P. V. LUBIANY
Ph.D., Associate Professor,
Head of the Department of Transport Systems and Technical Service
Kherson National Technical University
ORCID: 000-0003-2668-5063

O. A. VOITOVYCH
Ph.D., Associate Professor,
Dean of the Faculty of Engineering and Transport
Kherson National Technical University
ORCID: 000-0003-0510-4362

V. P. SLAVYCH
Ph.D., Associate Professor,
Associate Professor at the Department of Transport Systems
and Technical Service
ORCID: 0000-0001-7882-4198

I. O. KUZMENKO
Postgraduate Student at the Department of Economics, Entrepreneurship
and Economic Security
Kherson National Technical University
ORCID: 0009-0004-6878-7310

FORMATION OF THE PASSENGER TRANSPORTATION TARIFF
AS AN EXAMPLE OF POPULATION MOBILITY IN THE CITY OF KHERSON

The market of city passenger transport (CPT) services, which is dynamically developing, is accompanied by practically the same dynamic increase in the level of prices. The need for price regulation is dictated by three tasks facing the CPT:

firstly, the reduction of transport discrimination among the population of those areas of the city where, from an economic point of view, the functioning of public transportation is inefficient;

secondly, guaranteed provision of minimum transport services to the population;

thirdly, increasing the attractiveness of CPT to the population with average incomes (who have or have the opportunity to purchase a personal car), which is achieved by improving the quality of the services provided.

In the Soviet period, the regulation of the CPT price was pursued mainly by solving the first two tasks. However, the mobilization of the population, which is gaining momentum, in Ukraine increasingly requires the CPT to solve the third task. One of the mechanisms capable of determining the permissible level of the tariff is the analysis of consumer preferences when the population chooses a method of movement.

As a basis for calculating the cost of movement of residents of Kherson, the authors used the method of expediency to estimate transport costs using the given time of movement. In this way, the actual cash costs incurred by using different levels of income were translated into the time that had to be worked to offset the cash costs. Time spent on movement was translated into cost. Then this cost was summed up with the actually incurred transport costs. This is caused by a contradiction in the calculation of the criterion for choosing walking. Thus, the criterion for choosing to travel on foot was dependent on the consumer's income level and actually depended on the distance of travel. However, at the same level of time, it will be perceived differently by a person with a different level of income.

The goal *is to study the influence of the tariff and level of public transport services on the choice of the city population's mode of transportation.*

Key words: *tariff, motorization, route network, costs, movement, income level.*

П. В. ЛУБ'ЯНИЙ
кандидат технічних наук, доцент,
завідувач кафедри транспортних систем та технічного сервісу
Херсонський національний технічний університет
ORCID: 000-0003-2668-5063

О. А. ВОЙТОВИЧ
кандидат технічних наук,
доцент кафедри транспортних систем та технічного сервісу
Херсонський національний технічний університет
ORCID: 000-0003-0510-4362

В. П. СЛАВИЧ
кандидат технічних наук, доцент,
доцент кафедри транспортних систем та технічного сервісу
Херсонський національний технічний університет
ORCID: 0000-0001-7882-4198

І. О. КУЗЬМЕНКО
аспірант кафедри економіки, підприємництва та економічної безпеки
Херсонський національний технічний університет
ORCID: 0009-0004-6878-7310

ФОРМУВАННЯ ТАРИФУ ПЕРЕВЕЗЕННЯ ПАСАЖИРІВ НА ПРИКЛАДІ РУХОВОСТІ НАСЕЛЕННЯ МІСТА ХЕРСОНА

Ринок послуг міського пасажирського транспорту (МПТ), що динамічно розвивається, супроводжується практично таким же динамічним підвищенням рівня цін. Необхідність регулювання цін продиктована трьома завданнями, що стоять перед МПТ:

по-перше, зниження транспортної дискримінації населення тих районів міста, де з економічного погляду неефективне функціонування МПТ;

по-друге, гарантоване забезпечення населення мінімальними транспортними послугами;

по-третє, підвищення привабливості МПТ перед населенням, що володіє середніми доходами (які мають або має можливість придбати особистий автомобіль), що досягається шляхом підвищення якості послуг, що надаються.

