ECONOMIC ASSESSMENT OF TRANSPORT MOVEMENTS OF THE URBAN POPULATION IN AGGLOMERATIONS

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Resume

The article deals with the problem of estimating criteria of the road traffic quality used in domestic (Belarus) and foreign research works. Each separate property of the road traffic, as well as their entire set - the so-called "quality", can be assessed by means of losses - the smaller the loss is, the better the property and the higher the quality are. Evaluation using losses, which are expressed in money, is very convenient and clear, since it allows comparing contradictory properties of road traffic not only the each other, but the costs' expenses involved in their improving, as well. The value of the costs estimate of the time spent by a user in the process of travelling has not been officially established and is the subject of research. The proposed methodology makes it possible to assess, not only the quality of the road traffic in general, but its main components, as well, for example, traffic management or road conditions. It has been proved by methodology implementation findings on the streets in Minsk.

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1 Introduction

The problems of motorization are relevant for many countries, including Belarus, where, according to expert data, the road transport currently provides more than 70% of the volume of passenger traffic and more than 74.5% of the volume of freight traffic and the high social importance of passenger road transport is due to the fact that it provides 85% of work trips in cities. In the urban passenger transport system, the key participant is the resident facing the need to commute [1]. Human activity is determined by the presence of many alternatives of travelling (the ability to choose the method and route of transport), as well as the target function (minimization of costs associated with travelling, quality of transportation/trip). The choice of people is determined not only by the costs and time of travel, it also depends on reliability of transportation provided.

It should be noted that the use of individual means of mobility changes the structure of road traffic, redistributes passenger traffic in favour of a new type of traffic. It allows reducing the intensity of using car traffic and public transport, unclog the road network and increase the speed of traffic flow, improve the qualitative characteristics of public transport, reduce the so-called haulage time and to increase the efficiency of its use, to improve the overall road safety. The variability of the duration of a trip is peculiar to all the types of transport, although it is most clearly manifested in the urban road transport. It often results in significant additional time spending for the population. At the same time, there are still no methods allowing conducting a comprehensive economic assessment of the costs associated with the time of travelling by urban public transport. It is obvious that implementation of measures and projects to improve the work of urban public transport and to develop the transport infrastructure and traffic conditions in cities causes changes in the conditions of the land transport movement and directly affects the time spent by users of the urban public transport for travelling. Accordingly, the reduction in total travel time leads to the possibility of using the resulting savings in a more efficient way. Thus, one can say that the travel time is for the most part an overhead time in a person's life. Hence, there is an interest in minimizing the time spent on transport movements in cities.

Currently, it is necessary to develop a methodology for assessing the costs associated with the time of travel by urban passenger transport and the reliability of the urban transport system. This will provide an adequate assessment of the effectiveness of investments in the implementation of projects to organize the road traffic and improve the work of urban transport systems.

Losses can be used to evaluate both the individual characteristics of road traffic as well as the overall collection of those characteristics, or so-called “quality”; the smaller the loss, the better the characteristic and the higher the quality are [1-2]. Evaluation using losses that are expressed in money is very practical and straightforward since it enables comparison of opposing characteristics of road traffic not only to one another but also to the costs associated with their improvement. [3]. Obviously, when assessing the quality of the road traffic, those costs must be compared that cover all the aspects of the urban transport system.

The value of the loss costs estimates of the time unit by the user in the process of travelling has not been officially established and is the subject of research. The proposed methodology makes it possible to assess not only the quality of the road traffic in general, but its main components, as well, for example, the traffic management or road conditions.

2 Literature review

The system of the road transport fulfils 2/3 of the total volume of transport services. 8-10 % of the working population is involved in the road traffic services. Each person deals with the road transport system for about one hour per day on average, it means they spend up to 7% of their active time. Consequently, the road transport together with the road traffic serve as one of the most important life-sustaining environmental systems in modern society [1-2].

Due to the gigantic scale and other peculiarities of the road traffic, even minor drawbacks in its work cause enormous losses in economic, environmental, safety and social spheres. As far as the shortfall in work of Belarusian road traffic is quite significant today, the losses are so great that they affect the development of the state and the population wellbeing.

