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Leszek BYLINKO

University of Bielsko-Biala

Willowa 2, 43-309 Bielsko-Biała, Poland

Corresponding author. E-mail: lbylinko@ath.bielsko.pl

THE PRACTICAL IMPORTANCE OF TRANSPORT DEMAND MANAGEMENT POLICY

Summary. This article presents the results of the analysis and assessment of the effect on transport of programs supporting housing investments in the context of transport demand management. The evaluation of the presented programs confirms the dependence of inconsistent spatial planning policy and the growth of transport needs. The effects of the programs have been analyzed in detail. The article shows in a case study form that investment decisions directly affect communication behavior and changes in the demand for transport in Bielsko-Biała. It also presents the analysis and evaluation of the results of the author's studies (own research). These studies included knowledge and behaviors that generate demand for city transport. Analysis of these data allows to conclude that there is no simple relationship between the level of knowledge of travelers about their impact of congestion and shaping the demand for transport, and their balanced behavior in the context of urban mobility - statistical dependence is irrelevant. Numerous experiments show that both factors, transport policy and awareness of social causes in transport problems, have a very strong effect on the demand for transport. The analysis of this research is another argument that justifies the strong need to build and develop a consistent policy in this area.

1. INTRODUCTION

The main purpose of this article is to diagnose, define, and describe selected problems related to the increase in the demand for transport in urban agglomerations. One of the most important reasons for the increasing transport intensity of urban areas, as the research shows, is an inconsistent transport policy conducted at a longer time frame at various levels of the administration. Lack of coherence in such a policy, the criterion of which is the difficult to reconcile interests of residents, economic entities, and the cities themselves, may cause actions that result in a disproportionate balance to the expected demand for transport.

In today's urban mobility landscape, mobility management is growing in importance. The problems of transport demand management and managing the mobility of residents and entities in urban areas seem to be described in detail in the literature on the subject [7, p. 79-98; 6, p. 132-142]. However, there are still many aspects in this area that may have a significant, but not fully examined, effect on the growth in demand for transport and thus transport congestion, which is one of the main reasons for exceeding the capacity of urban transport networks.

This article is an attempt to fill a part of the gap in this research area through analysis and evaluation of selected problems of transport demand, which may be caused by the already mentioned inconsistent transport policy. The work is also original due to the fact that the subject of research in this context has never been with respect to government programs such as "Family on Their Own"

(“Rodzina na Swoim”), “Apartment for the Young” (“Mieszkanie dla Młodych”), or “Flat Plus” (“Mieszkanie Plus”), such that the current urban policies are often the main causes of suburbanization.

The research area for the aforementioned theses was the Silesian Voivodship, whereas the subject of the case study was the city of Bielsko-Biała. The Silesian Voivodship and Bielsko-Biała were selected for several important reasons. The Silesian Voivodship is characterized by the highest absolute number of accidents on roads. Analysis of the death toll rate on both 100,000 population and 100 thousand vehicles shows Silesia has the last position in the country [5, p. 199]. In addition, as research shows, Bielsko-Biała is by far the largest cumulative commuting destination and commuting to upper secondary schools in the southern sub-region of the voivodship and the second in the entire province of Silesia [5, p. 8-13]. The spatial distribution of commuting in the Silesian Voivodship indicates that their largest grouping in the southern part of the province occurs in the Bielsko agglomeration.

2. TRANSPORT DEMAND MANAGEMENT – BASIC PRINCIPLES OF THE CONCEPT

In the literature on the subject, it is assumed that transport demand management is such that its formation results in reducing the demand for travel or its more even distribution, both in time and in space. For better understanding of the economic benefits of transport demand management, it is helpful to analyze transport as a good characterized by demand and supply typical of material goods. The transport infrastructure managers are responsible for the design, implementation and management of the road network, transport services, and regulations related to vehicle traffic. Their planning policies and practices are usually based on the assumption of maximizing supply to increase the intensity and speed of vehicles [1, 19].