У радянський період регулювання ціни на МПТ переслідувало рішення переважно перших двох завдань. Однак мобілізація населення, що набирає темпи, в Україні все більшою мірою вимагає від МПТ вирішення третього завдання. Одним із механізмів здатних визначити допустимий рівень тарифу є аналіз споживчих переваг при виборі населення способу переміщення.

В основі розрахунку вартості переміщень жителів м. Херсона авторами використовувався метод доцільності оцінювати транспортні витрати з допомогою наведеного часу переміщення. Таким чином, фактично понесені грошові витрати за допомогою використання різних рівнів доходів переводилися в той час, який потрібно було відпрацювати, щоб компенсувати грошові витрати. Витрачений час на пересування переводилося у вартість. Далі ця вартість підсумовувалась з фактично понесеними транспортними грошовими витратами. Викликано це протиріччям при розрахунку критерію вибору пішого переміщення. Так критерій вибору пішого переміщення був залежний від рівня доходів споживача і фактично залежав від відстані переміщення. Однак, при тому ж рівні часу воно буде по-різному сприймається людиною з різним рівнем доходу.

Метою є вивчення впливу тарифу та рівня послуг МПТ на вибір міського населення способу переміщення.

Ключові слова: тариф, автомобілізація, маршрутна мережа, витрати, переміщення, рівень доходу.

Formulation of the problem

The study of consumer preferences when choosing a method of movement is one of the basic conditions for forming a rational level of the tariff for (CPT) services. Depending on the level of the tariff and the level of services provided, the CPT changes and the consumer preference of the population. And the analysis of the transport costs incurred by the consumer allows us to draw conclusions about which method of movement the individual will choose.

MPT services is characterized by a reduction in the time spent on moving the population and leads to an increase in the costs of the CPT system. The increase in costs is due to the development of the route network (expanding the geography of trips) and the reduction of intervals between the movement of route vehicles (vehicles) on the routes (which is achieved due to the increase in the speed of communication and the increase in the number of vehicles operating on the route).

Analysis of recent research and publications

The characteristics of different types of transport, which are directly evaluated by the consumer when traveling to the workplace, are: travel time and costs. Based on this provision, we will evaluate the services provided by CPT in terms of time and cost. Let's consider the impact of the tariff level on the resident's decision to choose a method of movement.

Activity [1] examines in detail the analysis methodology for the quantitative evaluation of the choice of one or another method of movement. The necessary data for calculating the given transport costs in the model is quite easy to determine in practice. A similar model of choosing between different modes of movement is presented in [2]. The characteristics of different types of transport, which are directly evaluated by the consumer during the trip, are: trip time and costs for it [3]. Based on this provision, we will evaluate the services provided by the CPT in terms of time and cost.

Formulation of the purpose of the research

The author used the method [1] with an amendment as a basis for calculating the cost of moving residents of Kherson. The activity was evaluated by transport costs using the specified travel time. Thus, the actually incurred cash costs by using different levels of income were translated into the time that had to be worked to offset the cash costs. Time spent on movement was translated into cost. Then this cost was summed up with the actually incurred transport costs. This is caused by a contradiction in the calculation of the criterion for choosing walking. Thus, the criterion for choosing to travel on foot was dependent on the consumer's income level and actually depended on the distance of travel. However, at the same level of time, it will be perceived differently by a person with a different level of income. The criterion for choosing a mode of movement was calculated:

$$K_i = A_1^i + A_2^i \cdot L + \frac{A_3^i \cdot L + A_4^i}{D} \tag{1}$$

The criterion for choosing a mode of movement was calculated as follows:

$$K_i = A_1^i \cdot D + A_2^i \cdot D + A_3^i \cdot L + A_4^i \tag{2}$$

where A_1^i – time spent that does not depend on the distance of movement, hour;

A_2^i – Time spent per unit length of movement, hour/km;

A_3^i – Costs per unit length of movement, hryvnias / km;

A_4^i – Costs independent of the length of movement, hryvnias;

L – distance of movement, km;

D – per capita income of the subject of displacement, hryvnias/hour.

