Rubric 4. TRANSPORT ECONOMICS

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APPROACH OF EVALUATION THE EFFECTS FROM IMPLEMENTATION THE PROJECTS OF CONSTRUCTION NEW PASSENGER MAGLEV LINES

Background: the aim of public passenger transportation service systems is improvement of the services quality while the competition between different modes of transport for transportation volumes and routes. Complex and objective evaluation of effects caused by construction of a passenger maglev line require the research of approach, which focused on detecting the changes in quality of public transportation services and anthropologic impact on environment.

Aim: research of the approach, which allow to do comparative evaluation of complex of effects, which appear while implementation the maglev transport into the public passenger transportation service system.

Methods: mathematical statistics, sociological researches, comparative analysis, modelling.

Results: for evaluation of effectiveness of different modes of transport for public passenger transportation services researches the approach to calculation the integrated index of consumer appeal of a mode of transport; for evaluation of practical benefits of maglev transport implementation researched the approach to calculation direct and indirect effects, which are the basis of a cumulative effect calculation. In addition, researched the approach for calculation the additional effects, which allow to evaluate the improvement of transportation accessibility, operational effects and ecological effects.

Conclusion: The approach allows to do objective evaluation of benefits of implementation new transportation mode into the system of public passenger transportation service at particular routes, which is the basis of its implementation into the practice.

Keywords: passenger maglev transport, urban passenger transportation, public passenger transportation services.

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Рубрика 4. ЭКОНОМИКА ТРАНСПОРТА

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МЕТОДИКА ОЦЕНКИ ЭФФЕКТОВ ОТ РЕАЛИЗАЦИИ ПРОЕКТОВ СТРОИТЕЛЬСТВА НОВЫХ ЛИНИЙ ПАССАЖИРСКОГО МАГНИТОЛЕВИТАЦИОННОГО ТРАНСПОРТА

Обоснование: Целью функционирования систем транспортного обслуживания населения является повышение качества оказываемых услуг при постоянной конкуренции различных видов транспорта за объемы и маршруты перевозок. Для комплексной и объективной оценки эффектов, возникающих при возможном строительстве линии пассажирского магнитолевитационного транспорта, необходима разработка методики, которая сфокусирована на выявлении изменений в качестве транспортного обслуживания населения и в антропогенной нагрузке на окружающую среду.

Цель: Формирование методики, позволяющей осуществить сравнительную оценку комплекса эффектов, возникающих при внедрении в схему организации транспортного обслуживания населения дополнительного вида транспорта – магнитолевитационного.

Методы: Математическая статистика, социологические исследования, сравнительный анализ, моделирование.

Результаты: Для оценки эффективности отдельных видов транспорта для транспортного обслуживания населения разработан подход к определению интегрального показателя потребительской привлекательности вида транспорта; для оценки практических выгод от внедрения магнитолевитационного транспорта разработан подход к оценке прямых и косвенных эффектов, которые закладываются в основу расчета кумулятивного эффекта. Кроме того, сформирован подход к расчету дополнительных эффектов, позволяющих оценить улучшение условий транспортной доступности, производственные эффекты и экологические эффекты.

Заключение: В результате разработки и последующего применения методики оценки эффектов от реализации проектов строительства новых линий пассажирского магнитолевитационного транспорта становится возможным объективно оценить выгоды от внедрения нового вида транспорта в систему транспортного обслуживания населения на отдельном маршруте, что создает предпосылки для использования методики в практической деятельности.

Ключевые слова: пассажирский магнитолевитационный транспорт, пригородно-городские пассажирские перевозки, транспортное обслуживание населения.

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INTRODUCTION

Public passenger transportation service systems are formed at large cities and city agglomerations. Their specifics and individuality determined by a complex of factors, and their elements are different means of transport. The purpose of passenger transportation service systems operation is services improvement at the conditions of constant competition for volumes and routes. It causes changes in systems: changes in relationships between the elements and changes in structure. And, despite market entering barriers, systems can expand because of new modes of transport [1, 2].

The newest mode of passenger transportation is the transportation system based on magnetic levitation technology. The development of maglev transportation systems is actively progressing during last decades. Maglev transport implemented in different countries of the world and positively evaluated because its timeliness, economics practicality, social and other important effects [3, 4, 5].