Supply is relatively easy to assess by the number of kilometres of toll roads, parking lots, motor vehicles, or travel length. However, measuring the demand for transport may be difficult because it results from the needs of people, their desire to be mobile, and from the needs of enterprises involved in the transport of goods [13, p. 42-47]. The basic goal of the transport demand management strategy is to maximize the efficiency of the urban transport system by systemically reducing unnecessary use of private vehicles and promoting more efficient and environmentally friendly public transport and so-called “No-Motor” [17].

The demand for travel is to a large extent a function of transportation choices realized by urban residents as a result of political and investment decisions of governments. A comprehensive demand management strategy for transport can be shaped within the framework of broader policy objectives, e.g. for the country. Such policy goals including elements of demand management for transport may include the following [11, 2]:

- Shaping the choices of how to travel to achieve broader policy objectives. Demand management tools can meet various policy objectives, such as environmental protection or public health care.
- Promoting more effective ways of traveling. Distinction of travel costs in the schemes of using transport systems and elimination of unnecessary travel, which may increase the economic competitiveness of systems based on the demand management policy for transport.
- Limiting unnecessary car trips. Ensuring safe and friendly travel conditions, as well as ensuring that new solutions improve connectivity with destinations and transfer from passenger cars to other modes of transport.
- Reducing the travel distance. The promotion of more compact urban development models, which facilitates more efficient transport, resulting in greater accessibility of functional areas of the city as well as reduction of transport needs of residents.

Urban areas with a high population density are burdened with an accumulation of passenger’s needs. Traveling to work or school (obligatory transport needs) causes traffic peaks. In Polish cities, optional trips are mainly intensified during the weekend. It is clearly visible that sources of transport needs in the city are mostly scattered, but destinations are concentrated. Additionally, another source of congestion problem in European cities is in the narrow building and a lack of possibilities to expand

transport infrastructure. If the infrastructure is being developed, traffic congestion occurs during the realisation of infrastructure investments. Nowadays, the subject of research is also traffic congestion due to traveling to shopping centers – unfortunately, some of them are located in city centers in Poland, which is the cause of the congestion. What is distinctive for Polish citizens is that trips to shopping centers take place mainly during the weekend, because these centers are also open on Saturdays and Sundays [20, p. 52].

3. LOCATION OF THE URBAN DEVELOPMENT POLICY IN THE CONCEPT OF DEMAND MANAGEMENT FOR TRANSPORT

One of the basic long-term goals of the state transport policy should be to reduce transport needs, and the current goal should create appropriate communication behaviors and rationalization of the transport structure [18]. Such a strategy as the main goal is to create conditions that ensure the smooth movement of people and the carriage of goods, while meeting the requirement to reduce the nuisance of transport to the environment [4, 22].

Reducing the demand for transport within the city in the area related to its spatial development can be realized by the following [8, 9]:

- Transforming urban structures from monofunctional to multifunctional.
- Stimulating concentration, including jobs, in areas well served by collective communication.
- Maintaining the high compactness of the city structure and inhibiting the processes of settlement deconcentration into areas that cannot be effectively served by collective transport.
- The location of intensive housing and the concentration of jobs and services as close as possible to the centers and public transport lines with good conditions for walking and cycling.
- Stimulation of development of multi-functional areas (work, services, and housing).
- Prediction of sites for the location of facilities for the development of public transport and integration nodes including loops, car parks, and “park and ride” (P&R).
- Making dependence on issuing location decisions for new traffic sources on the results of professional analysis of traffic consequences of such a location, such as the location of shopping centers on the main street routes.

Regulations that directly or indirectly shape the demand for transport require a long-term perspective. Limiting transport needs requires spatial plans that are essentially preventing cities from sprawling. An essential expectation is that spatial planning should be based on the guiding principle of reducing the demand for transport, and thus on the requirement to integrate spatial planning with planning of transport and mobility while maintaining the principles of sustainable development [9].

4. SILESIA VOIVODESHIP IN THE STUDY OF TRANSPORT CONSUMPTION OF HOUSING INVESTMENTS

This chapter presents the most important research results that concerned the generation of potential demand for transport by future housing investments. The main thesis was the assumption that the spatial development policy implemented by cities is a key tool for managing demand for transport.