Coefficients A_{1-4} for different methods of movement can be defined as follows.

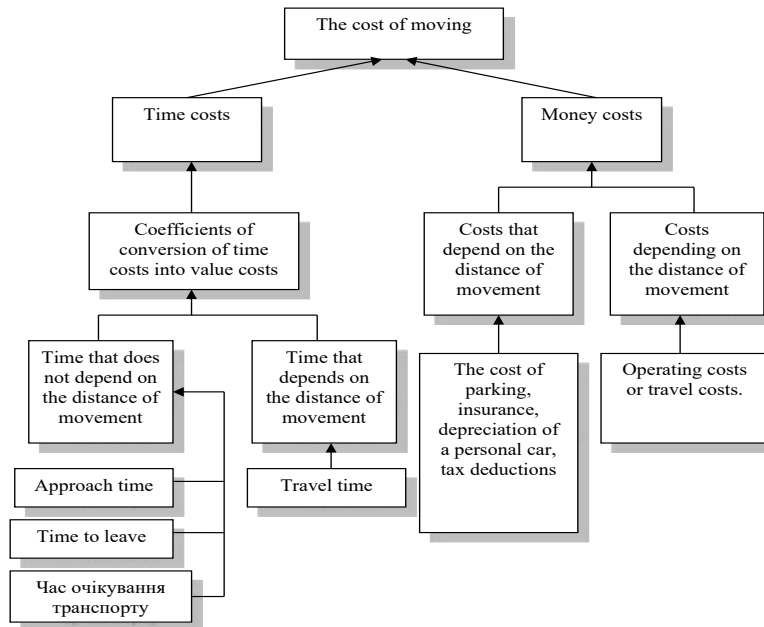The main parameters that determine the cost of movement are presented in fig.1.

Fig.1. Formation of the cost of movement

Movement on foot:

There are no time costs that depend on the distance to move. Worthwhile costs in your mode of movement can also be neglected. Therefore, the coefficients A_1, A_3 and A_{4in} in this case are equal to zero. Coefficient A_2 inversely proportional to the speed of walking and directly proportional to the psychological assessment of time spent on walking:

$$A_2 = \frac{P_{walk}}{V_{walk}} \tag{3}$$

where V_{walk} – walking speed, km/h;

P_{walk} – coefficient of psychological assessment of time spent on walking.

City passenger transport

Time costs, which depend on the distance of movement, are represented by the time of walking approach (departure) to the stopping point. These time costs are inversely proportional to the density of the CPT route network. Adjusted for the coefficient of psychological assessment of time spent on walking. The relationship between the network density and the approach (departure) distance to the stopping point corresponds to a rectangular network:

$$T_{walk} = \frac{P_{walk}}{3P_{nw} \cdot V_{walk}} \tag{4}$$

where P_{nw} is the density of the route network, km/km²

The same category includes the time for waiting for the vehicle at the stop. This time is perceived as half of the movement interval of CPT route units. Adjusted for the value of the psychological assessment of the waiting time:

$$T_w = \frac{P_w \cdot I_{mov}}{2} = \frac{P_w \cdot L_{Mar}}{2 \cdot A_o \cdot V_o} \tag{5}$$

where P_w is the coefficient of psychological assessment of waiting time;

I_{mov} – interval of movement of vehicles on the route, hour;

L_{Mar} – total length of CPT routes, km;

A_o – number of operating units of CPT, units;

V_o – operational speed of the CPT, km/h.

In total, these temporary characteristics constitute the value of the coefficient A_1.

$$A_1 = \frac{P_{walk}}{3P_{mw} \cdot V_{walk}} + \frac{P_w \cdot L_{Mar}}{2 \cdot A_o \cdot V_o} \tag{6}$$

The time spent on the actual trip per unit of its length (coefficient A_2) is equal to the reciprocal of the message speed:

$$A_2 = \frac{1}{V_s} \tag{7}$$

where V_s – the speed of the message on the CPT, km/h.

