International Journal of Industrial Engineering & Production Research December 2020 Vol. 31, No. 4: 491-498
DOI: 10.22068/ijiepr.31.4. 491

RESEARCH PAPER

Improving Management Decisions in Urban Passenger Transport Based on the Sociological Study

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Received 1 August 2020; Revised 1 September 2020; Accepted 1 October 2020; Published online 30 October 2020

ABSTRACT

This paper aims to conduct a sociological survey and the results of the formation of theoretical and methodological principles and practical recommendations for improving management decisions in urban passenger transport. We use the analytical economic methodology to analyse the transport industry of Ukraine; to investigate the theoretical and methodological principles of the compensation policy formation in urban public transport. We use expert evaluation methods to check the relevant factors while deciding to use or not use public transport. This study has proved that when making management decisions, it is necessary to take into account both the opinion of users and the opinion of experts; none of these opinions should prevail over the other, and therefore decisions should be made based on a balanced assessment. The authors identified 18 factors that have the most significant influence when deciding on the use of passenger transport; conducted a study twice on the importance of each factor, highlighted the impact of each of them. The authors also proposed theoretical and methodological developments that can be used to improve compensation policy in the field of passenger transportation. With this article, we show that when researching, it is necessary to take into account both the opinion of direct participants and experts in this industry it is this tandem that will allow developing the most relevant recommendations for making managerial decisions.

KEYWORDS: *Sociological survey; Compensation policy; Urban passenger transport (UPT).*

1. Introduction

Transport passenger traffic, as a component of the city-wide infrastructure, is an essential part of the socio-economic system of the State and refers to strategically important sectors of the economy, without its effective functioning, further improvement of the welfare of society is impossible. The main tasks of transport are timely and high-quality satisfaction of the needs of the economy and the population in transportation, as well as increasing the company's profitability. In the modern transport sector, a qualitative "leap" can be achieved through the use of new technologies [14; 16], especially intellectual innovations [8; 20], and the adoption of balanced, economically sound and effective management decisions to ensure transport processes that meet modern requirements and high international standards.

Previous studies by the authors [2-4; 10] have shown that Ukraine's transport system still has many shortcomings. Urban passenger transport operates in more than 50 cities of Ukraine, but the dynamics ofp transportation at 2014-2019 has been declining in recent years (Fig. 1). According to forecasts, if not change management policy, the decline is expected in the future.

The figure shows that the most significant decline is expected in tram and trolleybus traffic. As already noted by the authors, the fall in demand is observed in all urban transport.

To make valid and effective management decisions, which must take into account the strengths and weaknesses. Tab. 1 shows a SWOT-analysis aimed at forming a generalised

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capacity for effective decision-making to improve the system.

At the moment, the natural boundaries of large cities of Ukraine are fully formed. As long as the structure of the existing route network is tied to these cordons, there is no need for its further significant expansion. However, we believe that it can be improved by optimising the route network and compensation policy.

In Ukraine, with the support of the Ministry of Infrastructure of Ukraine under the Draft Framework Loan Agreement for Urban Public Transport of Ukraine, there is the "Urban Public Transport Project Ukraine", according to which cities apply for possible financing of urban passenger transport. For 2020, the cities that have used need to replace the mobile stock (Fig. 2) and the corresponding funding (Fig. 3).

It should be noted that not all cities apply for funding, even though it is possible to get it.