Evaluation of effects from implementation of new passenger maglev lines should focus on detection of changes in quality of public passenger transportation service and anthropogenic impact on the environment [6, 7].

For the purpose of complex and objective evaluation of effects, caused by a construction of passenger maglev line, we researched the methodic, which focused on detection of changes in quality of public passenger transportation service and anthropogenic impact on the environment.

ANALYSIS

One of the key criteria for selection the transportation mode is its usability for passengers, which the methodic of evaluation of effects from the implementation of new passenger maglev lines measures using the integral indicator of customer appeal (IICA). IICA evaluates the place of a transportation mode at particular passenger route. It considers:

- Annual volume of passenger traffic;
- Frequency of time-table;
- Travelling time;
- Number of connections;
- Tariffs.

IICA calculated, counting for value of its parameters, for all the route options of a traffic direction, including direct routes, indirect routes, including connections of different modes of transport.

It is important for IICA calculation to detect the borders of traffic direction, which limit the calculation. In case the methodic of evaluation of

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effects from the implementation of new passenger maglev lines suggested to consider new maglev lines, the borders are attraction zone of a new maglev line route. In addition, the methodic considers the line's end stations and traffic attraction stations [8, 9].

For the purpose of further analysis we build the matrix of passenger traffic volumes and transportation services parameters for all alternative modes of passenger transportation, which implemented at considered direction (Table 1) [10].

Table 1. Example of passenger traffic volumes and transportation services parameters matrix by modes of transport used at a direction

№	Parameter	Modes of passenger transport		
		Metro	***Municipal bus***	***Commercial bus***
1	Annual volume of passenger traffic, K pass	1 000	200	400
2	Frequency of time-table, min	1-3	20	10
3	Travelling time, min	20	45	35
4	Number of connections	0	1	0
5	Tariffs, RUR	45	40+40	50

An example of IICA calculation for all alternative modes of passenger transportation, which implemented at the considered direction, represented at Table 2. An example of comparison of annual passenger traffic volume and IICA, represented at Table 2, by modes of passenger transportation, which implemented at considered direction, shown at Fig. The picture illustrates the dependency of passenger traffic volume from IICA.

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Table 2. Example of IICA calculation for all alternative modes of passenger transportation used at a direction

№	Parameter	Mode of passenger transport								
		Metro			*Municipal bus*			*Commercial bus*		
		parameter volume	***parameter value***	***customer satisfaction***	***parameter volume***	***parameter value***	***customer satisfaction***	***parameter volume***	***parameter value***	***customer satisfaction***
1	Annual volume of passenger traffic, K pass	1000			200			400		
2	Frequency of time-table, min	1-3	1	96.4	20	0.5	63.3	10	1	75.1
3	Travelling time, min	20	1	96.3	45	0.44	68.5	35	0.5714	75.7
4	Number of connections	0	1	100	1	0.5	100	0	1	100
5	Tariffs, RUR	45	1	74.7	80	0.56	67.9	50	0.9	67.6
	IICA	**367**			**150**			**279**		