There are no costs depending on the length of the journey in the intra-city message ($A_3 = 0$). Disadvantages, which depend on the length of the movement (A_4), are equal to the fare to the CPT.

Trips by car:

Time costs not related to the distance of the trip (A_1) are equal to the time of walking to the parking place and from it to the destination. It is taken as a constant and adjusted for the psychological assessment of walking time.

$$A_1 = \frac{L_{park} \cdot P_{walk}}{V_{walk}} \tag{8}$$

where L_{park} is the average distance to the car parking place, km.

The time per unit length of movement (A_2) is inversely proportional to the speed of the flow of cars on city streets. Adjusted for the value of the coefficient of psychological assessment of movement in a passenger car:

$$A_2 = \frac{P_{pas}}{V_{pas}} \tag{9}$$

where P_{pas} is a psychological assessment of driving time in a passenger car;

V_{pas} - speed of a passenger car, km/h.

Cost category A is proportional to the distance of movement. Value costs per unit of trip length are equal to the rate of variable 1 km mileage costs. Its value is estimated by rationing for an average passenger car based on the actual value of the cost of operational resources. However, these expenses are not incurred during the trip or in connection with it (for intra-city transfers). For example, gasoline is bought based on the fact that there is a shortage of it in the tank, car repair and maintenance is carried out as needed, etc. The lack of an address connection with a specific trip reduces the significance of these costs from a psychological point of view after making a decision to choose a method of movement. Therefore, the value of A_3 is adjusted for the coefficient of psychological assessment of non-target costs:

$$A_3 = P_{nt} \cdot S_{1km} \tag{10}$$

where P_{nt} – coefficient of psychological assessment of non-target costs;

S_{1km} – the rate of variable costs per 1 km mileage, hryvnias /km.

Costs that depend on the distance of movement form two fundamentally different groups.

Expense category B does not depend on the distance of movement, but is directly related to the fact of the trip. Therefore, these costs directly affect the decision of the task of choosing a method of movement and should be included in the criterion without any adjustments.

The category of expenses refers to the group of expenses, the amount of which is not related to the operation of the car at all. For the owner of a personal car, these costs are set, and their value does not depend on the chosen decision on the method of movement. For a moving subject who does not have a personal car, the inclusion of these costs in the selection criterion corresponds to making a decision about the feasibility of purchasing this car. If, on average, the criterion for choosing a personal car with the included costs is less than others based on the totality of his movements, it is economically expedient for him to purchase this car. This will save him money and time in the process of intra-city transfers. Once the car is purchased, the costs involved have much less influence on the choice of mode of transportation. In other words, the choice of foot traffic – CPT – personal car" is made according to different criteria for a car owner who does not have one. This causes the process of motorization to be irreversible. The rationality of choosing a personal car after its purchase increases sharply, so the departure of a passenger of CPT to his own car is almost always irreversible. At least the reverse process is much more complicated. Accounting for this circumstance, and even the non-economic impact of the costs for the decision to choose a method of movement, can be made by the coefficient of psychological assessment of the costs.

Thus, the coefficient A_4 for categories of expenses B and B can be determined as follows:

$$A_4 = \frac{(C_{car}/A_{sl} + C_{year}) \cdot P_{as}}{N_{year}} + C_{fix} \tag{11}$$

where C_{car} – average cost of a passenger car, UAH;

A_{sl} – average service life of the car, years;

C_{year} – annual fixed costs for a car, UAN;

N_{year} – average number of trips per year, units.

P_{as} – coefficient of psychological assessment of costs;

C_{fix} – amount of fixed expenses during the trip, UAN.

The value of N_{year} can be represented by the value of the annual mileage of the car:

$$N_{year} = \frac{L_{year}}{L_{av}} \qquad\qquad (12)$$

where L_{year} – annual mileage of the car, km;

L_{av} – the average distance of movement, km.

If there is enough statistical information to calculate the choice of moving on foot and with the help of CPT, then the evaluation of the criterion for choosing to move using a car is complicated by such factors as:

First, costs that do not depend on the number of movements (supplied costs) depend on the make and year of the car, as well as the storage method.

