



# Sustainability Development of Smart Public Transportation in Globalization

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## Keywords

*smart public transport;  
sustainable development;  
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## Abstract

The paper studies the sustainable development opportunities of the public passenger transport market in the globalized environment. The main aim of the research is to improve the competitiveness of sustainable public transport. Transportation needs to be considered as an important aspect of the development of cities in a sustainable manner and for an attempt to create a smart city. Those cities care about inhabitants, apply environmentally acceptable methods of waste management, offer more efficient public transportation, health care, and social system.

Many studies have shown the relationship between effective public transportation services and sustainable development at the city level. European Commission is trying to motivate all the regional administration in an overall acceptance of sustainable urban mobility plans as part of the strategic vision for solving pressing problems in the process of functioning of modern cities.

The purpose of this study is to present a concrete step in achieving the objectives of the "smart city" concept with the use of modern information technology in the traffic and passengers in the real-time monitoring process, tickets issuing, as well as passengers informing in Subotica, Serbia. There is a wide gap between community expectations from public transportation services and the actual quality of service provided. The resulted grounded theory has brought attention to the necessary reform of transportation institutions; transportation policy which is integrated into settlement development of the smart city strategy and consistency of economic systems; public transportation development proceeding from supply improvement; and finally, the need of awareness improvement via education. The research conclusion is a necessity of external fund allocation through emerging means of liberalization and public-private partnership and the introduction of the more demand responsive transportation system while taking into account sustainable consumption as well.

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## 1. Introduction

The European Commission intensively motivates all regional and local governments to conduct Urban Mobility plans as an answer to the challenges of living quality improvement and environmental protection, since 2012. In accordance with these plans, many cities in Europe and throughout the world apply the concept of a smart city - the city of future with its several subsystems as their development guideline. The creation of smart transportation systems in accordance with the main principles of sustainable development based on protection of public health and environmental quality, respect for ecosystems, exhaust emission limits, sustainable use of renewable

resources and minimal use of non-restorative are accepted in “The Development Strategy for railroad, road, water, air and intermodal transportation in the Republic of Serbia between 2008 – 2015”.

On the other hand, the harmonization of traffic systems and the development of transportation infrastructure in the countries that are joining the European Union will largely redefine control mechanisms of modern cities and the roles of city sub/systems. The challenges of fast technical-technological development include the application of systematic approach in the use of new information technologies in the process of city sub-systems management.

## **2. Literature and regulation review**

Governing attitudes in available foreign and latest domestic literature indicate that establishing the necessary prerequisites for sustainable urban mobility as well as the application of new technical and technological solutions in the functioning of city subsystems is imperative for the survival and development of the cities.

The lack of legislation and scientific and professional observation of the problems in the functioning of the city subsystems, especially for public transportation have led to many different solutions implemented in various cities. Many of them are often unsuccessful in practice.

Awareness of the need to regulate the public transport problems in accordance with positive examples, first of all, those from the European Union has gained importance in our country in the recent years. The problem of public transport is very noticeable in the management of urban infrastructure (Brook, 1995).

The view that the government should improve urban planning by optimizing the rules and structure of public urban transport routes for the construction of the Public Transport Company (PTC) and sustainable development in the future is a new idea of public transport priorities (Han, 2010).

Several independent studies indicate the relationship between effective public transport services and sustainable urban development (Too & Erl, 2010). The aim of this study is to present and implement the "SERKWAL" framework for measuring public transport services performed within the Master Plan Community in Australia. According to the results of the survey, there is a big difference between the community's expectations from public transport services and the quality of services carried out on the ground. In particular, the results were useful in identifying areas where improvements are most needed, e.g. the response and reliability of services in order to encourage greater use of community-based public transport services.

In the study (Banister, 2008), the opportunities for a sustainable development of the public transport market are studied. The study focuses on the main problems of this activity and on finding a solution to the observed problems; Therefore, the basic theory is based on qualitative detailed interviews with experts. A study conducted by IBM Institute for Business Value in 2010 argues that so-called smart and lifelike cities use information and communication technologies in innovative ways in order to create a diversified and sustainable environment.

