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TRANSPORTATION DEMAND MANAGEMENT AS A TOOL OF TRANSPORT POLICY

Summary. This article presents the concept of transportation demand management (TDM) in the EU transport policy context. Authors present the source of transport intensity problems and also show good practices that effectively reduce the transport demand. To identify the major transportation demand problems that cities are faced with, primary and secondary research was carried out. Primary research shows the social awareness of mobility management. Secondary research consists of a thorough review of the existing literature on transport problems faced by cities. From this view, it is clear that transport in relation to the length of the roads in Poland is one of the highest in Europe. This paper also indicates that the current urban policies are often the main causes of suburbanization.

1. INTRODUCTION

It is hard not to agree that the economic growth, employment creation, and prosperity in developing countries require a well-developed and planned transport network. Transport networks are one of the most important part of the supply chain and they form the basis of local economies in all countries. It allows the safety and efficiency of movement of goods, people, and services.

Economic opportunities have been increasingly related to the mobility of people, goods and services. A relation between the quantity and quality of transport infrastructure and the level of economic development is apparent. High-density transport infrastructure and highly connected networks are commonly associated with high levels of development. When transport systems are efficient, they provide economic and social opportunities, and benefits that result in positive multiplier effects such as better accessibility to markets, employment, and additional investments.

Transport was one of the European Community's first common policy areas. In the 1957 Treaty of Rome establishing the European Economic Community, the creation of a single market for intra transport was judged as one of the necessary condition for achieving the “four freedoms”. The mission is to ensure that transport policies are designed for the benefit of all sectors of the society, businesses, cities, and rural areas [23, p. 3].

Construction and upgrading of the existing elements of the transport network require solid coordination of spatial policy and transportation demand management (TDM). The main goal of both is to reduce the demand for transport. The development of transport in urban areas should be strongly connected with the concept of sustainable development [13, p. 39-43].

2. CONSEQUENCES AND IMPLICATIONS IN TERMS OF TRANSPORT POLICY

Development and modernization of infrastructure are very expensive. The European Commission estimated that by 2020 Europe will need between 1.5 – 2 trillion Euros in infrastructure investments.

Between 2011 and 2020, about 500 billion Euros will be required for the implementation of the Trans-European Transport Network (TEN-T) program. Almost half of these investments were allocated in places with the biggest congestion problems.

One of the latest EU document connected with development of transport is the "White Paper"— a roadmap to a single European transport area — toward a competitive and resource-efficient transport system, a new strategy, adopted in 2011, that aims to transform the transport sector through profound structural change. It describes the perspectives of transport in EU by 2050. This document recommends changes in the general strategy. It also presents the overall strategy, and specific objectives and initiatives.

European cities are facing enormous challenges in terms of accessibility and livability. Congestion levels are still increasing. Air pollution and noise disturbs many lives and the desire to live in some of the (inner) cities is decreasing for these reasons. Today, transportation accounts for around one-quarter of EU CO_2 emissions. Scenarios of the European Commission based on unchanged policy and a yearly economic growth between 1.2% and 2.2% show an increase of 51% in personal transport and of 82% in freight transport in the EU during the period 2005–2050 [19, p. 312].

The most important challenges in the economic policy is transport demand. Commission predicts that transport demand will increase by 80% in 2050, just as important is the problem of suburbanization. Definitions of suburbanization exemplify the lack of consensus surrounding the concept of urban sprawl and ways to measure the extent. Bearing in mind that our research focuses on transportation costs, two measurements for sprawl will be retained in our research: density and proximity [22, p. 52].

Transport fuel supply today, in particular to the road sector, is dominated by oil, which has proven reserves that are expected to last around 40 years. Energy carriers as fuels also ensure the security of energy supply to transport by providing diversification of energy sources and suppliers. Reducing the emissions of greenhouse gases such as carbon dioxide could also reduce the amount of harmful air pollutants circulating [23, p. 18-19].

Traffic congestion in urban areas, fueled by economic growth, industrialization, urbanization, and the increase in freight traffic adds to the transport infrastructure barriers and bottlenecks. Different levels of transport policy may give the directions of strong and effective Trans-European Transport Network [1, p. 12]. The significant growth of urban traffic has led to traffic congestion, which is one of the main reasons for diminished productivity and standard of living in cities. The traffic infrastructure capacities are nevertheless physically limited. Therefore, a more efficient use of the current infrastructure is needed [14, p. 676].