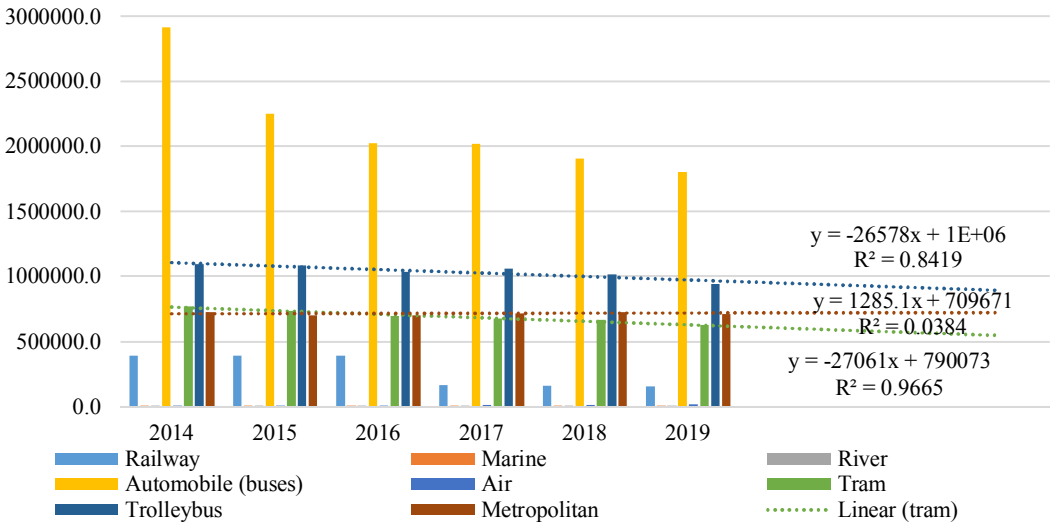

Fig. 1. Passenger transportation at 2014-2019 (compiled based on [22], 2014-2019)

Tab. 1. SWOT-analysis of the transport system of Ukraine

Legend	Opportunities	Threat
S Strengths of the industry W Weaknesses of the industry O Industry opportunities T Threats to industry activities	1. Activation of the processes of integration of the transport and road complex of Ukraine to the European one. 2. Use of alternative fuels and the introduction of international environmental standards. 3. Construction of additional transport corridors of international importance and development of a network of logistics centres, improvement of road quality. 4. Increasing passenger and freight turnover. 5. Improving the fiscal policy of the State.	1. Risks of accidents due to high levels of transport again and unsatisfactory condition of roads. 2. Worsening of the political and economic crisis and a further decline in the activity of transport enterprises in the real sector of the economy. 3. Devaluation of the national currency and, accordingly, the deterioration of the financial condition of carriers. 4. Rising fuel costs.
Strengths 1. Availability in Ukraine of its production base for the production of rolling stock of urban electric transport. 2. The wide network of highways. 3. One of the largest railway networks in Europe.	1S – 1O 1S – 2O 2S – 4O 3S – 1O 3S – 4O	1S – 1T 1S – 2T 2S – 2T 2S – 3T 3S – 2T

Weaknesses 1. Inconsistency of the development of the road network with the pace of state motorisation. 2. Low capacity of the main transport hubs. 3. Low level of quality and efficiency of passenger and cargo transportation. 4. The central part of Ukraine's transport is morally and physically obsolete 5. Wear of rail tracks.	1W – 1O 1W – 3O 1W – 5O 2W – 1O 2W – 3O 3W – 1O 3W – 3O 3W – 4O 4W – 1O 4W – 5O	1W – 1T 2W – 1T 3W – 1T 4W – 1T 4W – 3T

Source: Compiled by the authors

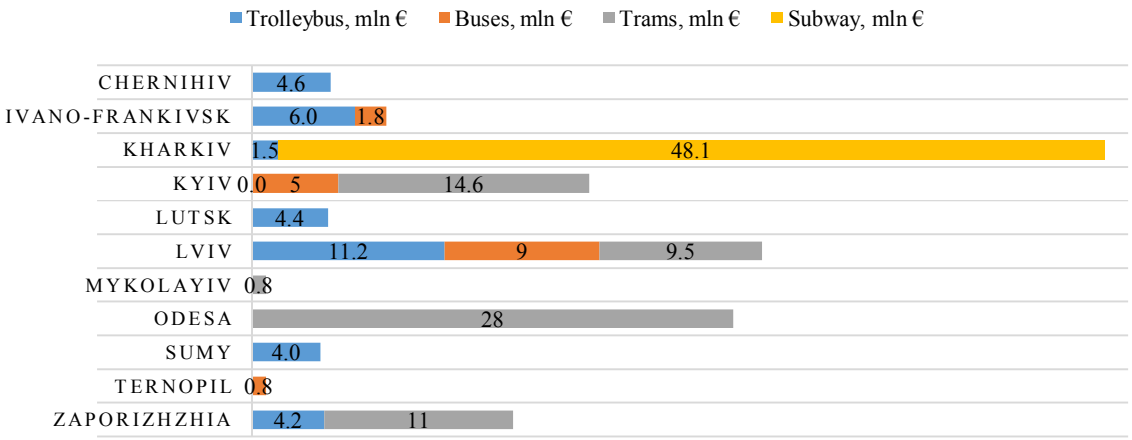

Fig. 2. The need for cities to upgrade the rolling stock of light passenger transport (compiled by the authors based on official data [21; 22])