Sustainable transport systems are in line with all the main principles of sustainable development: protection of public health and environmental quality, respect for ecosystems, exhaust emission limits, sustainable use of renewable resources and minimal use of non-restorative (Pitsiava-Latinopoulou et al. 2006). The Organization for Economic Co-operation and Development (OECD) regulations relating to the sustainable transport in the environment is considered very important. The European Community is moving towards the implementation of common transport rules by facing two basic problems:

breaking the link between economic development and transport development,

achieving equal development of all forms of transport.

The European Community of Transport Ministries (ECMT) is trying to create an integrated transport system across the Member States and the rest of the continent by analyzing social issues as well as environmental and traffic issues. The World Business Council for Sustainable Development (WBCSD) launched the “2002 Sustainable Mobility Project” in order to determine the goals of a sustainable transport system development.

The study of transport processes with an emphasis on PTC has been improved by the conclusion that the transport system is one of the most complex production systems, according to its organizational structure and technical and technological characteristics.

The system of public transport with all of its performances capacity, speed, efficiency, technology, quality, investment and exploitation costs is very complex. The environmental impact is one of the most important factors. It is influenced by the location, size, and structure of cities, their economy, social Relationships, etc. Optimizing the structure and functioning of cities and their transport systems is a very complex and delicate task with far-reaching consequences in all spheres of life of its inhabitants.

Two basic strategies have been crystallized in the development of the cities: “sustainable development” and “quality of life”. Satisfying these goals is possible by creating balanced urban transport system which would be achieved through a systemic approach in resource management, planning, implementation of new technologies, organization, financing, etc. In the European Union, the achievement of sustainable development and quality of life goals in transport systems is obtained through the conduct of a policy which takes the principle of realization of the mobility of residents with limited use of passenger cars (UITP, 2005), as the basis.

According to inadequate understanding of complex problems of transport mode choice, treatment of the city transport system as a free market, the demand for the pronounced influence of administrative bodies, the strong pressure of various interest groups is a serious obstacle to the generation of solutions that are in the general best interest (Vuchich, 2002).

Based on numerous studies in our country and in the region it can be concluded that public passenger transport systems function in an unregulated transport services market in most cases. The market is unregulated often based on system management according to the concept of “traveler” with a partial or complete absence of a qualitative concept of any kind.

The world passenger transport system development trends in cities (ISOTOPE, 1997) are directed towards the development of a new management concept which results in the quality of service improvement and lowering the costs. The lowering of transport services price is necessary in order to “gain” new users - a condition for more efficient functioning of the overall transport system and preservation of the quality of life in cities.

In relation to other public utility services, public transport is a specific activity because the cost of transport can't be based on costs of investments. Therefore it is necessary to finance the development and modernization of this activity from non-refundable financial sources by the city. Given the increased revenue risk associated with the sale of transport services due to the nature of the activity, in the best interest to resolve conflicts between local authorities and local operators there are various types of contracts based on total costs, net costs, subsidies or hybrid contracts (Mulley & Nelson, 2009).

The system and service quality in the PTC is measurable and represent the potential risks of misunderstandings between service providers, local operators, and local authorities. Establishing realistic and optimal organizational relations between the local self-government and the operator in the application of transport and economic models eliminates most of the financial problems. These problems would substantially endanger the survival and the operation of the public transport system (Murray, 2003).

The processes of world globalization, as well as changes in the political social and economic environment in which cities operate today and their transport systems, require the development of new management methods in the sphere of economic efficiency.

The European Commission seeks to accelerate and increase acceptance of the Sustainable Urban Mobility Plans in local and regional governments in Europe. The 2011 Guidelines Document “Development and Implementation of a Sustainable Urban Mobility Plan” outlines the steps needed to implement them. The implementation of the concept of “smart city” under the slogan “good functioning cities” is gaining more space in the process of managing modern urban subsystems at the same time.

### **3. Public City Passenger Transport (PCPT) model**

The public passenger transport system target function is defined by the size and characteristics of the transport services market in the territory of the local community and the demands from stakeholders in the system in one hand, on the other hand it is defined by the characteristics of the structure, technology and the organization of public passenger transport system. In order to realize the requirements and objectives of the public transport system it is necessary to define which key performance indicators are measured by the performance of the system, how are they quantified, what are the model connections between the defined indicators and the elements

of the structure of the system. Precisely defined indicators allow comparisons in different time intervals, which is one of the prerequisites for quality system management in the aspect of economic efficiency.