From transport point of view, the answer to the question what planned and future construction investments will have an impact on the choice of means of transport, length of journeys, and duration of these journeys is crucial. Table No. 1 presents synthetic distances planned or implemented as part of the “Mieszkanie Plus” program from points constituting natural traffic generators, i.e. city centers and traffic hubs associated with commuting to work, schools, colleges, etc. It has been assumed that nodal points are stops of public transport or railway stations. Their availability has a decisive influence on the choice of transport means other than private cars.

As part of the housing policy, the administration at various levels undertakes activities that most often have the characteristics of programs in various ways and at various stages co-financing

construction investments or the costs of renting a property. Over the past dozen or so years, these have included the following:

- "Social Building Societies" ("Towarzystwo Budownictwa Społecznego" - TBS).
- "Apartment For The Young" ("Mieszkanie Dla Młodych" - MdM).
- "Flat For Start" ("Mieszkanie Na Start").
- "Family On Their Own" ("Rodzina Na Swoim").
- "Flat Plus" ("Mieszkanie Plus").

The new governmental "Mieszkanie Plus" program was adopted as part of the resolution on the National Housing Program on September 27, 2016. It is worth adding that the criterion of transport accessibility selected for land implementation became an element of the "Mieszkanie Plus" policy only after the amendment of the act, which was adopted in 2019 [14].

The conducted research shows that the policy of transport demand management carried out by the central administration has not changed significantly in recent years. Average, measured by the distance to the main traffic generators, length of potential journeys in the case of the "Mieszkanie Plus" program is about 3 km (in big cities even 4.5 km). A short distance from the point infrastructure of public transport needs to be supplemented with information that, as a rule, these are points that require an increase in both the number of lines and the frequency of running buses (e.g., Chorzów) or trams. It should also be added that most of the locations proposed under the program are communicated with local roads (very rarely -regional).

5. CASE STUDY – BIELSKO-BIAŁA

The analysis of the phenomenon of suburbanisation allows to conclude that the increase in demand for transport caused by the so-called "the spreading of urbanized areas" also starts to include medium and small towns. Bielsko-Biała is an administrative unit with approx. 170,000 residents. The Bielsko Agglomeration, created by the Bielsko-Biała district together with the city of Bielsko-Biała, is an area inhabited by 336,000. people. In recent years, the typical tendency in our country has been a two-track character: a drop in public transport passengers (Fig. 1) and a rapid increase in the number of private cars (Fig. 2).

It may be concluded on the basis of the analyzes carried out that in the last dozen or so years in Bielsko-Biała, under the governmental programs, investments indirectly and directly affect the length of travel within the so-called agglomeration and thereby sanction suburbanization. The observation shows that the locations of real estate were created as part of government programs and land that was included in the spatial development plans of the city as intended for housing development. It can be assumed that the effect of such a policy is the change in population density of individual city districts presented in Fig. 3.

Indirect proof of the suburbanization described above are data on the number of inhabitants of Bielsko-Biała and the Bielsko agglomeration. Although in the past 18 years, the population of the city of Bielsko-Biała, as shown in Table 2, decreased by almost 8,000 inhabitants, the number of inhabitants of the Bielsko County increased by 19,000 residents. Until recently, this tendency was observed almost exclusively in large and very large cities (with at least 500,000 inhabitants). At the present time, it can be stated that a similar phenomenon is also characteristic of medium-sized cities, which creates a threat all the more that it is the basis for claiming that the phenomenon of suburbanization affects urban centers regardless of their size or location in the local system.

The analysis of data results, which was achieved thanks to the "case study" procedure, shows that among the most important conditions that create the behavior of residents of urban areas are the current social conditions.

Detailed later are the results of the research, which indirectly confirm the thesis that in order to change the habits of travelers, it is necessary to have an appropriate state policy in the field of modeling behavior related to the implementation and satisfying the demand for transport, especially where there is still room for creation and management of transport infrastructure.