According to the UNO report on studying urbanization prospects, about 66% of the planet population (6.5 B people) will live in cities by 2050. At the same time, according to the World Bank, 80% of gross domestic product is generated by cities, they are the heart of economic and social interaction [2, 4]. Transport systems play a crucial role in the development of urban areas, as they are an important component of Public Economics: transport systems ensure the mobility of the population, expand trade and business opportunities. Transport increases the competitive ability of cities, improves the economic environment of regions and living standards.

People’s choice of transport is conditioned not only by financial and time losses, but by the comfort and safety of travelling, as well. The use of personal mobility devices changes the structure of travel, redistributes a passenger traffic flow in favour of a new means of travelling, enables to unload the road net and to increase the travelling speed of a traffic stream, to improve the qualitative indicators of public transport functioning. Personal mobility devices also makes possibility for reducing the so-called “transportation time” out of the common time budget and to advance the efficiency of their use, to improve the overall road traffic safety.

Increase in the number of personal cars causes traffic jams and boosts the number of car accidents. It brings on emissions of harmful substances and greenhouse gases into the atmosphere, increase in noise level. All of these deteriorates the road traffic quality as a whole.

Problems of motorizations are of great current interest for many countries, including Belarus. In the system of urban public transport, a city resident is a crucial participant who faces the necessity to commute. Person’s activities are conditioned by many alternatives of travel (an opportunity to choose the means and routes of travel, type of vehicle), as well as by the target function (costs minimization connected with travelling, the quality of travelling) [5-7]. People’s choice of transport is conditioned not only by financial and time losses, the comfort of travelling, but it depends on the safety of transportation. The variety in trip duration is unique to all modes of transportation, although it is most visible in urban road transportation. It frequently leads in significant extra time spent by the populace. At the same time, no tools exist for undertaking a full economic assessment of the expenditures connected with the time spent traveling by urban public transportation.

It is obvious that the implementation of measures and projects to improve the work of urban public transport and to develop the transport infrastructure affects the time spent by the users of urban public transport on travelling. The reduction in total travel time leads to the possibility of using the resulting savings in a more efficient way.

One must distinguish economic losses in road transport from those in the road traffic, though they are closely connected. Losses in the road transport system - are the total losses in all the subsystems, including the road traffic system. It is common knowledge that the road transport system includes such subsystems as roads, means of transport, automobile transportation, protection of rights, motorway service, personnel training, etc. In all of these subsystems great economic losses can be found, which are connected with the following:

- production prime costs (including service) - practically everywhere in Belarus due to the outdated equipment, faulty technologies, the quality of the labour force, transportation process expenses etc., the production prime costs are much higher than in the mature developed economies;

- not the best possible decisions are made - there are not the best road locations, wrong location of fuel stations, prolonged time periods of construction, reconstruction or repair work, etc.;
- the second-rate reliability and short exploitation time period of the products used in the road transport infrastructure - technological machines and equipment, tools, training systems, etc.
- An important role is played by the quality of final products and services, which are produced in the road transport infrastructure, but they are revealed already in the process of travelling: the quality of roadway paving, of vehicles, of management systems, personnel training, etc. One can easily notice that the quality discussed, together with the faulty traffic process control, is one of the main causes of economic losses in the road traffic. Those losses are associated with optional expenses of the traffic process that are mostly of economic value. They are the following:
- delay (time loss) of transport through reducing the speed of movement or through an unwanted standstill in a street and road network;
- coming to a full standstill, which consists of such stages as putting on the brake, the standstill itself, starting the movement and accelerating;
- excess mileage in all of its forms;
- excess fuel consumption through an unfavourable brake-release mode;
- accelerated vehicle and road surface wear through an unfavourable brake-release mode;
- pedestrians' delay (time loss);
- pedestrians' excess mileage;
- delay of passengers (they are taken into account as a part of the delay and excess mileage of transport).

The list above discusses the so-called immediate expenses. However, there are also the mediate (direct) expenses such as, for example: loss of profit by traffic participants due to unplanned traffic delays, losses of profit in related sectors due to failure to deliver duties, loss of expected gain due to partial use of opportunities, etc. All of the above results in enormous economic losses.