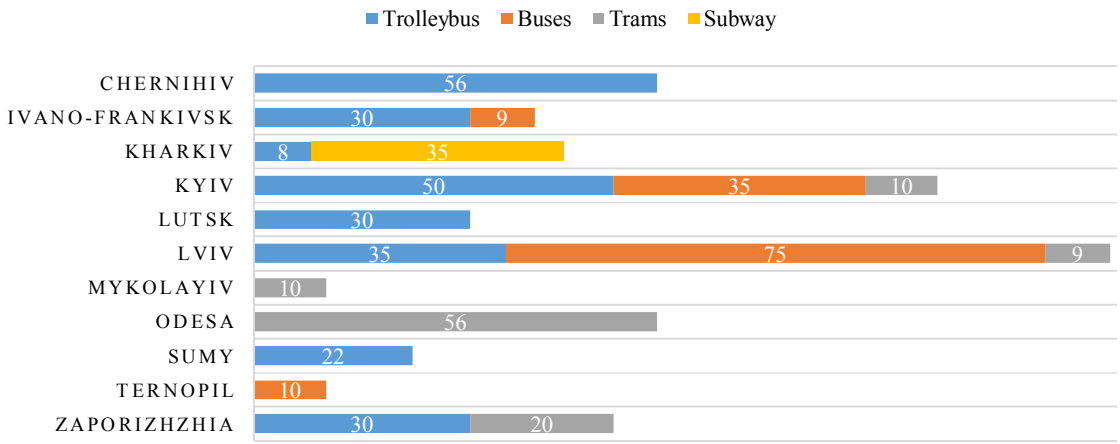

Fig. 3. Funding is needed to upgrade the rolling stock of urban passenger transport (compiled by the authors based on official data [21; 22])

2. Materials and Methods

In their previous study [4], the authors conducted a sociological survey of non-population. However, due to the limited possibilities of presenting the study, it must be supplemented with a survey of experts and specialists in making managerial decisions regarding urban passenger transport. The following questions remained unsolved:

research of expert opinion regarding decision-making in urban passenger transport;

search for directions of route network optimisation;

search for ways to improve compensation policy;
development recommendations for improving tariff and compensation policy.

The primary purpose of expert assessment methods is to determine the individual points of view of experts and form a single solution based on them. Expert assessment methods are organisational, logical and mathematical-statistical procedures that are aimed at obtaining information from specialists, analysing and generalising it for preparing and making effective decisions. The successful use of the method of expert assessment was shown in their works not only by Ukrainian scientists [1; 5; 6; 11; 13; 15; 17], but also by foreign ones [7; 8; 9; 23].

Expert systems are built using methods of successive approximations to some "ideal" option. The errors found motivate to adjust the program and increase the knowledge base, which is the basis of the expert system. In fig. In Fig. 4 shows a block diagram describing the General algorithm for creating an expert system.

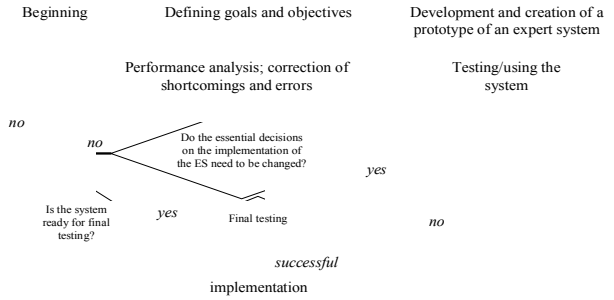

Fig. 4. Algorithm for creating an expert system (improved on the base [13])

The application of the technology described above should lead to the creation of such an expert system that:

1) monitors its "thought processes", displays intermediate results and answers critical questions related to the process of task performance;
2) effectively uses heuristic constructions;
3) allows you to modify the knowledge base (add and delete necessary information).