Table 1

Transport availability of the location of construction projects implemented as part of the „Mieszkanie Plus” program. Own study based on [14]

No.	City	Location (street/quarter)	Number of flats	Distance to a town center [km]	Distance to the nearest public transport stop [km]	Distance to the nearest train station [km]
1	Chorzów	Ul. Legnicka	189	3	0,2	1,5
2	Czeladź	Kondratowicz	375	1	0,3	4,5
3	Gliwice	Ul. Szafirowa	680	4,5	0,2	3,4
4		Ul. Dworska	no data	2	0,5	1,5
5	Katowice	Nikiszowiec	1370	4,1	0,5	2,1
6		Ul. Korczaka	no data	5,5	0,2	1,6
7	Kuźnia Raciborska	Ul. Działkowców	150	0,6	-	1,2
8	Mysłowice	Ul. Wielkiej Skotnicy	no data	1,3	0,3	1,5
9	Piekary Śląskie	Ul. Zygmunta Starego	no data	1	0,3	3,6
10	Tychy	Ul. Oświęcimska	30	4,5	0,1	3,2
11	Ujszoły	Ul. Kwiatowa	10	0,1	-	4,5
12	Zabrze	Ul. Wolności	no data	1,4	0,1	0,9
13	Żory	Al. Armii Krajowej	no data	2,5	0,2	3,5
14	Częstochowa	Ul. Wiolinowa	636	4,5	0,5	4,8
<i>on average</i>				2,57	0,28	2,70

number of passengers (millions)

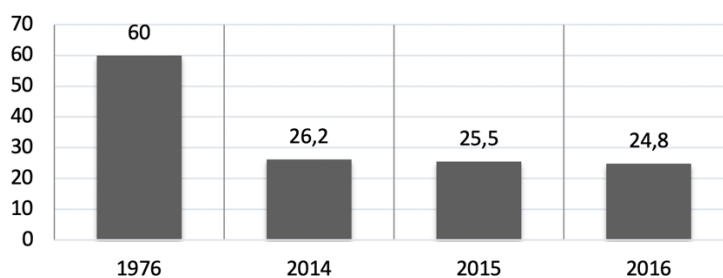


Fig. 1. Number of public bus passengers in the years 1976 – 2016 in Bielsko-Biała. Own study based on [5, 10]

number of cars per 1000 inhabitants

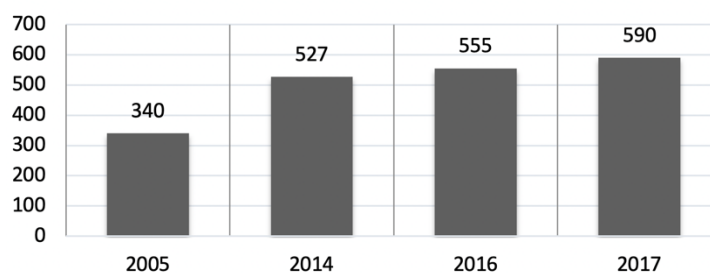


Fig. 2. The number of registered cars per 1000 inhabitants in 2005 - 2017 in Bielsko-Biała. Own study based on [15]

