line transport, the above points include bus stops, bus stations; in the case of rail transport, these points include trolleybus and tram stops, railway stops, railway stations and metro stations. This issue, whether focused on the availability of only certain types of stops, such as bus stops (Salvo & Sabatini, 2005; Corazza & Favaretto, 2019) or public transport stops in general (Benenson *et al.*, 2016), affects all smaller and larger cities.

Accessibility is usually perceived as the relative proximity of one place to another. One of the complex definitions says that accessibility expresses “the extent to which the land-use transport system enables (groups of) individuals or goods to reach activities or destinations by means of a (combination of) transport mode(s)” (Geurs & van Wee, 2004). Geurs & van Wee (2004) identify four types of availability measures:

- Infrastructure-based measures are used to assess the performance and level of transport infrastructure services and are, therefore, suitable for transport planning. The evaluation of the physical accessibility of stops was performed, for example, by Boruta (2010).
- Location-based measures are used to analyse accessibility in localities. They are used in geographical studies and spatial planning. The evaluation of transport accessibility based on geographical location was dealt with, for example, by Horák (2006).
- Person-based measures assess accessibility at the individual level and the possibilities of meeting the needs using the concept of spatiotemporal geography (Hägerstrand, 1970).
- Utility-based measures analyse and evaluate the economic benefits that people derive from the use of spatially distributed activities. Their current use in geographical research is limited.

Most commonly, site accessibility measures are used, which include potential measures and connectivity measures (Geurs & van Wee, 2004).

2. Research

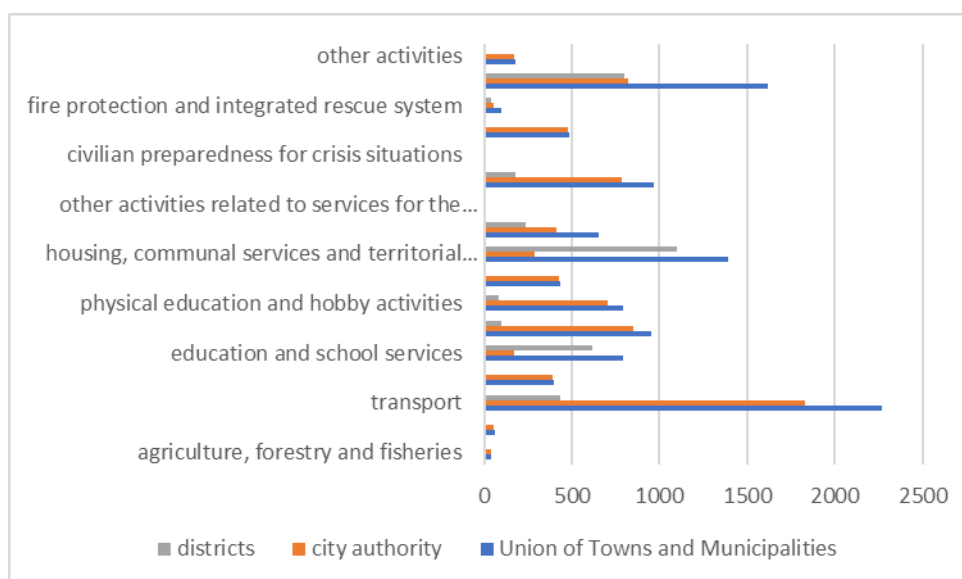
2.1 Data and Methods

In the Czech Republic, the regulation of Act No. 194/2010 Coll. Act on Public Passenger Transport Services and Amending Other Laws approved in accordance with the European Union on 20 May 2010. The traditional financing model in the Czech Republic is a situation where the passenger contributes to the total operating costs of public transport only a certain part; the rest is paid in the form of subsidies. In the conditions of the Czech Republic, the amount of this contribution is typically only 40% of the cost of a given journey. The remaining 60% of the price will be paid by the city for the passenger from public funds.

As part of the project “Methodological - application tools for efficiency financial management of territorial structured statutory city”, which has been addressed in the statutory city of Ostrava (SCO) and its districts” in the period 2018-2020, the issue of urban public transport was also intensively investigated. The initial input data for the solution of the project were used for the year 2017. The project also analysed and processed data for 2018, 2019.