Note that creating a prototype allows developers to explore the problem and its essential relationships by building a real program. If the prototype turned out to be very cumbersome or the developers decided to change the approach to solving problems, then the existing prototype can simply be discarded, creating a new one. After gradual modification, a more compact and efficient version is often created with less than the initial number of rules and program blocks.

3. Results and Discussion

As mentioned above, improvements for making effective management decisions are expected in two aspects:

1. to analyse the theoretical basis of compensation policy for the development of recommendations in the future.
2. check what factors are relevant to the decision to use or not use public transport;

3.1. Improving the compensation system

Sometimes the tariff is calculated taking into account the coefficient that takes into account the number of transported passengers who enjoy benefits, for example:

$$\mathrm{T} = \frac{\sum C_{\mathrm{i}} * KF * K_{VAT} * KB}{L * q_n} * \frac{\bar{\mathrm{l}}_{av}}{\bar{\gamma}_{bc}} \qquad (1)$$

where C_{i} – the total annual amount of regulatory costs of the carrier, UAH / year;
KF – coefficient of estimated profitability;
K_{VAT} – coefficient that takes into account the payment of value-added tax;
KB – coefficient that takes into account the number of transported passengers who enjoy benefits;
L – annual mileage of buses on the route, km;
q_n – nominal passenger capacity of the bus, passengers;
$\bar{\mathrm{l}}_{av}$ – average distance travelled by the passenger, km;
$\bar{\gamma}_{bc}$ – average utilisation factor of bus capacity.

The paper [19] proposes the following method of calculating a socially-oriented fare based on the costs and revenues of the transport company, and depending on them is adjusted by coefficients to obtain a fare acceptable to passengers:

$$TSO = \frac{TEJ}{K_{sl} * K_{Iav} * K_p * K_{pc} * K_{tr} * K_{Lav} * K_c} \qquad (2)$$

where TEJ – economically justified tariff, UAH;

K_{sl} – coefficient indicating the share of residents whose average per capita income is below or equal to the subsistence level;
K_{Iav} – coefficient indicating the ratio of average monetary income per capita to the subsistence level;
K_p – coefficient indicating the share among the population of pensioners and the unemployed population, as a percentage of the total population;
K_{pc} – coefficient indicating the share of the people that owns personal cars;
K_{tr} – coefficient indicating the required average value of the transfer coefficient;
K_{Lav} – coefficient indicating the average distance travelled on urban routes;
K_c – coefficient indicating the level of competition in the market of passenger transport services.
Methods for determining the amount of compensation:
– depending on the number of passengers that were transported and paid for the ticket (direct proportional dependence of the amount of compensation on the transported "paid" passengers of urban passenger transport);
– distribution of compensations by the losses incurred by carriers in the period preceding the reporting period;
– determining the amount of compensation per citizen. The calculation of the amount of compensation is carried out for the year according to the number of privileged categories in the area served by a particular enterprise.
– adjustment of the amount of compensation according to the volumes of work planned;
– coefficient (for example, as the ratio of passengers paying for travel and privileged categories to the total amount based on statistical data);
– promissory note (registration of beneficiaries with the help of season tickets, which are noted in the letters of registration and the amount is reimbursed by special bodies of the city);
– based on detachable tickets (the amount of compensation is calculated based on used tickets);
– convertible coupons (provide a one-time trip on urban passenger transport, regardless of ownership) [12].

Thus, there are a large number of methods for the formation of tariff policy; the most appropriate is the one that relies on costs + profit.

3.2. Checking the relevant factors while a decision to use or not use public transport

The study involved 32 experts, 15 of whom are scientists in the field of studying the problems of urban passenger transport management and 17 – managers of different levels in companies that are directly or indirectly related to urban passenger transport. A theoretical study [4] called to identify 18 factors that influence a person's decision to use or not use public transport; all factors were combined into four groups – Safety, Comfort, Time Saving, Cost. If a factor could be simultaneously attributed to several groups of groups, we chose 1 group to which it belongs to a greater extent. Further, the experts were asked to evaluate factors from 1 to 18, while the points should not be repeated. After collecting the results, it is necessary to check the consistency of the opinions of the experts. For this we use the coefficient of concordance (expert consent) W is calculated by the formula:

$$W = \frac{12 \times \sum(S_j - \bar{S})^2}{m^2 \times (n^3 - n)} \quad (3)$$

where m – the number of experts, pers.
n – the number of ranking factors, pcs.
Sj – the sum of columns, score;
$\bar{S}$ – average sum in columns, point.