Fig. 1 shows the proportion that is significant and detrimental to the quality of transport services. It presents this proportion from the perspective of traffic intensity on the transport infrastructure in selected EU countries.

The values shown in the chart are from 2013 and 2014, and they are presented for international, national, or regional roads. In this view, it is clear that transport of goods in relation to the length of roads in Poland is one of the highest in Europe.

In conclusion, it can be safely stated that the primary and long-term goal of transport policy should be reducing the transport needs and the current goals should be to create appropriate transportation behaviors and rationalization of transport structures. This strategy determines the conditions that ensure the efficient movements of people and goods. This happens when the requirement to reduce the environmental impacts of transport, especially in urban areas, is respected.

3. SUBURBANIZATION AS ONE OF THE MAIN CAUSES FOR GROWTH OF TRANSPORTATION DEMAND

Sustainable development, which leads to a lasting improvement in the quality of human life uses three types of capital: economic, human, and natural. In the economical process, it is important that one capital should be not increased or used at the cost of others. This balance in local, regional, or

global scale is necessary to ensure sustainable development. Unfortunately, the standard of economic efficiency causes this balance not to be properly appreciated and often overlooked [16, p. 9].

Effective economies require a certain amount of transport. This amount is a derivative of the state of the economy, its transportability, and the quality of infrastructure. The demand for transportation determines the modes of transport, technologies, organizational forms, and number of services purchased according to their utility.

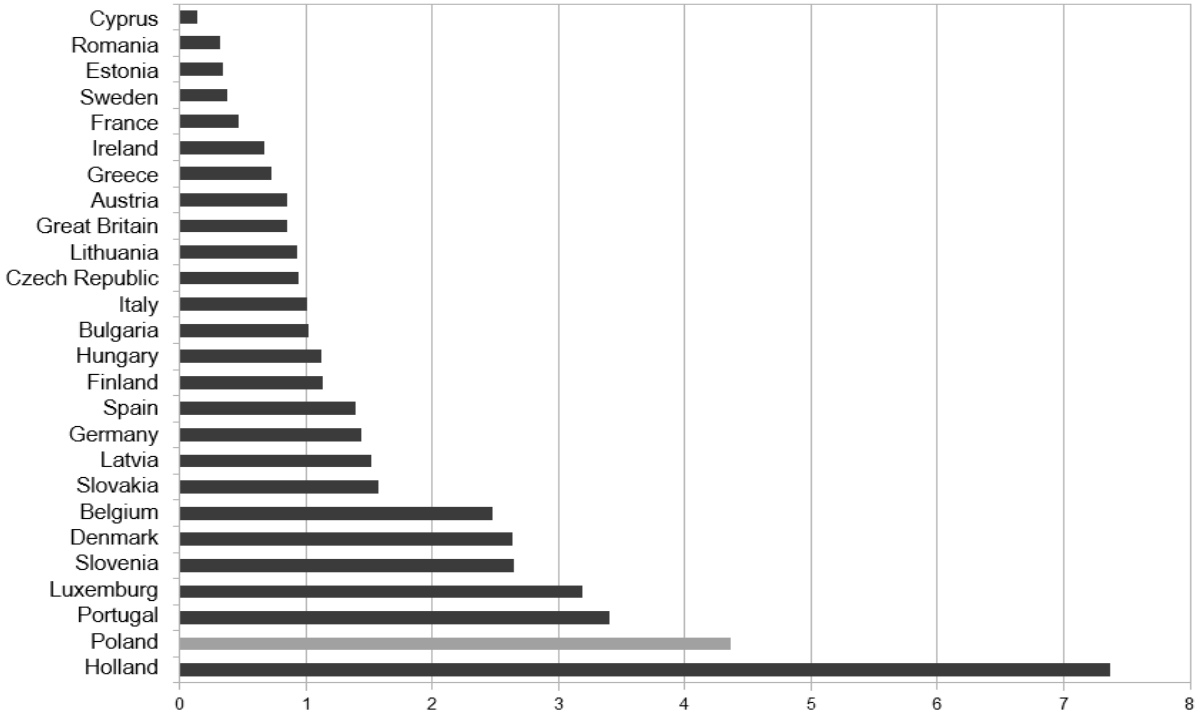

Fig. 1. Transport of goods in relation to the length of roads in the selected EU countries

Transport has developed and evolved as a result of demand for traveling and transport of goods. At the same time, through development, it created new demand for its services. This demand was generally characterized by quantitative and qualitative growth [15, p. 13-15].