Thirteen years of research on the functioning of the city subsystems and its management, in different environments, in the territory of our country, a member of the European Union and abroad, revealed that the establishment of the necessary volume and level of organizational relations in the field of regulation of the transport services market presents a bigger problem than technical-technological procedures on the establishment of functionally capable subsystems.

Cities that desire to develop the distinctive features of smart cities by innovatively using new information technologies build new organizational relationships and create a friendly and sustainable environment suited for the work of all of their subsystems.

Based on sublimated knowledge from examples of such subsystems, the necessary (but not yet sufficient) preconditions for a successful implementation of organizational relationships are:

political will to execute management functions,

the quality of service improvement,

the quality of service improvement,

financial sustainability.

The structure and economic aspects of functioning are analyzed through the prism of local self-government and operators organizational relations within the public passenger transport system framework.

The system of public passengers transport is the basic logistic subsystem of the city and the state which ensures the presence of its users as elements of production and other processes, at the place and in the moment where and when it is needed. As a specific transport system, public passengers transport belongs to a group of organizational-technologically complex and open systems with a stochastic change of state.

The system name itself points to its basic determinants. The system determines that it is a complex component composed of parts which as the result has a greater quality than the combined quality its parts. The system is "public" because it is available for use by all residents of the city on equal terms. The "transport" definition defines that it is a system that is organized to perform "relocation/transfer" role with all sub-processes that help to accomplish this task. And finally, the transport is about people or travelers.

From the basic guidelines, it can be concluded that the system of public passenger transport is a system with a complex structure of several technological and organizational subsystems, which represent an irreplaceable way of the realization of transport needs in the cities. It represents an economic activity that engages large resources invested in the system: vehicles, employees, facilities and equipment, energy, finance, etc., at the same time.

The goal of each local government is the optimal management of city subsystems. The management process itself is a very complex process that envisages the implementation of several sub-processes and activities. For the successful organization and management of the traffic subsystem and in particular the PCPT, local governments have to provide the appropriate environment, which implies the definition of contractual frameworks in the PCPT system, as well as the definition of the type of contractual relations and the manner of implementing the contracting process with the operator. In the interest of smooth management process operation, the city system should be divided into functional subsystems whose analysis is carried out with using of hard - statistical as well as soft - subjective indicators.

The increase in economic power leads to an increase in the mobility of urban residents, but at the same time it leads to problem of increased use of passenger cars, resulting in negative consequences caused by irrational use of resources (urban space and energy), congestion and the decrease in the speed in the transport system, negative consequences from traffic accidents as well as increased negative impact on the environment.

Sustainable urban mobility principle application in synergy with the necessary management processes based on the concept of smart cities in regulating the transport services market and selecting the appropriate transport and

economic model will give PCPT the optimal preconditions for systemic solving of the increasingly prominent organizational issues of modern cities.

The new organizational relations solutions implementation process takes place in conditions of social transition and inevitably faces certain difficulties that hinder the smooth functioning. The most significant obstacles to this implementation are:

technological and practical limitations,

limitations caused by the lack of regulation,

limitations in terms of accepting the principle of sustainable urban mobility and new solutions (resistance to change).

When establishing organizational relationships with the operators of certain urban subsystems, local self-government face a dilemma of the applicability of the smart city concept and the effects of its implementation on ensuring the sustainability of the PCPT as a whole.

#### **4. Modern cities in the global market conditions**

In order to achieve optimal functioning of the city's traffic subsystem, it is necessary to investigate the impact of the implementation of the smart city concept on the public passenger's transport sustainability. As the part of identifying and determining the boundaries of variables, their impacts on the sustainability of the PCPT system must be examined:

The system of public urban passenger transport is a system of complex organizational and technological characteristics. In order to successfully achieve the goals of such a system, it is necessary to specify in detail all the obligations, rights and risks of the system itself as well as environments that may affect its functioning.

The contemporary professional practice the work, efficiency, and functionality of individual city subsystems are monitored and analyzed systematically in the function of the entire organization and realization of the smart city concept.

The natural environment for the manifestation of organizational relationships in the traffic subsystem is the transport services market in a certain territory, which can be regulated or disordered.

The basic goal of each local government in the sphere of public transport is regulated transport services market with the model of the regulated PCPT system.

Regulation of the system and regulation of relations implies the distribution of competencies and responsibilities between entities in the transport services market. This is defined in a clear and comprehensive contract.