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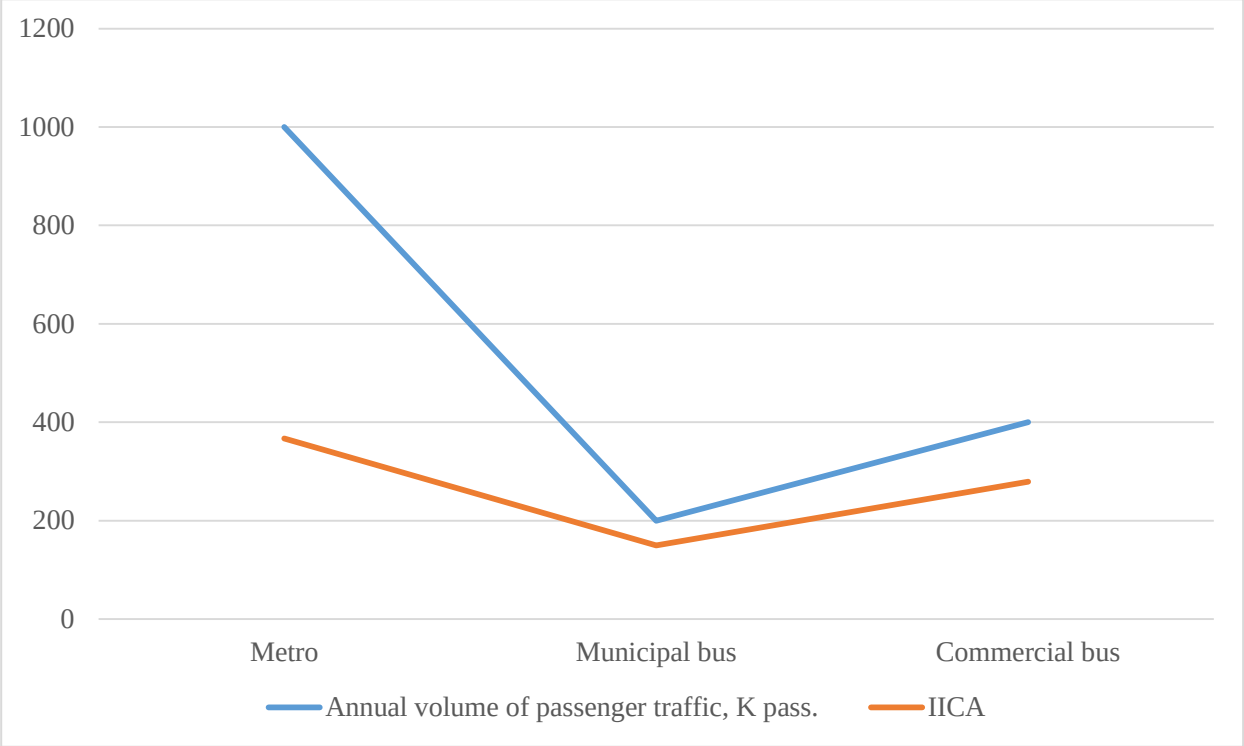

Fig. Example of comparison of annual passenger traffic volume and IICA for all alternative modes of passenger transportation used at a direction

Considering the fact that demand for a particular transportation mode tightly correlates with IICA volume in comparison with alternative travelling options, we can make some conclusions:

1. IICA of a new transportation mode at the considering direction should be not lower than IICA of alternative transportation modes if the implementation goal is not the attraction of considerable passenger traffic only but and operations profitability;
2. Maximization of IICA reached by optimization of key parameters for each of designing route and based on complex analysis of social researches and competitive advantages of existing modes of transportation.

If IICA of maglev transport reflects the objective advantages of its operation in comparison with alternative modes of transportation, then the practical advantages from its implementation could be evaluated with a use of direct and indirect (additive) effects.

The basis of direct effects calculation is quantitative evaluation of passenger migration to maglev transport. This requires, first of all, the defining of parameters of the line attraction zone: volume of passenger traffic at other modes of transport, volume of private car users, which can switch to a public transport in case of fulfillment of the requirements – changes in travelling time, number of connections, tariffs. The evaluation of passenger migration volume based on the results of social researches.

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The size of geographical area of a line attraction zone for public transport passengers influenced by parameters of IICA – mainly costs and time. For a shaped attraction zone IICA calculated for all actual modes of transport, including maglev transport. The switch of passenger traffic to maglev transport comes proportionally to its IICA.

While considering private car users detection of the attraction zone depends on time parameter and comparative cost of travelling. Number of private car users, switching to maglev transport, calculated on the basis of number of passengers, who are prepared to switch to a public transport in case of improvement of travelling quality by time and cost parameters and car average load.

General effect for public transport passengers is improvement of the travelling comfort level. The effect appears as a result of transportation services supply growing, and it leads to decreasing the load of vehicles.

The effect evaluation accomplished on the basis of data on peak load of vehicles at existing public transportations services lines and calculation of passenger traffic migration between different modes of transportation.

For other modes of public transport the positive effect from passenger traffic migration is peak cut, which results in decreasing the demand in additional vehicles, which operates successfully at rush hours only.

The effect calculation accomplishes on the basis of defining the required amount of vehicles, counting for peak requirements after passenger traffic migration, and defined level of vehicles load at the level not higher than current – before passenger traffic migration.