Transportation demand is created by some other basic needs. They may be differently classified.

The most important determinants are:

- type of basic needs, which created transportation demands, e.g., work, cultural life, or social relationships
- the necessity to satisfy the basic needs, e.g., the need to go to work and school, and optional, e.g. related to satisfying the needs of recreation or culture
- spatial relationship. It can be specified by direction, names of area units (start and end), functional (home, work)
- the required time of arrival, which means the time of the need for transportation, e.g. transport to shopping centers during the opening hours.

Urbanization is the result of constant development of cities and population growth. This is manifested by the territorial expansion of cities. Contemporary bigger cities exist thanks to the growth of non-agricultural zones in urban agglomerations, conurbations, and the formation of new towns and estates [4, p. 404].

People move to cities where most of the elements of economic and social life are concentrated. It is a world-wide process of different pace and progress in each country. This process shows signs of high acceleration [17, p. 13]. It is connected not only with the progress of industrialization in villages and small cities, but also with the developing services in local centers, specialization of agriculture, and

professionalism of farmers. The development of moto industries and increasing availability of cars have led to an increase of building processes at the borders of existing cities. Suburbanization requires more parking land, leaving less for other uses; some central residents relocate to the suburbs. All of these changes are inefficient, leading to a city with too much road usage, too much road investment, and too much suburbanization, effects that reduce the urban utility level [2, p. 21].

Modern cities are compact, buildings are mostly multistorey. There are a growing number of public, administrative, and cultural institutions. These institutions are centrally located. Residential areas are spread over sprawling suburbs. A typical diagram of urbanization processes connected with populating and industrialization of cities is presented in Table 1.

Table 1

City transformation life cycle

City life cycle		**Directions and pace of changes in population**	
		Center	**Ring**
Urbanization	UA	It grows faster than the periphery	It decreases slower than the population of the center
	UR	It grows at the periphery zone	It grows at a central zone
Suburbanization	SR	It grows slower than the periphery	It grows faster than the center
	SA	It decreases slower than periphery population grows	It grows faster than the center
Counterurbanization	CR	It decreases faster than periphery population grows	It grows slower
	CA	It decreases	It decreases
Reurbanization	RR	It deceases slower than the periphery	It decreases faster than the center
	RA	It grows slowly	It decreases faster

Industrial perspective allows to see cities as business. Indeed – cities are experiencing all phases of the life cycle [8, p. 104]:

- birth and initial development
- growth
- maturity
- decline.

The experiences of the cities that have been most successful in the fight against the negative consequences of uncontrolled development indicate that high quality of the city environment, housing conditions, cultural institutions, and leisure organizations are required in order to avoid the process of counterurbanization. Structure investments that meet the needs of inhabitants are conducive to the sustainable and economic development of the cities [11, p. 135-136].

4. MAJOR ASSUMPTIONS OF THE TRANSPORTATION DEMAND MANAGEMENT (TDM)

Cities need efficient transport systems to support their economy and the welfare of their inhabitants. This is one of the most important goals of the urban policy. Transport barriers lead to barriers in the performance of city functions. Failures of the transport system are able to stop further development of the city [3, p. 69-71].

The major, long-term goal of transport demand policy should be to reduce and direct transport needs. The current goal should create appropriate transport behaviors and rationalization of the transport structures [10, p. 55]. It provides conditions for the efficient movement of freight and people. At the same time, it fulfills the requirements of reducing environmental impact.

Measuring, understanding, and managing transport and transportation demand is an important aspect of sustainable transport. Reducing the transport needs requires adjustments that will be preventive rather than reactive. It is also important to integrate spatial planning with transport planning and mobility. Furthermore, spatial planning should be based on the principle of reducing the need for motorized travel. The position of demand management in the city's transport system is shown in Fig. 2.