All the processes in the road transport system can be roughly divided into two stages - preparation for travelling and the travelling process itself. During the first stage, all the necessary infrastructure is created: road construction and maintenance, production (or acquiring) and maintenance of vehicles, creation of management systems, personnel training, etc. At the second stage, passengers and cargo are relocated in the created conditions. Obviously, very significant expenses are required at the first stage - the so-called expenses in the infrastructure. Of no less importance are the expenses of the second stage - travel (relocation) expenses: time losses, fuel consumption, road and vehicle wear, emissions, car accidents, etc. And one more thing. Road traffic caters for all the spheres of our life, all the country's population takes part in it, our roads, streets and facilities are public ownership. For these reasons, transport maintenance costs are considered as public, whole-of-government, nationwide. That is why any loss in the transport system, regardless of the reason, consequences or casualties, is a national loss. As a result, any losses in the road transport or road traffic systems, regardless of the fact whether we know about them or not, turn out to be our own losses. Consequently, all of us are extremely interested in the decrease in these losses.

The notion "transport maintenance costs" has several meanings. In its first meaning, when we speak about the huge regional or national road transport systems, it usually denotes an overall costs taking into account all the components of the system. A noteworthy detail is that while choosing means of travelling, people assume not the physical time losses, but base on a psychological assessment of the travel duration. Therewith, the psychological assessment of travel duration is inadequate. For this reason, a notion of overhead (total) costs of time is usually used, which is obtained in view of weighing coefficients of a psychological assessment of travel duration. Such approach to calculations suggests that the coefficient value does not depend on the time period and travel conditions. Apart from the time period, the psychological assessment of travel duration is also influenced by individual psychological peculiarities of a person, his physical well-being and conditions of travelling [5, 8]. People can estimate actual time losses in an adequate way or not, over- or underestimate the value. It means that while choosing the technical and technological maintenance of transportation processes to get adequate results, one should take into account the combination of factors, which determine the time spent by the users of urban public transport on travel and influence the psychological assessment of its duration. The value of monetary estimate of a time unit loss while travelling is not discovered in Belarus yet. It is a subject for research. To sum it up, the travel time is mostly overhead time of a person's life. Therefore, it is of great interest to minimize the time losses while travelling around a city [5].

Value of Travel Time Savings (VTTS) is the most important factor in assessing the profitability of investments in transport infrastructure [9-11]. Becker [12] and DeSepra [13] were the first to find a solution in the field of economic theory of time assessment, drawing the dependence of time allocation on a consumer choice, based on utility maximization and taking into account the restrictions on income and the minimum time required to perform any actions. They used a variety of methods to assess people's preferences to pay for time savings. Where it was possible to observe behavioural patterns, for example, the choice of a mode of transport or route, as well as to track other random factors, ratings were derived based on the revealed preferences. The most commonly used methods are those of

Table 1 Determination of VTTS valuation by different experts

Source/Researcher	Value of Travel Time Savings (VTTS)		Remark
	For business and work trips	For educational/cultural/ personal (for recreation) trips	
Venables [18]	61% of the gross costs of hiring or 85% of the employee's gross salary		Applied to the French accounting system
Boiteux and Baumstark [19]	61% of the hourly costs of employment or 85% of the employee's gross wages	Recommends increasing VTTS by 50% with high occupancy of the interior of urban passenger transport and 100% when walking to the stopping point and waiting	Do approaches vary across groups defined by mode of transport, driver or passenger, or type of employment
Gwilliam [10]	133% of wages per hour (employer estimate)	33% - for adults, 15% - for children from household income per hour	Waiting/walking - 150% of the costs of the trip by urban passenger transport (for the transport organizations the costs consist of the hourly costs of operating the vehicle, the driver's wages per hour and the costs of using the infrastructure)
Mackie and Worsley [14]		90% of the value for commuting and back	For time spent "forced" commuting to and from work – 25% of the average for Labour and business travel

stated preferences, which use questionnaires to identify a hypothetical choice of a travel option that varies in several dimensions. This approach enables a researcher to take into account a number of behavioural alternatives and independent variables.