Ostrava is divided into 23 city districts, the largest of which has about 100 thousand inhabitants and the smallest under 1 thousand residents. Approximately 300 thousand people live in the city of Ostrava, including 10 thousand foreigners. The city has an area of 21,400 ha, which is an area that could accommodate up to 1 million inhabitants. The built-up area with lower building density, a number of gaps, peripheral places and barriers are a major problem in the development of the city and the effective maintenance of its infrastructure. In terms of expenditure sections, the SCO budget is mostly represented by transport expenditures (mostly covered by the municipality), housing, communal services and territorial development expenditures (mostly financed by municipal districts) and administrative expenditures, where the share of municipal expenditures and city districts is almost balanced. In 2019, 17 expenditure sections were identified in the SCO budget (for more details see Figure1).

Figure 1. Representation of the individual expenditure sections in the budget of the city of Ostrava (in millions of CZK) in the year 2019



(Source: Own processing based on the economic results of city districts and the SCO municipality in 2019)

The highest share of municipal expenditures in 2017 is transport expenditures (about 25.1% of all expenditures); in 2019, transport expenditures represented about 25.0% of all expenditures. On average, city districts spent CZK 13,784,000 on transport, and per capita, CZK 1.6 thousand, in 2017, and in 2019, the city districts spent on average CZK 19,062,000 on transport, and per capita CZK 1.5 thousand, see Tab. 2.

From the above documents, it is possible to trace a growing trend of expenditures in the field of transport.

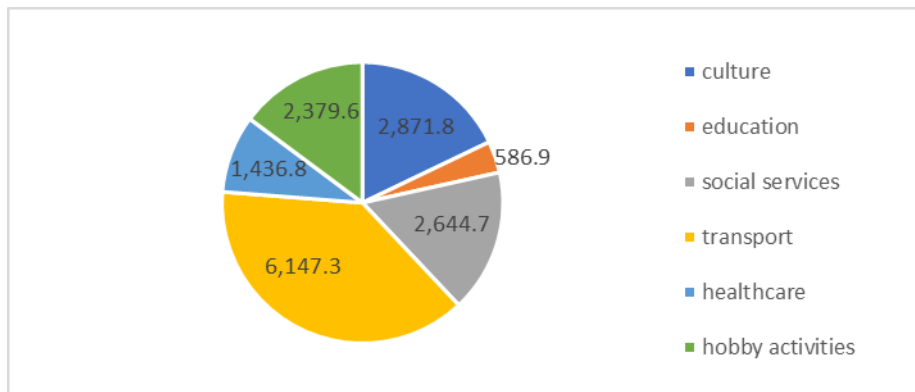
Table 2. Expenditures of city districts on selected areas in 2019 in CZK

City districts	Expenditures of transport	Expenditures of education and school services	Expenditures of culture	Expenditures of social services
Total	438,433,043.2	617,437,603.7	95,634,022.5	180,125,789.8
Diameter	19,062,306.2	26,845,113.2	4,158,001.0	7,831,556.1
Median	3,718,017.8	5,161,510.5	1,159,861.1	455,501.3
Expenditures per capita of city districts				
Maximum	4,040.4	3,446.0	5,914.7	1,212.8
Minimum	144.0	0.0	118.5	0.0
Diameter	1,474.1	2,075.9	321.5	605.6

(Source: Own processing based on the economic results of city districts and the SCO municipality in 2019)

In the monitored period, the SCO was the founder of a total of 35 organisations with city-wide scope. Two organisations are established in the field of transport: Dopravní podnik Ostrava, a. s. (the Transport Company of the City of Ostrava), and Koordinátor ODIS, s. r. o. Due to the fact that the founder of all the above organisations is the SCO, the funds spent on their operation from the SCO budget for the period under review were recalculated for the SCO per capita and aggregated by individual areas (culture, education, social affairs, transport, health and leisure). Figure 2 shows the specific values of funds spent per capita in CZK from the SCO budget in 2019, respectively.