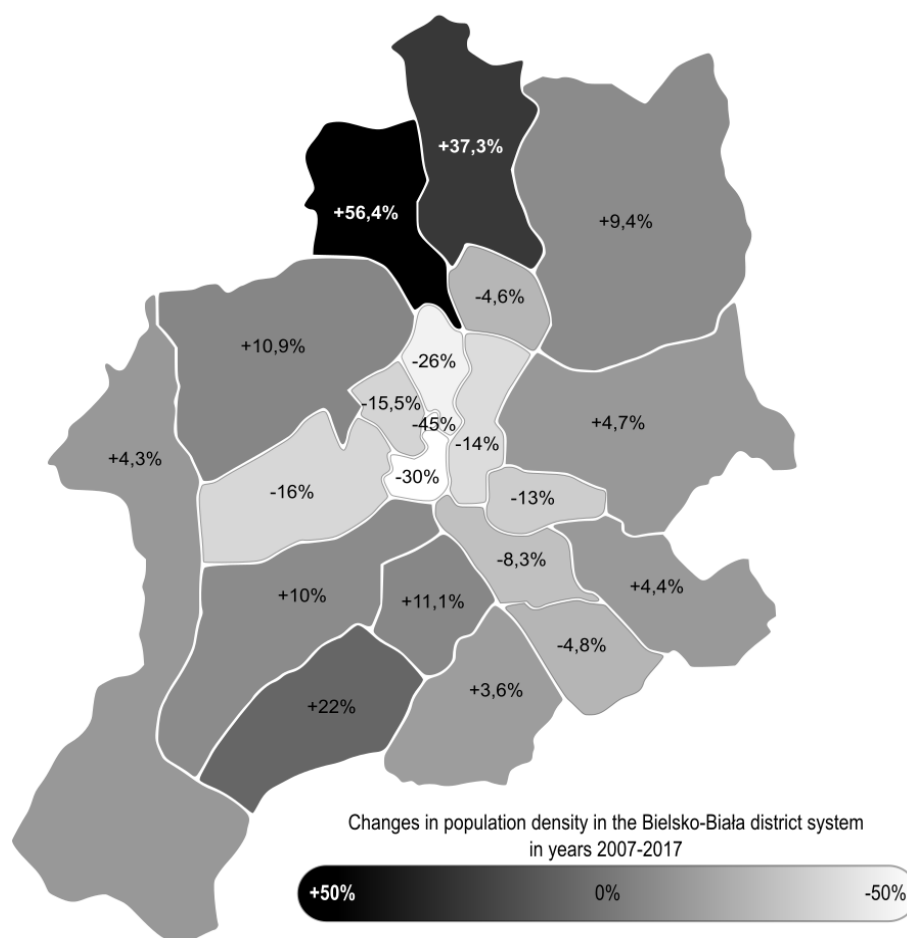


Fig. 3. Changes in population density in the Bielsko-Biala district system. Own study based on [10]

Table 2

Population of the city of Bielsko-Biala and Bielsko County in the years 1999 – 2017. Own study

Years	Bielsko-Biala	Bielsko County	Bielsko and Bielsko County together
1999	178 936	144 922	323 858
2000	178 611	145 772	324 383
2004	176 987	149 361	326 348
2007	175 690	152 695	328 385
2010	174 755	157 119	331 874
2016	172 407	162 495	334 902
2017	171 277	164 003	335 280
<i>difference 1999-2017</i>	<i>-7 659</i> ↓	<i>19 081</i> ↑	<i>11 422</i> ↑

6. KNOWLEDGE AND BEHAVIOR OF TRAVELERS AND THE EFFECTS OF INCREASED TRANSPORT DEMAND - THE RESULTS OF OWN RESEARCH

The subject of the research presented later is the assessment of the level of knowledge and behavior of road users, as a result of which we observe an increase in transport demand. The study covered a group of travelers of different sexes and ages, living in towns of different sizes and also traveling for

different purposes. A survey tool specifically developed for the purposes of this project was used as a research tool. The questionnaire consisted of three types of content:

- Content related to the level of knowledge about transport needs, ways of satisfying them, and the effect of transport on the environment.
- Content regarding views and attitudes of travelers toward the increase in traffic.
- Content enabling assessment of travelers' behavior in relation to their effect on the increase in traffic intensity and suburbanization.

In the survey, the issues were reversed: first, the behavior and attitudes of travelers were examined, and finally the level of knowledge. The idea was that questions about knowledge did not affect the further answers of the respondents.

The study verified the knowledge of residents of urban areas about the effect of the choice of means of transport on the environment and the possibilities of the so-called creating urban mobility. Analyzing the answers of the respondents in terms of their knowledge on the aforementioned topics, the following can be concluded:

- They lack detailed knowledge about the effect of transport decisions on the congestion.
- They definitely underestimate the relationship between the way transport demand is met and the congestion.

Against this background, the awareness of the harmfulness of transport to the natural environment is surprising. However, there are differences in this respect between residents who travel around cities by car and those who travel by public transport. The difference is also visible in the case of residence. Different are the criteria for choosing means of transport for people residing outside the city or its suburbs, and others living near the center.