The type of contract choice depends on the structure of the system and the costs that are produced in the system as well as the division of risks.

The key risks in this relationship are the risk of the production of transport services and the risk of revenue.

These two types of risks combined with financial risk, planning risks, and environmental risks are the basic accident-related parameters that can jeopardize the smooth operation of PCPT.

The specific position of our country expressed the intention to join the European Union and incompletely harmonized regulations on the one hand, as well as the more articulated wishes of the inhabitants of local communities to make their living space and the functioning of all subsystems of the urban environment sustainable and "friendly" on the other hand clearly impose the need for implementation of a strategic approach to the organization of the transport services market and the management of the PCPT system.

Inevitable Globalization processes have become a natural environment for economies around the world. Modern economy no longer recognizes the information, innovation and capital flow boundaries. Technology improvements meet the desires of consumers who are craving for the cheapest and best quality products (Vivier & Pourbaix, 2005). Regardless of the illusion of the limitless economic space and many opportunities investors

do not forget the fact that the global thinking is combined with "local action" for using all the advantages of the local market. A modern digital economy would be inconceivable without the tools of modern information and communication technologies.

The "smart city" uses innovative and rational of the available technology in order to create a sustainable and diversified environment. New technology influences the operation of all seven city subsystems and enables their more efficient systemic connection. City subsystems are distinguished on their key functions basis:

- People (health, public safety, and education);
- Business subsystem (city business policy and regulations);
- Urban Service subsystem;
- Traffic subsystem;
- Communication subsystem;
- Water management subsystem;
- Energy management subsystem.

City subsystems are in continuous connection and interaction between themselves and with the city environment as well. Optimal operation of the city is actually the result of a harmonious functioning and proper response of the subsystem to management actions. One of the world's most renowned portal dealing with new technologies "Mashable" has defined a list of 25 innovations whose fulfillment leads to the epitome of a smart city. Among other things, there are technical and technological solutions related to water recycling, building management, optimization of public transport, redirection of drivers due to crowds, video surveillance, parking management and information of citizens. All these solutions contribute significantly to the improving the quality of life in urban areas and environmental preservation.

Managing the traffic subsystem of the city is one of the areas where direct and immediate improvement can be seen because broader layers of the population in real time can have a clear picture of the city management actions success. The optimal functioning of public transport is very important within the traffic subsystem. The precondition for successful management of the subsystem is the accurate real-time information availability that is relevant for making good quality decisions. Electronic real-time traffic monitoring systems with the option of issuing tickets in public transport have become an effective solution for removing inconsistencies brought by dynamic changes in the public transport environment.

## **5. Public city transportation system organization and management in the city of Subotica**

Management is a very composite process with multiple subprocesses and activities and involves a systemic approach to problem-solving. Subotica as a city has to form an organizational unit in the form of an expert body that would professionally deal with giving arguments in the field of system strategy in order to operationalize the goals and policies. The expert body must perform tasks and responsibilities from several areas such as research of the transport services market, regulatory frameworks adoption, planning, system design, and development as well as all tasks related to operational management of the system and control of system functioning.

### **5.1. An integral approach in the budget of costs and revenues in the public transport system in Subotica**

When building a model of sustainable urban mobility one must take into account the analysis of the costs and revenues of the public transport system itself as well as on the costs and interests and benefits of the wider community. A sustainable urban mobility plan can't be limited exclusively to traffic it must take into consideration environmental factors, economic development, social equity, health, and safety, etc. The efficiency and cost-effectiveness criteria must not be neglected at the same time. City budgets have been shrinking. In the last few years, this logically leads to a reduction in urban transport expenditure and mobility. Unfortunately, in the City of Subotica, expenditures for these needs are by about 70% lower than in other cities that have similar traffic systems of public passengers transport of by volume, structure, and complexity. With these very strict conditions, the key question is how to achieve the greatest impact with the least spending of resources. An integral approach involves considering costs and benefits, even those that are more difficult to measure such as gas emissions, greenhouse effects or air quality impacts. The European Commission in its White Paper on Transport (2011) emphasizes the importance of internalizing external costs for all modes of transport through

common principles, taking into account the particularities of each type of traffic. (Www.mobilityplans.eu, Plans of sustainable urban mobility - Planning for people).