$$W = \frac{12 \times \sum(S_j - \bar{S})^2}{32^2 \times (18^3 - 18)} = \frac{5179576{,}32}{5953536} = 0{,}87$$

At a coefficient equal to zero, there is no consistency of opinion; at a coefficient similar to one - the highest level of flexibility. This tests whether the hypothesis of agreement between experts is accepted and whether the results of the expert group's questionnaire can be trusted. Thus, experts are consistent, and the results of the survey can be trusted. Thus, we obtained the following factors, which, according to experts, are decisive in the use of urban passenger transport (Tab. 2).

Tab. 2. Comparison of the results of the expert survey and social research

Expert survey		Residents survey	
Factor's No.	Factor	Factor's No.	Factor
7	strictly scheduled traffic	2	availability of Wi-Fi
13	the ability to get to the right place without changes	5	the ability to pay for the fare in the cabin with a card
2	availability of Wi-Fi	7	strictly scheduled traffic
5	the ability to pay for the ticket in the cabin with a card	13	the ability to get to the right place without changes
17	significant savings in the cost of a single trip when buying a subscription	17	significant savings in the price of a single trip when buying a subscription
18	vehicle interior cleanliness	18	vehicle interior cleanliness
14	number of people in the cabin	3	air-conditioning
1	vehicle technical condition	14	number of people in the cabin
16	round-the-clock traffic	8	the ability to track the movement of the transport in real-time in the app
3	air-conditioning	11	increased driver requirements
8	the ability to track the progress of the transport in real-time in the app	16	round-the-clock traffic
11	increased driver requirements	1	vehicle technical condition
4	the ability to pay for the fare in the cabin	4	the ability to pay for the ticket in the cabin
15	permission to transport animals in public transport (in compliance with the necessary standards)	9	50% increase in fare
10	significant increase in tariff (3-4 times)	15	permission to transport animals in public transport (in compliance with the necessary standards)
9	50% increase in fare	12	extra charge for oversized baggage
6	criminogenic environment	6	criminogenic environment
12	additional charge for oversized baggage	10	significant increase in tariff (3-4 times)

Thus, the opinion of the experts coincided with the opinion of the population, but it is worth noting some exciting moments:

– in general, when the factors were divided into groups, the views of the experts and the population coincided, however, within the group, views on the importance of individual factors differed; Safety, Comfort, Time Saving, Cost;

– experts also considered factors from the "Time Saving" group to be more important than from the "Comfort" group, the population, in turn, singled out the opposite;

– experts found factors from the "Cost" group to have a total negative impact, although the people, in turn, was more loyal to some of them;

– in general, two factors coincided absolutely, the agreement in the groups reached 79.57% on average.

4. Conclusions

This study has proved that when making management decisions, it is necessary to take into account both the opinion of users and the opinion of experts; none of these opinions should prevail over the other, and therefore decisions should be made based on a balanced assessment.

The analysis showed that there are effective ways to improve the functioning of urban passenger transport, but for each local purpose should be defined evaluation criteria, limitations and main areas of implementation. The implementation of local goals is carried out by the measures developed by the responsible executors and approved in the prescribed manner. Deadlines and available resources should coordinate implementation.

Concerning pricing policy in urban transport, the study confirmed earlier findings:

– not all participants in the transport system have the same functional load. The winners of the competition do not have their own vehicles, do not spend money on maintenance and at the same time have constant cash flows that do not depend on the number of passengers transported;

– the method of calculating the price allows you to add too low a percentage of the cost of restoring the technical condition of cars to the cost. In these cases, the return period of the vehicle is too long and in some cases may

exceed the useful life of the vehicle, taking into account the quality of the road surface;
– the current system of imposing excessive plans for drivers leads to severe violations that significantly reduce the quality of passenger service.
To take into account the interests of both passengers and carriers, as well as to prevent social tensions in the region, funds for the modernisation of the transport system should be approximately 15-17% per annum. Before raising the tariff, it is necessary to calculate what changes can already be made, first of all, these are the factors that do not carry significant capital investments, but have a positive effect on the use of transport.

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