The analysis of the research results in this part allows to state that the views on road congestion do not result from knowledge about the reasons for the increase in traffic volume and the demand for transport. There are possible behaviors that can be included in the set of tools included in the mobility management group, but this is not related to knowledge about this category of activities. The tools that were asked in the survey are presented in Table 3.

The research, which included behaviors that are implemented by the rules listed in Table 3, showed relationship between knowledge and behavior as two of the elements shaping attitudes. The analysis showed that more important is knowledge about how to behave than knowledge about the harmful effects on urban transport and the environment. This is also a guideline to implement educational programs.

Given that travelers' behavior is far from expectations, this part of the study compares behavior with the level of knowledge of people traveling in the city about the impact of their choices on creating transport demand. The comparison was possible because the number of correct answers and the number of correct behavior cases included in the study were the same. The comparative difference is presented in diagram 4.

Analysis of the data illustrated in Chart 4 (it shows the numbers of correct answers to the questions on the transport demand management tools) allows to conclude that there is no simple relationship between the level of knowledge of travelers about their impact of congestion and shaping the demand for transport, and their balanced behavior in the context of urban mobility - statistical dependence is irrelevant. There is a group of travelers whose behavior corresponds to the state of knowledge, but there are also those who, despite their knowledge, do not behave in this context in a way that balances the demand for transport. There are also those who reduce the necessity of traveling in a natural way, despite the lack of sufficient knowledge. It can be said that the latter do it based on a very generalized belief or intuitively. A high level of knowledge favors behaviors balancing the demand for transport at least at an average level. However, this level of knowledge is presented by a small group of travelers. It is hard to generalize. All this leads to the conclusion that, although such behavior is possible without detailed knowledge, a low level of knowledge usually leads to a lack of such behavior.

In the next part of the analysis of research results, one can observe the level of knowledge and behavior typical of sustainable mobility in specific social and professional groups functioning in urban areas (Chart 5). The graph shows the numbers of correct answers for five TDM instrument groups: planning (A), regulatory (B), economic (C), information (D), and technology (E).

Table 3

Chosen tools of the Transport Demand Management – subject of studies

Management area	Management tools	Implementation examples
A. Planning Instruments	1. Integration of Land Use and Transport Planning	e.g. Transit-oriented development
	2. Public Transport Promotion	e.g. Priority at intersections
	3. Strategies for Non-Motorized Modes	e.g. Cycling policy
B. Regulatory Instruments	4. Physical Restraint Measures	e.g. Pedestrian zones
	5. Traffic Management Measures	ITS
	6. Regulation of Parking Supply	Maximum parking limits
	7. Low Emission Zone	In city center
C. Economic Instruments	8. Speed Restrictions (30 km/h)	In built-up areas
	9. Road Pricing	e.g. during peak hours
	10. Tax Incentives	e.g. for cleaner vehicles
D. Information Instruments	11. Parking Pricing	off- and on-street parking
	12. Public Awareness Campaigns	e.g. participation in mobility weeks
	13. Stakeholder Conferences	on transport policy documents
E. Technology	14. Driver Training / Eco Driving	e.g. for city drivers
	15. Promotion of Mobility Management in Companies	e.g. Employer passes, flexible work hours
	16. Promotion of Cleaner Technology	e.g. Green procurement