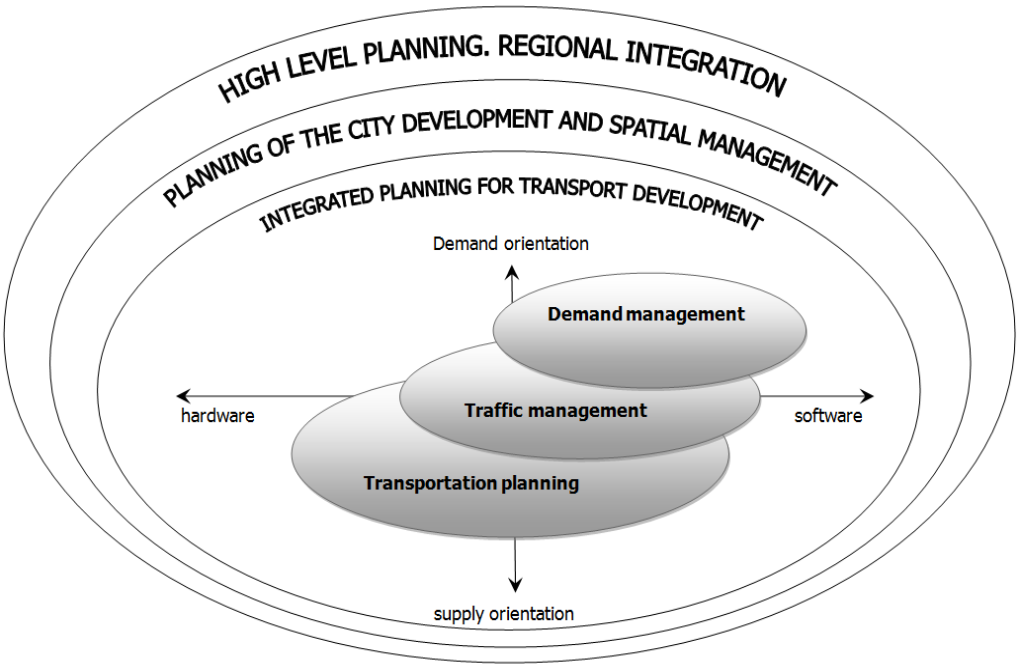

Fig. 2. Position of demand management in the city's transport system [13, p. 39-43]

Research in TDM has focused on the evaluation of the effectiveness of TDM and the development of tools to forecast the impacts. Effectiveness evaluations consist of empirical studies of TDM programs using aggregate data at the regional level or disaggregate data at the individual site level. The objective of these historical evaluations is to report the progress and adjust the implementation strategies. Some of the localized studies focus on before and after studies of individual TDM strategies (e.g., the guaranteed ride home). However, few studies monitor the performance of the TDM effort over time to track the relative impacts. These longitudinal studies could ascertain those techniques and approaches with long-term benefits. Very few of these studies have used control groups (employers or commuters) to determine the relative impact of various TDM strategies under different environments.

Collectively, these studies provide evidence of the effectiveness of TDM programs to reduce vehicle trips by increasing vehicle occupancy, reducing VMT, or both. At the regional level, 3 to 5% of vehicle trip reduction has been reported. At the site level, 20 to 40% of vehicle trip reduction has been achieved, usually through a combination of parking charges and financial incentives. A common transportation goal of urbanized areas is to reduce traffic congestion during weekday peak hours [9, p. 80].

The second major area of TDM research has been the development of tools to predict the impact of TDM strategies. This area has primarily focused on forecasting commuting behavior from data aggregated at the employer level. There remains a need for research at the regional or corridor level. These tools are necessary for integrating TDM in the transportation planning process and developing realistic expectations [20].

5. CHOSEN TOOLS OF THETRANSPORTATION DEMAND MANAGEMENT (TDM)

Adopting a transportation demand management strategy gives challenges for the management of transport. This strategy uses a number of practical tools. These methods give effective results. Most TDM actions have modest individual impacts, typically affecting a few percent of the total vehicle travel in an area. In order to achieve significant total impacts, it is usually necessary to develop a comprehensive TDM strategy that includes an appropriate set of procedures. A comprehensive TDM strategy can have synergistic effects, that is, the total impacts are greater than the sum of TDM measures implemented individually [5, p. 9-11].

For maximum effectiveness and benefits, a comprehensive TDM strategy needs both positive (pull) incentives such as improved travel options and negative (push) incentives such as road and parking fees [3, p. 72]. TDM refers to various strategies adopted to change the travel behavior to increase the transportation system efficiency and also to achieve reduction in congestion, energy and fuel conservation, and savings in parking and road costs, while focusing on the safety and mobility of the road users [7, p. 2].