Most studies use discrete choice technologies (choice from a finite set of alternatives), for example, logistic analysis to assess parameters that affect the choice of a particular mode of transport or route. As the number of published studies was growing, some researchers also began using the meta-analysis to assess the reasons for the variation in results of individual studies [1, 5]. Value of Travel Time studies conducted in the United States have found that the value of business travel time is often set equal to the gross hourly costs of working hours, including payroll taxes and fringe benefits. Some studies have found that the time value for car users is lower than for drivers and the time value for shopping travel or recreation trips is lower than that for commuting.

In the UK, as seen from the work by Mackie et al. and from the UK Transport Analysis Guidance (TAG) [14], it is customary to distinguish between modes of transport by the average income of the population and not by the distance. The Value of Travel Time Savings (VTTS) value for commuting to and from work is set at less than 25% of the business trips average and VTTS for other purposes is 90% of the value for commuting. Gwilliam assumes that the World Bank uses 33% of hourly household income for adults and 15% for children to estimate the VTTS [10].

The studies by Concas and Kolpakov recommend a rate of 50% of the average salary in a country both for commuting and for other personal trips [15]. They assign the VTTS to only 35% of travel time reduction in urban public transport while sitting and 100% - when travelling while standing and up to 175% of earnings - to the waiting in uncomfortable conditions. The TAG [14] and Zhang et al. [16] recommend that the VTTS should be doubled in comparison with the normal value for walking and cycling and 2.5 times when waiting, although cycling can be considered as a beneficial use of time. The Value of Travel Time Savings is of practical use for assessing the social benefits resulting in transport projects implementation, but they are difficult to use for predicting the number of people who will choose a particular mode of transport or route. These aspects determine the differences in travel time reduction estimates. At the same time, such assessments should take into account the possibility of using the travel time for remote work, taking into account development of modern information and telecommunication technologies and robotics, for physical exercise (cycling) and so on. Variations in the duration of the trip over a certain period of time would be different for different pairs of points of the beginning and end of the trip, depending on both the reliability of each segment of the trip and the correlation of delays between the segments. Value of Travel Time Savings (VTTS) Studies are conducted not only to understand the motivations of users' travel decisions, but to assess the impact of measured factors on other groups of people, as well, often separated in time and space. Each assessment depends on the demographic characteristics of the travelling population, mode of transport, time, location and purpose of travel and the choice of alternatives available, so the chosen explanatory variables should be important while making these decisions.

The VTTS is not the same for different types of trips (labour, cultural, domestic, business) [17]. Value of Travel Time Savings studies are often based on factors influencing the choice of mode of transport, including comfort, private space and prestige, duration and costs of travel. If different modes of transport are relatively close substitutes for each other, concerning a place, purpose and distance of travel, it is advisable to assume that the incomes and preferences of transport network users are distributed identically between and within modes of transport, which gives an overall value of travel time savings. As can be seen from Table 1, the results of studies are heterogeneous enough to eliminate some arbitrariness in the estimates.

3 Results

Vrubel [3] proposed a new universal assessment criterion - “road traffic losses”, which is understood as the socio-economic costs of the unforced expenses of the traffic process. This criterion is applicable to assess the quality of both road traffic in general and its individual properties. Since the quality is assessed in monetary terms, it is possible to compare not only the quality of individual properties of road traffic, but the costs of achieving this quality, as well. This makes the comparison evident and allows optimizing easily and quickly (according to the criterion of losses minimization) the decisions made on the traffic organization. [1, 4]. The proposed criterion is gradually being introduced into the practice of traffic management. Methods for calculating the economic and environmental losses for the most typical facilities, as well as the basic (preliminary) methods for calculating car accident losses for individual typical facilities have been developed. In the Policy of ensuring the road traffic safety in the Republic of Belarus, losses are recognized as the main assessment criterion of the road traffic quality and it is required to improve the methods for calculating losses.

In recent years, views on the goals and methods of designing the urban transport systems have changed. The main problems in Belarusian road traffic, among others, are: the excessive dependence of population of some regions on individual cars, congestion with motor transport in cities, especially their centres [4]. Road traffic in the country is characterized by the increasing integration of the road traffic management with other types of transport and urban planning. An obligatory element of transport projects is the assessment of their impact on the urban environment in terms of accidents, as well as environmental and social friendliness [4, 12].