Figure 2. Expenditures per capita in CZK from the budget of the Union of Towns and Municipalities of the Czech Republic in the year 2019 according to the focus of the organizations with city-wide scope



(Source: Own processing based on the economic results of city districts and the SCO municipality in 2019)

The total amount spent in 2017 on the operation of city-wide organisations, calculated for the SCO per capita, is CZK 8,874. The highest amount of funds is spent to ensure transport services in the SCO – CZK 3, 953,8. The total amount spent in 2019 on the operation of city-wide organisations, calculated per SCO per capita, is CZK 16,067. Figure 2 shows that the highest amount of funds is spent to ensure transport services in the SCO.

Given that each SCO inhabitant has a comparable opportunity to use the services provided by city-wide organisations, Table 3 then shows the total amount of funds needed to finance city-wide organisations in 2019, which are recalculated to individual city districts but are spent from the SCO budget (according to the number of inhabitants in the district).

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Table 3. SCO expenditures in 2019 in thousands of CZK according to the expenditure area and the number of inhabitants per city district

City districts	Expenditures in 2019 in thousands of CZK according to the expenditure area and the number of inhabitants per city district						Total in thousands of CZK
	Transport	Culture	Healthcare	Social services	Hobby activities	Education	
Hošťálkovice	10,726	5,011	2,507	4,615	4,152	115	27,127
Hrabová	24,156	11,286	5,647	10,394	9,352	260	61,094
Krásné pole	16,983	7,935	3,970	7,307	6,575	183	42,952
Lhotka	8,519	3,980	1,991	3,666	3,298	92	21,546
Mariánské Hory a H.	75,468	35,260	17,641	32,471	29,216	812	190,868
Martinov	7,259	3,392	1,697	3,123	2,810	78	18,359
Michálkovice	21,040	9,830	4,918	9,053	8,145	226	53,212
M. Ostrava a Přívoz	241,038	112,618	56,343	103,711	93,315	2,594	609,618
Nová Bělá	13,701	6,401	3,203	5,895	5,304	147	34,651
Nová Ves	4,499	2,102	1,052	1,936	1,742	48	11,379
Ostrava-Jih	638,278	298,216	149,199	274,632	247,101	6,869	1,614,295
Petřkovice	20,099	9,391	4,698	8,648	7,781	216	50,834
Plesná	9,281	4,336	2,170	3,993	3,593	100	23,474
Polanka nad Odrou	31,280	14,615	7,312	13,459	12,110	337	79,111
Poruba	397,849	185,883	92,998	171,182	154,022	4,281	1,006,216
Proskovice	7,757	3,624	1,813	3,338	3,003	83	19,618
Pustkovec	8,335	3,894	1,948	3,586	3,227	90	21,080
Radvanice a Bartovice	40,162	18,764	9,388	17,280	15,548	432	101,575
Slezská Ostrava	133,989	62,602	31,320	57,651	51,872	1,442	338,877
Stará bělá	25,490	11,909	5,958	10,968	9,868	274	64,467
Svinov	27,315	12,762	6,385	11,753	10,575	294	69,084
Třebovice	11,887	5,554	2,779	5,115	4,602	128	30,065
Vítkovice	53,063	24,792	12,404	22,832	20,543	571	134,205
Total	1,828,173	854,159	427,341	786,608	707,753	19,673	4,623,708

(Source: Own processing based on the economic results of city districts and the SCO municipality in 2019)

The analyses show a growing trend in the total amount of funds needed to finance city-wide organisations in the field of transport, which are recalculated to

individual city districts but are spent from the SCO budget (according to the number of inhabitants in the district).

The analyses of expenditures of the SCO for the monitored period made it possible to monitor expenditures both from the point of view of the SCO as a whole, from the point of view of municipal administration, and from the point of view of individual districts. The analysis clearly shows that expenditures on urban public transport are among the largest items of city budgets in the Czech Republic, and the situation is the same in the city of Ostrava; therefore, it is necessary to pay increased attention to this area.