TDM tools are classified in many different ways. Table 2 shows the scheme that groups these tools according to the instrumental standard. TDM concept requires increasing the participation and safety of non-motorized road users. Alongside the promotion of non-motorized movement such as pedestrians and cyclists, TDM also offers travel systems such as carpooling and carsharing. Most pedestrianisation schemes aim to decrease road traffic in the targeted areas. There is an immediate impact on traffic in the streets where the traffic is restricted and a broader impact on the road that surrounds the pedestrian area where the displacement of traffic may occur [12, p. 98]. Unfortunately, there is not enough data to model non-motorized traffic at the same level of details as motorized traffic. It limits the ability to influence the TDM on transport conditions [6, p. 14].

This newer approach models the behavior and needs of individual transport users, rather than aggregate groups, which improves the consideration of modes such as walking and cycling, the transport demands of non-drivers, cyclistsn and the disabled, and the effects of factors such as parking supply and price, transit service quality, and local land use accessibility factors. Simulation models can provide a bridge between other types of models, since they can incorporate elements from the conventional traffic, economic and land use models [21, p. 46].

6. THE RESULTS OF RESEARCHES IN SELECTED AREAS OF TDM

This chapter presents the selected results of primary research. It shows the social awareness of mobility management. The experience of more developed countries shows that the main problem of transport demand management is not money, but communication behaviors. Communication behaviors, effects of those behaviors are connected with choices and decisions in the city logistics area. This analysis presents the results of the study carried out in 2018 in Bielsko-Biała.

The characteristic feature of urban agglomerations is the rapid increase in the number of private cars, and the poor condition of many commercial and private vehicles. The dynamic development of individual motorization causes a decrease in the number of passengers using public transport and a decline in the profitability of the communication lines. Typical TDM tools such as carsharing and carpooling in Poland are practically not used nowadays.

Respondents participating in the research indicated the possibility of changing the modes of transport or the way of travel. However, they did it on the condition that integration and cooperation of various modes of transport will take place. The distribution of responses to the question: how the integration of different modes of transport could influence the decision on the choice of modes of transport is shown in Table 3.

Table 2

Chosen tools of the Transportation Demand Management (TDM)

Management area	Management tools	Implementation examples
Planning Instruments	Integration of Land Use and Transport Planning	e.g. Transit-oriented developement
	Public Transport Promotion	e.g. Priority at intersections
	Strategies for Non-Motorized Modes	e.g. Cycling policy
Regulatory Instruments	Physical Restraint Measures	e.g. Pedestrian zones
	Traffic Management Measures	ITS
	Regulation of Parking Supply	Maximum parking limits
	Low Emission Zone	In city center
	Speed Restrictions (30 km/h)	In built-up areas
Economic Instruments	Road Pricing	e.g. during peak hours
	Tax Incentives	e.g. for cleaner vehicles
	Parking Pricing	Off- and on-street parking
Information Instruments	Public Awareness Campaigns	e.g. participation in mobility weeks
	Stakeholder Conferences	On transport policy documents
	Driver Training / Eco Driving	e.g. for city drivers
	Promotion of Mobility Management in Companies	e.g. Employer passes, flexible work hours
Technology	Promotion of Cleaner Technology	e.g. Green procurement

Table 3

Modes of transport in choices

The most popular mode of transport	Whether the integration of different modes of transport could influence the decision on the choice of modes of transport?			Together
	Yes	No	Hard to say	
Individual transport	22%	5%	20%	47%
Public transport	14%	4%	17%	35%
Combined transport	11%	0%	2%	13%
Other (pedestrian, bicycle)	3%	1%	1%	5%
Together	50%	10%	40%	100%

Integration of different transport modes would probably change the mode of transport 50% of respondents. Ten percent of respondents are not interested in changing the modes of transport. In turn, 40% of people participating in the research would have difficulty in making a simple decision.

In the next question, respondents were asked for solutions that integrate the city transport system. Distribution of these answers have been presented in Fig. 3.