## 5.2. Costs and revenues in the public transport system in Subotica

Public Company “Subotica-Trans” has been assigned by the city decision to transport passengers in public urban and suburban traffic in the city Subotica, therefore the indicators are taken from the annual financial statements of Public Company “Subotica-trans”.

### Total costs in the public transport system in Subotica

The costs and revenues of the city public transport system are influenced by several factors starting with the quality and structure of the vehicle fleet, the fuel, and energy types and prices, spare part prices and availability, employee salaries, transport service prices, quality of organization and management. When approaching the analysis of the total system cost several different levels of aggregation can be utilized. Costs can be viewed at the level of the entire system of public transport of passengers or at a modular level in order to obtain a clear picture of the participation of individual subsystems in the total costs of the entire system. The criteria for grouping each heterogeneous cost structure should be the nature of costs.

Table 1. Structure of total costs in the public transport system of passengers for the period 2014-2016 (RSD – Republic Serbia Dinar)<sup>1</sup>

No.	Cost Description	2014.		2015.		2016.	
		Realisation	%	Realisation	%	Realisation	%
1	Business Expences	590.040.000	98,64	664.989.000	98,18	679.179.000	98,84
2	Financial Expences	3.491.000	0,58	5.469.000	0,81	1.647.000	0,24
3	Other Expences	3.073.000	0,51	5.668.000	0,84	5.957.000	0,87
4	Expenses based on write-off	1.595.000	0,27	1.184.000	0,17	326.000	0,05
TOTAL Expenses		598.199.000	100,00	677.310.000	100,00	687.109.000	100,00

Table 1. represents the structure of total costs observed by year, it shows that business expenses (operating costs) account for more than 98% of total expenses. Other categories of costs (financial expense, other expenses, and write-off expenses) are practically negligible in relation to costs that are directly attributable to the production of transport services (costs of materials and spare parts, fuel and energy costs, wages and other personal income, Depreciation, etc.).

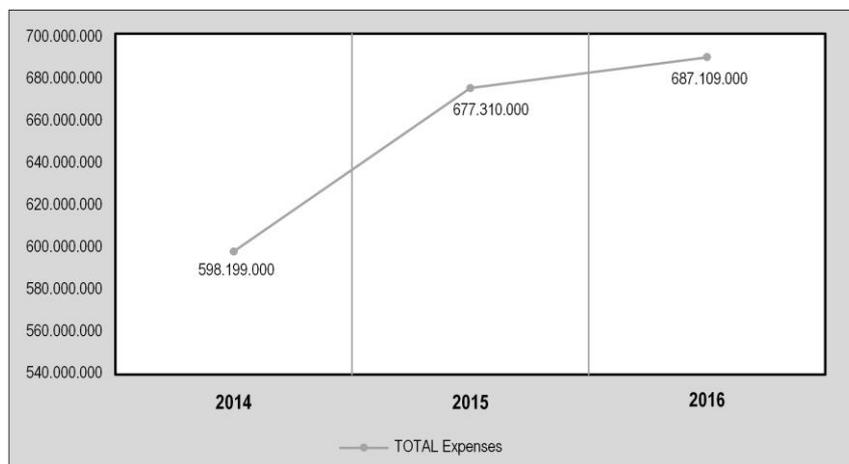


Figure 1. Total expenses in the public passenger's transport system in the period between 2014.-2016.

<sup>1</sup> Data from the annual financial statements of Public Company “Subotica-trans”

The second-largest operating costs group is fuel and energy costs with a participation ranging from 24% to 31%, respectively per year. Such large oscillations in the cost of power generation are the result of an unstable oil and oil derivatives market in the year 2014. and 2016.

The two categories of costs practically represent two-thirds of the total operating costs (operating expenses) of the public urban and suburban passenger transport system in Subotica. Figure 1. shows the business expenditure of the public transport system in Subotica for the period 2014.-2016.