A direct effect for road network is decrease of vehicles amount influenced by the reject of private transport passengers for maglev transport.

Effect evaluation accomplishes as a ratio of private cars passengers migrating to public transport to average cars load in the region / city. The effect calculates for main push-pull migration routes only.

Additive effects appearing causes by rebalancing of public passenger transportation service system. The values of IICA components for other modes of transportation change as a result of maglev line implementation [11, 12].

Effects, caused by maglev line construction, affect passengers, other modes of transportation, traffic intensiveness at road network, which shown at Table 3.

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Table 3. Content and characteristic of direct and indirect effects caused by maglev transport lines construction

№	Effect	Effect type	Calculation rule
1	Travelling comfort level change	direct	Average vehicle load at rush hour after maglev line implementation to the rate before
2	Rolling stock (vehicles) demand change	direct	Rolling stock at a route, including the reserve amount, after maglev line implementation to the rate before
3	Traffic at road network change	direct	Time to pass the narrowest place at a route after maglev line implementation to the rate before
4	Push-pull migration cost change	indirect	Unit cost of a tariff after maglev line implementation to the rate before
5	Non-productive national costs change	indirect	Unit cost of a trip (calculated in a connection to average salary) after maglev line implementation to the rate before

The results of calculations for each mode of transport are the following properties [13]:

- investments effectiveness indicators (NPV, IRR, payback period);
- integral indicator of customer appeal;
- cumulative effect.

The cumulative effect calculates as direct and indirect effect values intersection. Positive impact of new line to increase of public passenger transportation services reaches if the effect value is less than 1, negative – if greater than 1. In case of alternative options comparison, the most attractive option is the one, which has the lowest cumulative effect value.

The methodic integrity provides by calculation of the following additional effects (Table 4).

Table 4. Additional effects caused by maglev transport lines construction

№	Effect	Entity	Calculation rule
Transportation accessibility parameters improvement			
1	Number of citizens provided with higher-speed urban public transport	Improvement of agglomeration transportation accessibility with higher-speed urban public transport	Population of line attraction zone
2	Connection with city agglomeration time decrease	Reduction of time, needed for a trip to city aglomeration	Difference between travelling time of existing transportation lines and maglev line
3	Capacity at the connection with city agglomeration change	Public transport passenger-seats supply increase, comfort level improvement	Difference between actual and potential (future) traffic capacity, changes in vehicle load at rush hour

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№	Effect	Entity	Calculation rule
		Operation effects	
1	Capacity	Public transport passenger-seats supply	Calculated parameter
2	Dotation amount	Dotation amount on compensation of losses from tariffs regulation	Difference between discounted (subsided) tariff and base tariff, multiplied to discounted passengers traffic forecast
3	Incidents decrease	Incidents decrease cause by traffic decline	Multiply of incidents on 1000 vehicles and decline of vehicles
		Ecological effect	
1	CO_2 emission reduction	CO_2 emission reduction caused by: - decline of car run because of passenger migration; - decrease of rolling stock	Multiply of CO_2 emission standard value for different vehicles, length of car and bus routes, volume of car and bus use decline
2	Other pollution reduction (dust, heavy metals), acoustic pollution reduction	Emission reduction caused by: - decline of car run because of passenger migration; - decrease of rolling stock	Multiply of emission standard value for different vehicles, length of car and bus routes, volume of car and bus use decline

The assembly of descried effects allows to evaluate the advantages of new mode of transportation implementation to the system of public passenger transportation services at particular route objectively, which creates conditions for the use of the developed methodic in practice [14, 15].

CONCLUSION

The developed approach of evaluation the effects from implementation the projects of construction new passenger maglev lines is a universal tool for the evaluation of transportation projects implementation at particular routes (lines) effectiveness. The values, described at methodic, focused on maglev transport, therefore some aspects (like emission) ignored at calculations. The use of the methodic for different modes of transport requires the adaptation of values accordingly to the specifics of a transportation mode.

The methodic is recommended to use for the analysis of options of public passenger transportation services organization at mainlines.

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The authors make it expressly clear that:

1. No conflict of interests has taken or may take place;

2. The present article does not contain any researches with people as the objects involved.

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