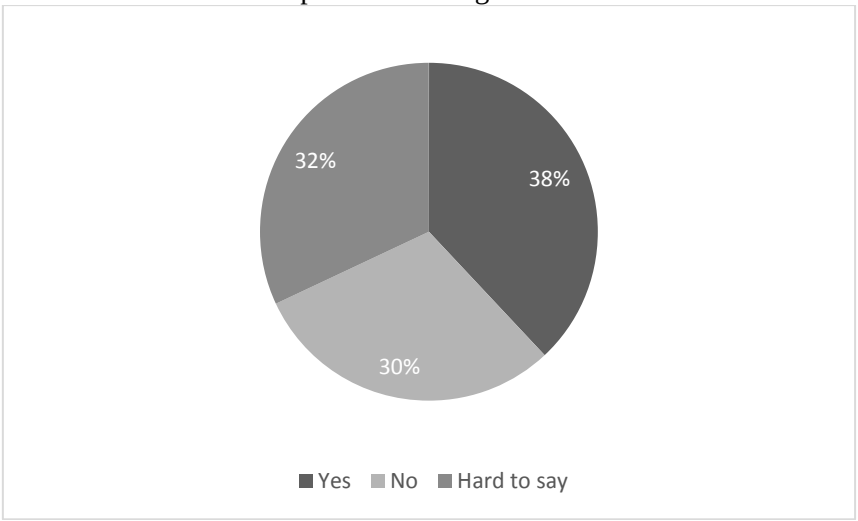

Fig. 3. Knowledge of solutions that integrate the city transport system

A total of 38% of the respondents previously met with methods that integrate the city transport systems, 30% of respondents gave a negative answer, and 32% of respondents did not give a clear answer to this question.

Next respondents indicated specific solutions known to them that integrate the city transport systems and belong to the mobility management tools. The knowledge of these solutions is presented in Fig. 4.

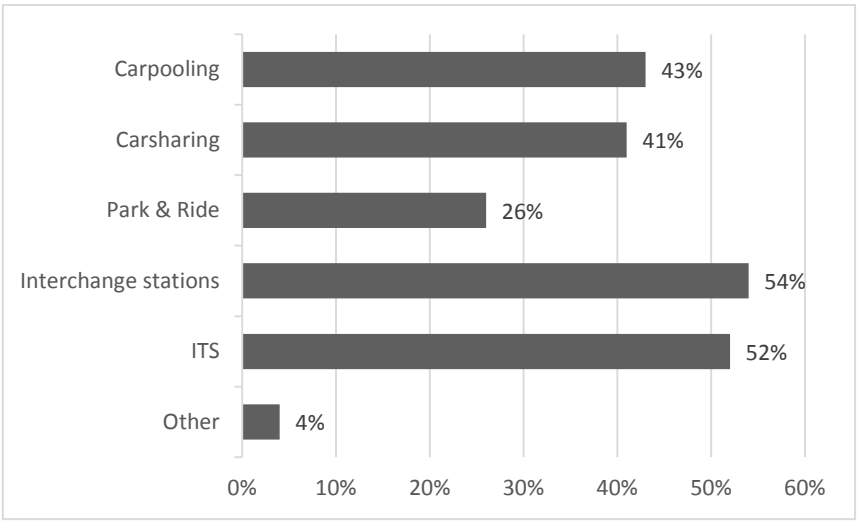

Fig. 4. Knowledge of specific solutions that integrate the city transport system

The most known transport solutions are interchange stations (54% of responses) and ITS (52% of responses). Less known are the concept of carpooling and carsharing. The “Park & Ride” concept is the least known solution. It is known by 26% of respondents, 4% of respondents indicated the “other” tab.

Next, respondents were asked if they ever used websites for carsharing or carpooling travelers (eg www.blablacar.pl). The distribution of responses is shown in Fig. 5.