Belarusian National Technical University has developed a methodology and is modifying a procedure for assessing the quality of road traffic on a given section of the street and road network (SRN), which takes into account economic, environmental and car accident losses (social losses, unfortunately, due to the lack of reliable methods and validated formulae, are not yet taken into account) [3]. This methodology is based on calculating, summing up and comparing the losses at a given section of the SRN for any option of traffic management. It enables to quantify (in monetary terms) and therefore optimize any traffic management decisions.

Obviously, when assessing the quality, one must compare the costs that cover all the aspects of the urban transport system. In the simplest cases, when assessing the quality of the control options at an individual facility, it is sufficient to compare the losses from traffic expenses only. In general cases, one must consider the costs of losses of road traffic expenses and the costs of changes in road traffic conditions.

Those costs and expenses are very diverse and manifest themselves in a variety of forms, for example, in the form of the costs of land given for the road, emissions into the atmosphere, the support of a huge mass of people serving road traffic and road transport, car accidents, disobedience of road users, wasted time, etc. Therefore, comparing them is very difficult and rather conditional. However, there is always a certain normalized sum of costs and expenses that characterizes the cost of transport maintenance or transport service. These costs are made up of two main components - infrastructure costs and traffic expenses:

$$C = Z + E, \qquad (1)$$

where:
C - the costs of transport maintenance or transport service;
Z - infrastructure costs;
E - traffic expenses.

All these are estimated in monetary units, for example, in rubles or conditional currency units, or, as it is often accepted, in rubles/year or USD/year.

If the investigated costs are close to the minimal possible one, then it is considered that the system works in the optimal way, without losses. If these costs are not minimal, then there are losses, which are understood as the excess of the investigated costs over the minimal possible one:

$$L = C + Cmin, \qquad (2)$$

where:
L - losses in the investigated system;
C - investigated costs of transport maintenance or transport service;
$Cmin$ - the minimal possible costs.

The concept of the "minimal possible costs" is rather relative and has an extended interpretation. Firstly, all the unnecessary costs, such as car accidents, are considered to be expenses, although it is known that accident-free traffic does not exist. Secondly, the standard permitted speed, for example, in settlements (60 km/h) is taken as a basis for comparison to the speed of commuting. To gain such a speed any-place is impossible. Thirdly, to achieve the lowest possible costs, it is necessary to bring together all the best world achievements in the location or a system under investigation, which is also almost impossible. Therefore, the minimal possible costs today actually act not as a standard, but rather as a kind of cue that one must aim for. As a result, the concept of "a loss" implies not only what we have lost, but also what we have missed, have not used, taken, etc.

Comparison of losses is carried out according to the so-called "unital/single/normalized" losses, including both economic and social components:

$$L = L_e + L_s, \tag{3}$$

where:
L - normalized losses of a given type rubles/year;
L_e - economic component of a given type of losses, rubles/year;
L_s - social component of a given type of losses, rubles/year.

The definition of the social component is carried out using the so-called "social coefficient", K_s, showing how many rubles a society agrees to pay (or has already paid) to avoid the socio- economic losses of a given type, per 1 ruble at a given time:

$$K_s = \frac{L_e + L_s}{L_e} = 1 + \frac{L_s}{L_e}. \tag{4}$$

Normalized losses of a given type can be defined as the product of the economic component times the social coefficient:

$$L = L_e \times K_s, \ rub/year. \tag{5}$$

The total normalized losses in the investigated location or in the investigated system are determined from the formula:

$$L_\Sigma = L_{ekon} \times K_{sekon} + L_{ecol} \times K_{ecol} + L_a \times K_{sa} + L_s \times K_{ss}, \text{ rub/year}, \tag{6}$$

where:
L_{ekon} and K_{sekon} - the economic component and the social coefficient of economic losses resp;
Le_{col} and K_{secol} - the same for ecological losses;
L_a and K_{sa} - the same for accident losses;
L_s and K_{ss} - the same for social losses.

Since losses are, by definition, derivative of value, they can be characterized in the same way as costs - global, of travel expenses and in the infrastructure.

Costs losses, as well as the costs themselves, can be divided into four types - economic, environmental, accident and social. All of these types are quite closely related and it is sometimes difficult to draw a clear line between them. Therefore, this division, as well as the given names should be considered conditional or operating names. However, more than 20 years of using this classification have shown that it is clear and quite user-friendly, especially when analyzing the loss structure of an individual site or system.