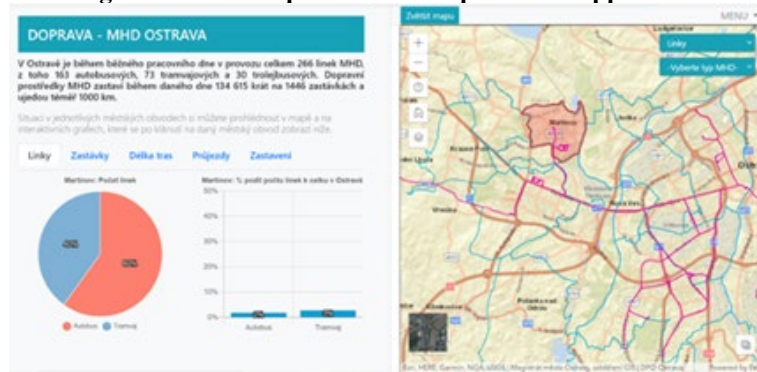
The processed outputs of the performed analyses formed the necessary basis for creating the R-Point web map application, which aims to clearly evaluate and present information on the state and drawing of the budget (and its individual areas) and the effectiveness of funds from the budget of the Statutory City of Ostrava and city districts through selected indicators. This web map application is based on a client-server architecture, specifically on a three-tier architecture separating the presentation, application and data parts. When creating the application, the HTML 5, the JavaScript object scripting language, and the language for describing the way CSS (Cascading Style Sheets) elements are displayed are used. The core of the web map application is based on ESRI technology, specifically on the ArcGIS JavaScript API library in version 4.14. This API is built on the open-source JavaScript framework Dojo Toolkit.

During the creation of the model, we worked with information with tabular data concerning reports for the evaluation of budget implementation from 2017-2019 of the SCO and with background spatial data of the digital vector geographical database of the Czech Republic ArcČR® 500. Data on population numbers in municipalities from the Czech Statistical Office and for analyses of the availability of data from the Register of Educational Facilities and the National Register of Health Service Providers were utilised. Extensive internal data of Dopravní podnik Ostrava a.s. were also used.

The R-Point web map application is divided into two thematic units – the financial and transport part. Within the R-point web application, it is possible to display 23 city districts of the Statutory City of Ostrava. The current status, according to the selected statistical indicators and the type of transport in individual city districts can be found on the map and on interactive graphs. The following data can be displayed and subsequently analysed (always separately for the given district and also as a share of the total in Ostrava, expressed as a percentage):

- routes of individual lines of trams, trolleybuses, and buses offered by DPO, a.s. for the whole of Ostrava and for individual city districts, including their length, see Fig. 3,
- number of the tram, trolleybus, and bus stops,
- the number of passages of all tram, trolleybus and bus lines through individual city districts in operation on a typical working day,
- frequency of stopping of all tram, trolleybus and bus lines through individual city districts in operation on a typical working day.

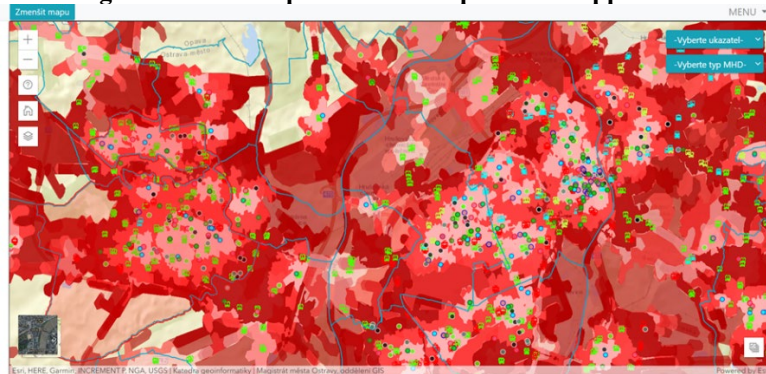
Figure 3. An example from the R-point web application



(Source: Authors own contribution)