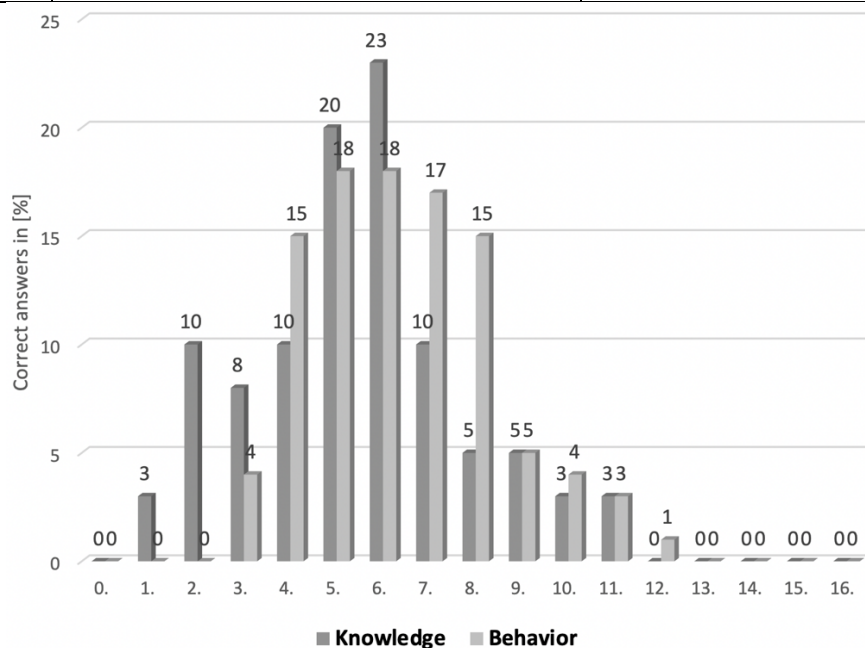


Fig. 4. The number of correct answers to the questions on the transport demand management tools – percentage distribution. Own study

Behaviors balancing the mobility of urban residents also seem to depend on the education, age, and seniority in driving vehicles traveling in cities. Many of such behaviors were also noted among travelers with higher education, and less among drivers with a small (up to 5 years) experience in driving a vehicle.