It can be noted that the total costs in the public transport system of passengers in Subotica were steadily increasing in the period from 2014. to 2016. Costs in the system had a positive trend of growth and they were accompanied by the total operating costs in the mentioned period. (Figure 2)

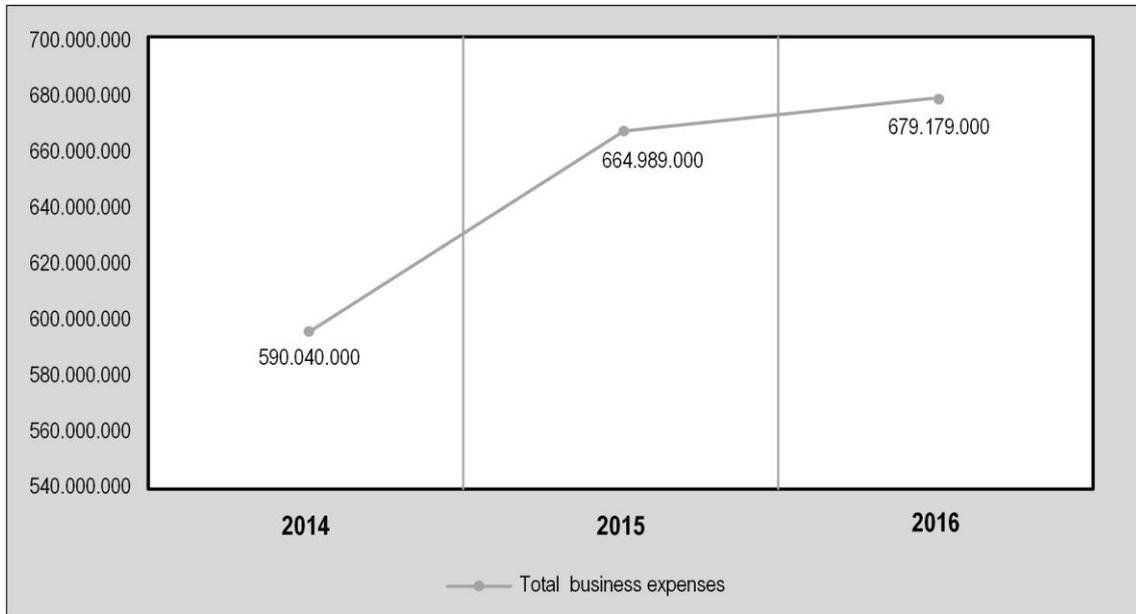


Figure 2. Total business expenses in the system of public passengers transport of in the period 2014-2016.

It is very interesting to notice that the costs of propellant fuel and energy have increased by as much as 24%, which is evidently disproportionate growth trend compared to the number of kilometers traveled (an increase of about 1%) (Figure 3).

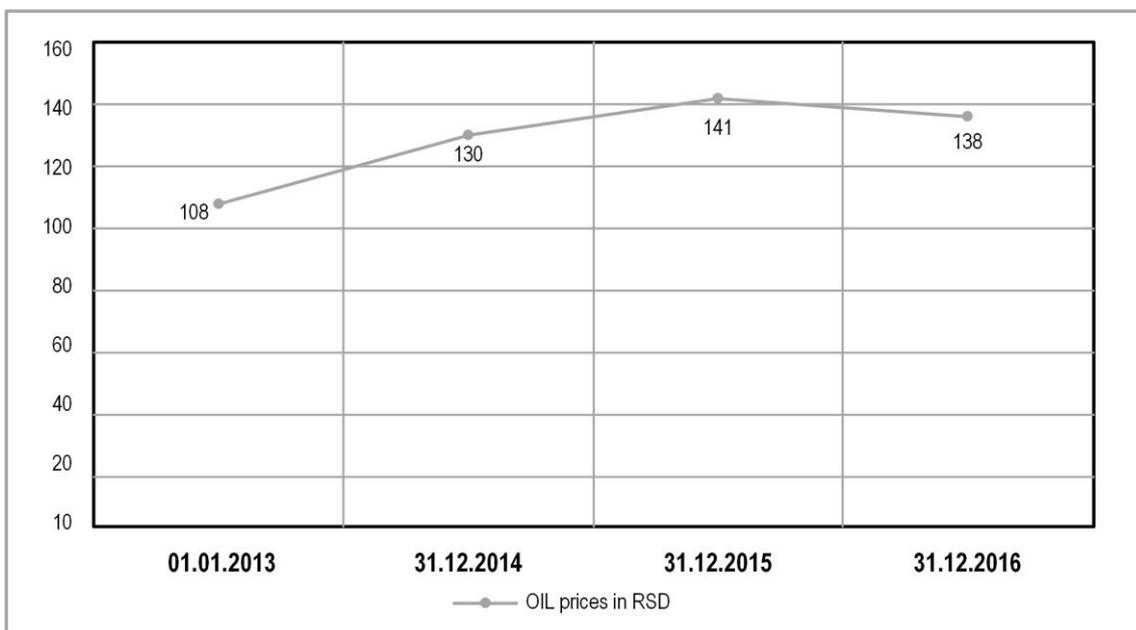


Figure 3. Change in the price of power (oil) prices in "Suboticatrans" for the period 2014-2016.