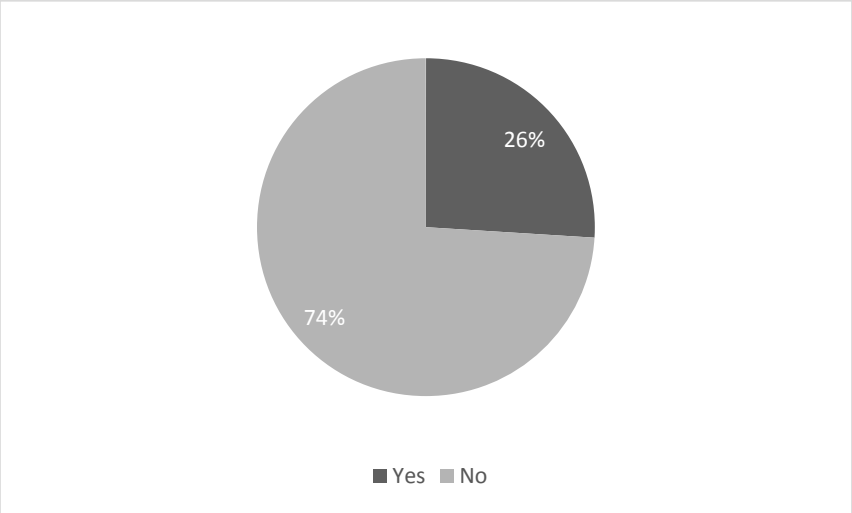

Fig. 5. The use of internet carsharing services

74% of respondents never used that internet services, 26% of the respondents used thematic pages in order to take advantage of the opportunities offered by carpooling and carsharing solutions.

In the last question, respondents were asked about possible reasons for the low popularity of solutions for the integration of city transport systems (carpooling or carsharing). The respondents were able to mark two answers. The distribution of responses is presented in Fig. 6.

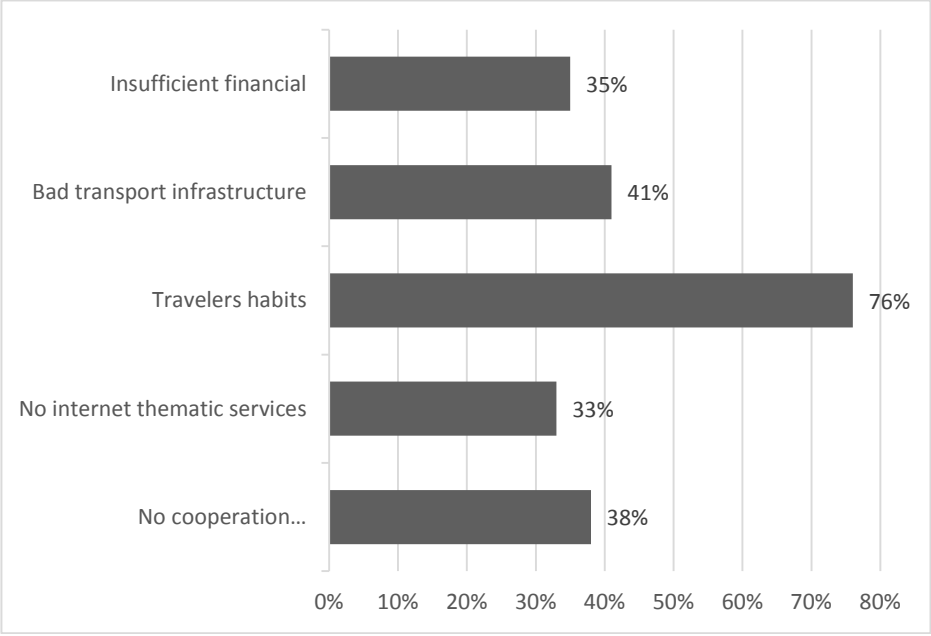

Fig. 6. The reasons for the low popularity of solutions integrating various branches of transport

The main reason for the low popularity of solutions for the integration of city transport systems are the habits of the travelers (76% of respondents), 41% of respondents indicated as one of the main reasons are badly developed transport infrastructure, 38% of respondents indicated the lack of cooperation between the individual transport branches, 35% of respondents returned attention to low financial intended for the promotion of such transport solutions, and 33% of respondents indicated a small number of online thematic services as one of the main reasons for low popularity of solutions.

7. CONCLUSIONS

In this context, we can say that the fundamental and long-term objectives of transport policy should be to reduce the transport demands. In addition – the current goals should be to create appropriate transportation behavior and the rationalization of the transport structure. Such strategy provides conditions to ensure that the required transport flows and reduce the negative effects of transport on the environment, particularly in the urban areas.

The selected research results presented in the article are strong evidence that the basic barrier to the effective operation of transport demand management tools is the ignorance and bad habits of the travelers. Appropriate transport demand management is an important aspect in achieving sustainable transport. Plans, legislation, and programs that create the right level of transport demand have to be long term. Reducing transportation needs requires rules that will be the important part of a coherent transport policy, not only at the local and the regional level, but also at the national and the international level.

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