Obviously, in assessing the quality of large systems, global costs covering all the aspects of the road transport system must be compared. In the simplest cases, it is sufficient to compare only the travel costs losses when assessing the quality of control options at a single facility. In general, the so-called comparative costs, including travel costs losses and costs of (limited) changes in traffic conditions, etc. should be considered:

$$C = L_\Sigma + Z \text{ rub/year}, \tag{7}$$

where:
C - comparative costs;
L_Σ - total normalized losses;
Z - annual normalized costs of changes in travel conditions.

The object to be studied is divided into elementary areas, which are either conflicting objects or similar sections of a road. At each conflict point (or zone) or at a given section of a road, all the losses' types are defined and the results are summed. The resulting value of the total loss is added to the annual normalized costs in the infrastructure and the comparative value is set at which the quality is assessed. The absolute estimate is characterized by the comparative value of road traffic at the site under study, θ = C, rub/year. Three types of estimates are considered: absolute - θ, relative - θ_r and comparative - θ_c. The relative estimate is the ratio of the absolute estimate to the normalizes (current) volume of traffic:

$$\theta_r = \frac{\theta}{F_{(Q_1,Q_2,L)}} \times x, \text{ rub/year}, \tag{8}$$

where:
$F_{(Q_1,Q_2,L)}$ - some function, which characterizes the normalizes volume of traffic;
x - the dimension of the function that describes the volume of traffic, such as cars, automobile kilometres, etc.

Obviously, only the characteristics of the conflicting flows are relevant to the conflict objects

For the road sections (Q_1, Q_2) are the characteristics of the flows and the road section's length, respectively. There are several approaches to definition of the normalized volume of traffic. For example, for the conflict objects the following formula is used:

$$F_{(Q_1,Q_2,L)} = \sqrt{Q_1 \times Q_2} \quad , \tag{9}$$

for the road sections:

$$F_{(Q_1,Q_2,L)} = Q \times L \,. \tag{10}$$

A comparative estimate is a quotient of the relative estimate of the object being investigated by the relative estimate of the prototype object, normalized to the usual, for example, a ten-point rating system:

$$\theta_s = \frac{\theta_{ri}}{\theta_{rprot}} \times \delta_{10} \quad , \tag{11}$$

where:
θ_{ri} - relative estimate of the object being investigated;
θ_{rprot} - relative estimate of the prototype object;
δ_{10} - some constant (in this case 10).

Obviously, it is possible to select such elementary objects, which by agreement can be accepted as prototype objects. By comparing the relative estimates of the surveyed object and the prototype object, it is easy to make a comparative assessment of any object or section of the road network.

The proposed methodology makes it possible to evaluate not only the quality of road the traffic in general, but of its main components, as well, such as traffic management or road conditions. To evaluate the quality of the management, it is necessary to find the best way to manage under the given road conditions and traffic-pedestrian load and compare it to the existing ones.

Thus, the main features of the methodology being developed for evaluation of the quality of the road traffic were briefly considered. As it can be seen, the valuation principle and valuation criteria are extremely simple - the less the losses (comparative value), the better. The assessment itself is somewhat more complex and includes three types of estimates for at least three subsystems. As for the determination of the total losses, without which no assessment can be made, this is the most difficult task. It requires automated data collection, its processing and storage, prediction of characteristics and losses, optimization of management, etc. All these requires considerable intellectual capacity and appropriate infrastructure. This is no longer a technical task, but a social and national one.

Figure 1 shows a fragment of a linear graph of the traffic losses on a city street, where accident, environmental, economic and total annual losses are shown for each elementary section.

Such information will make it possible to systematically distribute the available opportunities for scientific and practical activities to improve the quality of the road traffic. In addition, it will demonstrate the true importance of traffic, especially its urban component, where, on busy streets, millions of dollars are lost annually. This should contribute to a positive change in the attitude of managers to the organization of traffic in cities. Figure 2 shows a comparison of various sets of measures to improve the quality of traffic on the main street of the largest city of Minsk. It can be seen that the two options are comparable in terms of payback periods, but have different “survivability” and relevance, which makes one of the options more attractive for saving capital investments for a longer period, despite its costs.