Taking into account all the facts related to the increase in the volume of production of transport services and their impact on the costs of propulsion fuel and energy, the biggest cause of the increase in this category of costs is a direct consequence of unexpected disruptions in the price of propellant fuel in the last three years (an increase of 28.7%).

The costs of salaries and other personal earnings of employees also had a positive growth trend in the observed period. The number of employees did not change in the same period in the public transport system in Subotica, unfortunately, the system can not reduce this category of costs. These costs still have a very high percentage of participation in business expenses of about 42% in the year 2016.

Acquisition of revenues in transport systems of public transport is one of the most sensitive issues of interrelations between the operator - the local government authority. The guaranteed revenue of the operator that ensures the smooth operation and development of the system is obtained from the following sources: income from the core business (revenues from the sale of tickets, subsidies from the city budget and other sources). This important and sensitive issue is critical to the financial sustainability of the system.

This must not be viewed without a wider context approach and the interest of the social community. Although the local authority under the pretext of saving and reducing budget funds wants to reduce expenditures to cover the real needs of the transport system of public transport. Balanced relations can also address issues of financial sustainability of the transport system as well as the interests of the sustainable urban mobility of the community.

An acceptable transport economy model for all contracting parties must be a motivating factor in adapting the public transport system to modern demands of sustainable urban mobility.

## 6. Conclusions

The non-conflict functioning of the system of public passenger transport includes the creation of the necessary ambiance achieved through the adoption and implementation of regulatory documents for the public transport system.

In regard to the sustainability criteria, neither the planning and risk management of the environment should be ignored:

The planning risk sources lie in the fact that the planning of the centers of attraction, production, and travel is transformed into the separation of the public urban passenger's transport system from the rest of traffic and innovation at all levels of functioning of the system. The risk of planning is essentially the risk of a local government authority that has the necessary capacities to take over that risk.

Environmental Risk: "One of the greatest ironies of the twentieth century is that all over the world we give away invaluable resources such as land, oil, clean air and all in the name of automobile traffic, although most people will never have it available" (Lowe, 1994).

Most members of the European Union use large funds from joint funds for the construction of modern transport systems in addition to technical and technological efforts and a lot of attention is paid to legislation that ensures sustainability. Our country, as well as our cities, they have to adapt the work of their city subsystems, above all the traffic subsystem, the standards of the European Union at the time of approaching the standards of the European Union.

Environmental risk, therefore, becomes a very important topic in relation to the operational authority of the local administration, because of the environmental pollution problem as well as the "greenhouse effect" by the public transport system. In the mutual regulation of organizational relations, a special part must be devoted to stimulating acceptable environmental effects and nonstimulating forms of transport of passengers on the territory of the city harmful to the environment.

Although there are cases in which an operator takes over this form of risk, it is more appropriate that the local government provides support for the renewal of the fleet in accordance with state regulations concerning the environment through the grant of subsidies. Conclusions should state concisely the most important propositions of the paper as well as the author's views on the practical implications of the results.

The structure and functioning concept of the PCPT system today is aimed at implementing a continuous process of future positioning the system in terms of its sustainability and independence by defining the goals that the system seeks to achieve as well as the directions and ways for achieving the goals of the entire system.

The current situation in the transport services marketplaces Subotica in the ranks of unregulated markets (due to the lack of institutional, staffing and regulatory prerequisites). Because of this, it is necessary to undertake certain management actions on market stabilization and management. The conclusion is that an external source of funding is needed through systems such as upcoming liberalization and/or partnerships between the public and private sectors and that there is a growing demand for "responsive" transport systems which is generated by the consumption. Public passenger transportation environment consists of many complex conditions with different technical-technology organizational systems and levels of development and heterogeneous ownership structure.

Our region mostly has disconnected public transportation systems which are going to be replaced with intermodal transportation system (integrated system of ticket sales, integrated luggage management, uninterrupted mobility, high accessibility for physically challenged people) which will include entirely new approach by the transportation operators.

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