As part of the project solution, an analysis of accessibility was also performed, as transport accessibility is listed as one of the factors influencing the economic usability of the monitored site, and providing transport services is one of the important tasks of public administration. The ArcGIS Online environment was used to create network analyses, which uses NAVTEQ data. The result of such analyses are the so-called polygons of accessibility; their boundaries are also anisochron, i.e. a line connecting places equally spaced from the source place. The polygons thus formed can overlap each other, join at the points of blending, or divide at the points of blending and, at the same time, not overlap. Times up to 5 minutes, 5-10 minutes, 10-20 minutes from the starting point were chosen as the border time slots. In addition to the accessibility of public transport stops, spatial analyses concerning the time availability of kindergartens and primary schools in the city of Ostrava were prepared, as well as the availability of general practitioners and dentists, see Fig. 4. A population grid (population density) from Eurostat was used for a better description of the situation in the districts of the city of Ostrava in connection with the distribution of the population.

Figure 4. An example from the R-point web application



(Source: Authors own contribution)

2.2 Discussion

The created R-point interactive map application belongs to the group of applications called the “decision support system”, and its use makes it possible to offer the user available information for optimal decision-making using interactive tools. Within the R point web application, users can quickly and clearly obtain information concerning, for example, the number of lines, stops and the number of stops in individual city districts of the SCO. The “situation” in individual city districts, which in some cases differ significantly in area, density, and population, can be analysed and compared very quickly.

The costs of urban transport within the city budget seem large, but it is necessary to realize that the funds invested in the development of urban transport, on the other hand, can reduce transport costs in other directions of city expenditures, i.e. on building car parks, road repairs, and can save areas in cities, etc. The amount of funds spent on transport from the city budget indicates the need to address the issue of transport efficiency in cities in all aspects. It is proving to be more efficient to ensure the management and financing of transport within a large city from one centre, i.e. from the municipality, where higher efficiency of spending can be expected than if individual districts provided their own transport in the city. If the costs of urban transport were to be paid separately by city districts, then the objective quantification of costs for urban transport for individual districts could be a problem, which also supports the centralization of traffic management and financing in the city. It then seems appropriate to entrust decisions on the construction of car parks, pavements, public spaces, etc., to the competence of city districts within transport.

3. Conclusions

Given that the public sector is undergoing changes, the main goal of which is to increase the efficiency and effectiveness of financial management in the public sector, cities must really always place a strong emphasis on ensuring maximum efficiency of services provided and the use of public resources in all expenditure areas of the budget.

The goals of implementing the strategy of modernization of public administration (so-called Smart Administration) include, among others, reducing administrative expenses, increasing the efficiency of public administration and the introduction of modern information technologies. The main task of effective public administration is that the provision of public services and the connection with the concept of sustainable development provide the necessary quality of services for citizens. It is the use of modern information technologies that automatically brings previously unimaginable possibilities, as it is possible to automatically perform a considerable amount of work with information in fractions of a second and at a negligible cost. The main goal is to create an optimal system of providing information and services to improve daily lives of citizens and legal entities using

modern information and communication technologies and accessibility independent of the social status of the entity. It is the R-point application, which was created within the project, which can significantly contribute to the improvement of services for the citizens of the statutory city of Ostrava.

The functioning of public transport in large cities affects the functionality of the whole city. It is reflected in the impact on the environment in these cities in terms of their own environmental conditions of urban transport and reducing emissions from individual transport. A lower amount of funds spent on urban transport could lead to an increase in price and the transition of the population to individual transport with negative consequences for the city's functioning. The use of urban transport by the population is then associated with its accessibility to the population's needs, which is reflected, for example, in the number of lines, the number of stops, distance from home, in traffic intervals, information about changes in transport, etc. Therefore, each city should monitor these parameters and adapt them to citizens, leading to greater use of urban transport. To this end, it is appropriate to carry out transport surveys so that transport can respond to the needs of the city's inhabitants. Furthermore, the population's awareness can be expanded by making information systems about the city accessible, which will make it possible to link financial indicators on transport with performance indicators, etc.

Acknowledgements

The paper was created within the financial support of the grant TACR (Technology Agency of the Czech Republic) No. TL01000145 „Methodological - application tools for efficiency financial management of territorial structured statutory city“.

Authors Contributions

The authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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