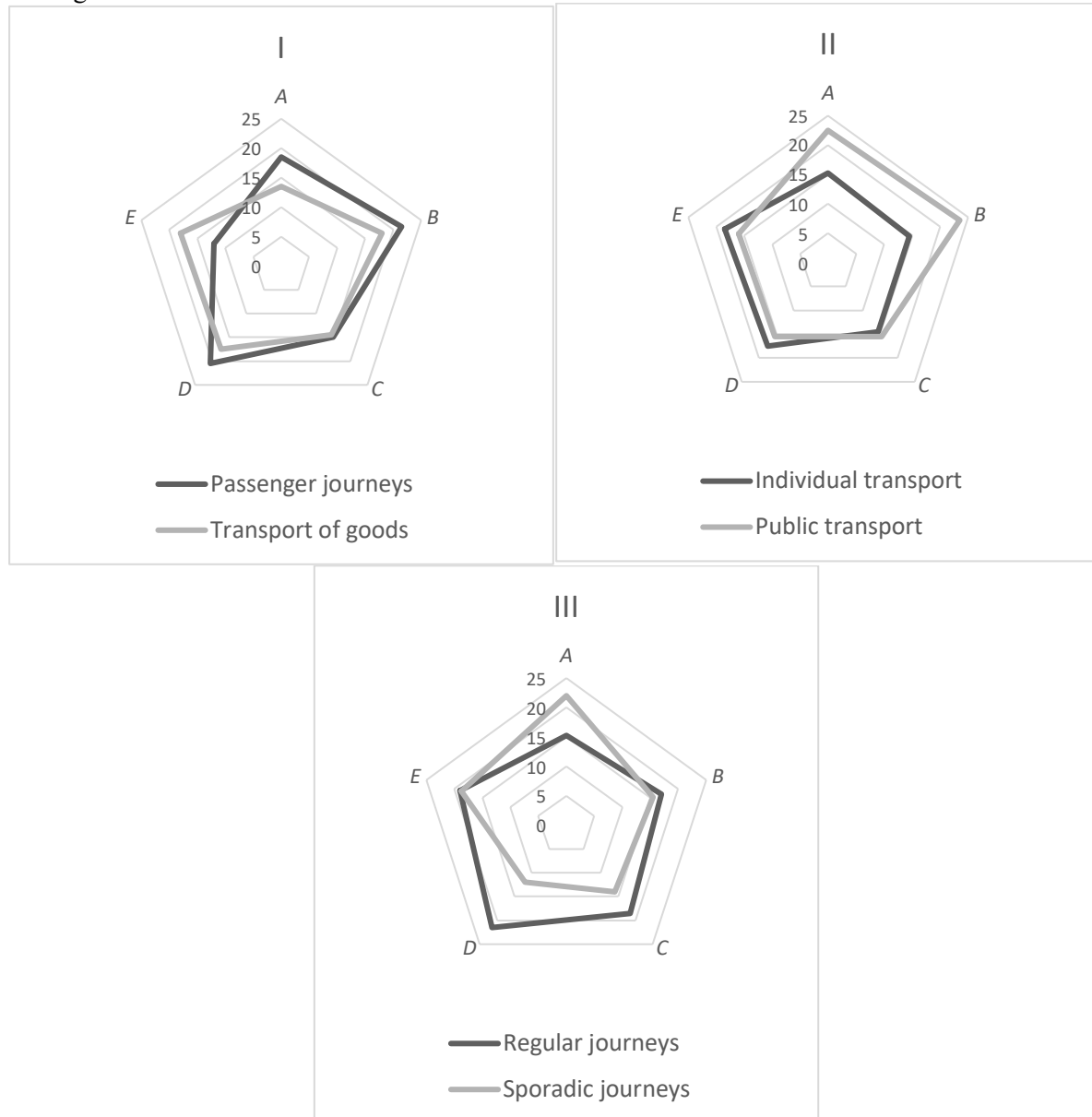


Fig. 5. The numbers of correct answers to the questions on the transport demand management tools in chosen groups of city travelers – percentage distribution. Own study

Characteristic here are the differences, which increase with the greater dependence of social or economic efficiency of urban entities on transport (Fig. 5/I), and therefore also the regularity of urban journeys. Greater awareness of the importance of behaviors limiting the demand for transport can also be seen in those traveling by public transport (Fig. 5/II) and making regular journeys (Fig. 5/III) than those traveling sporadically and using individual means of transport.

7. CONCLUSIONS AND RECOMMENDATIONS

Presented in the framework of this study, elaborations concerning the Silesian Voivodship and the city of Bielsko-Biala confirm the thesis that the problem of increasing the demand for transport within

cities is directly and indirectly caused by suburbanization, which, apart from the obligatory needs, are caused by inconsistent transport and spatial policies. The spatial policy that is unregulated or too weakly fixed in the criteria and restrictions results in an unfavorable change in the size and structure of the trips.

The analysis of the results of the survey leads to the conclusion that educational activities can only be effective in relation to a specific group of city entities. For others, sustainable behavior in the area of urban mobility is possible without proper knowledge. This means that in relation to a certain group of travelers, their behavior in relation to the natural environment is shaped under the influence of factors other than knowledge. The policy of managing the demand for transport appears here as a factor shaping knowledge and forcing specific attitudes.

Changing transport behavior is particularly difficult and time consuming. If mobility means the ability to move about and make transport choices, the role of urban mobility management is to stimulate informed choices and decisions. This can be achieved by e.g., harmonizing land use planning and transport planning, in particular by delivering the concept of compact development in urban areas. This is designed to reduce the use of urban space by transport and bring down the demand for transport and car dependence. Lifestyle changes to adjust to new systems should be geared toward the use of alternative modes of transport rather than the car and to reduce the demand for transport.

It seems that the basic and long-term goals of transport policy should be to reduce the demand for transport. In addition - current goals should be based on creating appropriate mobility behaviors and rationalization of the transport structure. Such a strategy, as experience shows, provides conditions that ensure safe driving conditions and tolerable transport volume as well as reduces the negative effect of transport on the environment, especially in urban areas.

Policy and documents constituting the basis for mobility management and building the transport offer in public transport should be developed at the level of the city council. In Poland, these documents include:

- study of the conditions and directions of spatial development,
- local spatial development plans,
- city development strategy,
- city transport policy, and
- public transport development plan.

Mobility management policy is primarily a city's responsibility. Recognition of mobility planning as the city's own mission makes the transport offer a task of the city administration and representatives of non-governmental organizations. On the contrary, the nature of public transport activity as a public service, satisfying common transport needs, causes interest in its offer on the part of residents.

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