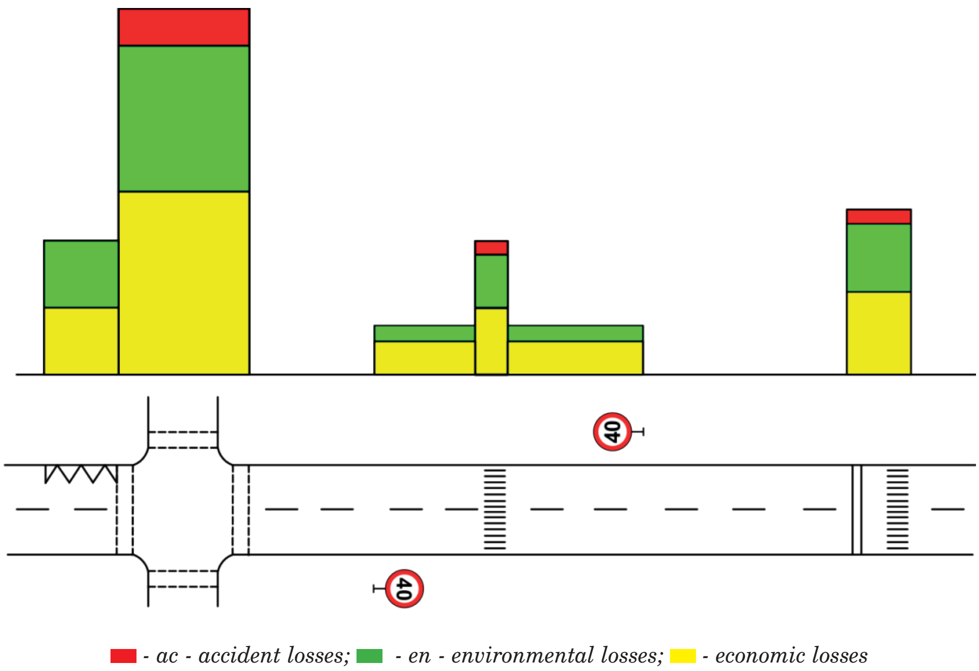

***Figure 1** Linear graph of losses on a city street*

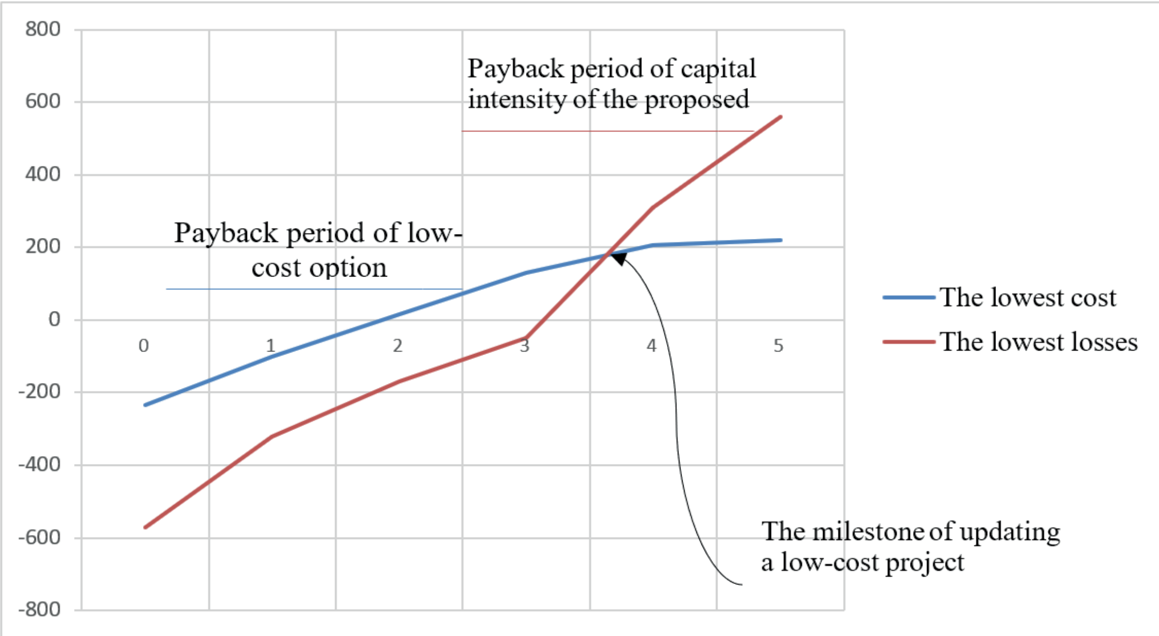

***Figure 2** Application of the developed methodology (Street K. Cetkin)*

4 Discussion

It is clear that the management of traffic and of the entire road transport system cannot be based on erroneous criteria and be carried out in a rudimentary manner, resulting in huge and increasing losses. While it is costly to build sophisticated management systems, it is not only necessary but also very beneficial, as the road traffic losses exceed those costs by several orders. Assessing the quality of decision-making is the foundation of any management system. Nowadays, the first steps to establish an objecting reliable methodology for assessing the quality of the road traffic and transport systems are being taken in the Republic of Belarus. The popularization, implementation and improvement of the methodology lead to hope that huge losses in the road traffic would be noticed by the society and the problem of their reduction would move things forward. The valuation of urban transport efficiency is the subject of further research.

Undoubtedly, it is desirable to take into account the final economic consequences of expanding production, wages and employment when assessing losses [3]. Under these assumptions, it is supposed to allow more accurately exploring the area called "standard scope of cost-benefit analysis". However, with the standard application of transport cost-benefit analysis, there are problems that can be described as follows.:

- the scope of benefits covered in the standard cost-benefit analysis that is limited by the practical possibilities of forecasting and estimating;
- improvements in urban transport systems and traffic conditions can stimulate fundamental changes in the number or location of institutions, households and employers that are not included in the standard cost-benefit analysis [20]. Therefore, there is a possibility to extend this conducted research taking into account such conditions.

For some USA states, cost-benefit analysis has not been mandatory and has not been considered at all in the transport investment decisions [21], while in Northern Europe and Australia such analysis has been dominating in the decision-making [22-23].

This research supports the idea of the obligatory projects' revision, based on the careful strategy planning under national, regional and local missions and aims of the country [24].

The economic impact analysis of the project is also supposed to be used in the pre-project assessment for a direct forecast of the resulting final economic effects [25-26].

5 Conclusions

A sharp increase in car flows in urban transport systems in recent years is caused by:

- the constant intensive growth in the level of population motorization;
- the increase in the number of business trips;
- the use of passenger cars with small volumes of cargo transportation;
- the emergence of "commercial" routes.

This has resulted in significant overloads of transport networks, especially in the central parts of cities. It also has led to an increased level of accidents and environmental impact on urban ecosystems and a decrease in traffic speeds. In this regard, the whole range of tasks arises, related to improving the comfort of movement and the quality of citizens' life in general, which is possible by optimizing the operation of route passenger transport and increasing its attractiveness for users of all the levels. The proposed methodology is applicable to assess the effectiveness of measures aimed at reducing delays in route passenger transport, as well as to compare the technical and economic indicators of the proposed options, including when using the international CBA methodology (Cost Benefit Analysis). The methodology, in fact, is a business model for assessing the implementation of standard measures aimed at improving the quality of the entire transport system of cities and the efficiency of the route passenger transport, in particular.

The analysis of the studies carried out showed that there is no universal methodological approach to the economic valuation of the expenses associated with the travel time of the urban population and the efficiency of the urban transport system. The results of the studies confirm the point of view that the effectiveness of the implemented transport projects aimed at improving the quality of road traffic and the efficiency of the transport system is directly linked to the reduction of the travel time total costs. The developed methodological approach to the economic estimation of unanticipated (unenforced) road traffic losses in each specific transport system related to the time of travel, would ensure the selection of the best priority for urban traffic management and is an effective tool for investment priority guidelines in transport infrastructure and urban traffic management. The developed method for the economic evaluation of the efficiency of transport solutions, based on the total travel time losses of road users and the efficiency of the transport system, allows evaluating and justifying investments in transport projects of any level, i.e. to select and justify rational (optimal) decisions on the road traffic management (organization) and to plan the work of urban public transport.

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Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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