Secondly, depending on the make and year of production of the car, there are different operating costs.

Presentation of the main research material

The basic data for the formation of the tariff in the city of Kherson are the standards of the 80s, the last century. However, the method of calculating this tariff is not correct, i.e. unclear initial parameters for the formation of expenditure items.

As a result, negative points in the current tariff formation system were identified:

– when calculating the tariff, only the costs and revenues of communal passenger enterprises are taken into account, the costs and revenues of commercial operators are not taken into account, although they are a component and already quite large in the volume of work performed by CPT.

– the «acceptable» level of the tariff is not calculated based on the expenses of the family budget.

categories of citizens lead to an inflated level of both the tariff and the bearing of losses, because even such a high level of the tariff does not compensate for the costs actually incurred. Setting the tariff only at the level of the cost of transportation of one paying passenger allows the transportation of beneficiaries without any compensation. At its core, in the city of Kherson, in the field of public transportation, there is a situation where there is cross-subsidization in an implicit form, which is expressed in the fact that the passengers who pay the fare partially compensate the fare of the beneficiaries. This statement is valid only for utility companies. *As* a result, commercial enterprises work at an increased tariff, which contributes to the development of the commercial sector of the CPT.

Conclusions

An unjustified increase in the tariff for CPT services destabilizes the situation in society, forcing low-income groups of the population to use CPT less and to look for other alternatives both for movement and for the purposes that prompted the trip. Medium-income and high-income population groups will look for alternative, more acceptable solutions to maintain their transport mobility or ways to reduce it.

Bibliography

1. Луб'яний П.В., Войтович О.О., Макаренко В.Д. Якість пасажирських транспортних послуг на основі нефінансових показників. Вісник Херсонського національного технічного університету. № 1(84). 2023р. С. 48 – 55.

2. Понкратов Д. П., Фалецька Г. І. Вибір пасажирами шляхів пересування в містах: монографія. Харків: ХНУМГ ім. О. М. Бекетова, 2015. 164 с.

3. Логачов Є.Г. Визначення та використання вартісної оцінки неякісних транспортних послуг, що надаються перевізником на маршруті МПтС / Є.Г. Логачов, О.Є. Сокульський // Вісник НТУ. К., 2011. № 24.С. 183 – 188.

4. Лігум Ю.С. Економічна модель якості обслуговування пасажирів на маршрутах міської пасажирської транспортної системи / Ю.С. Лігум, Є.Г. Логачов // Науково-економічний журнал «Актуальні проблеми економіки». 2004. Вип. № 7. С. 124-140.

5. Звіт про науково-дослідну роботу «Обстеження пасажиропотоків на міських автобусних та троллейбусних маршрутах загального користування в м. Херсон»; ХНТУ договір від 23.07.2021р. № 148. 2021. 51 с.

References

1. Lub″yanyy P.V., Voytovych O.O., Makarenko V.D. (2023) Yakist′ pasazhyrs′kykh transportnykh posluh na osnovi nefinansovykh pokaznykiv. Visnyk Khersons′koho natsional′noho tekhnichnoho universytetu. № 1(84). S. 48 – 55.

2. Ponkratov D. P., Falets′ka H. I. (2015) Vybir pasazhyramy shlyakhiv peresuvannya v mistakh: monohrafiya. Kharkiv: KHNUMH im. O. M. Beketova, 164 s.

3. Lohachov YE.H. (2011) Vyznachennya ta vykorystannya vartisnoyi otsinky neyakisnykh transportnykh posluh, shcho nadayut′sya pereviznykom na marshruti MPtS / YE.H. Lohachov, O.YE. Sokul′s′kyy. Visnyk NTU. K., № 24. S. 183 – 188.

4. Lihum YU.S. (2004) Ekonomichna model′ yakosti obsluhovuvannya pasazhyriv na marshrutakh mis′koyi pasazhyrs′koyi transportnoyi systemy / YU.S. Lihum, YE.H. Lohachov. Naukovo-ekonomichnyy zhurnal «Aktual′ni problemy ekonomiky». Vyp. № 7. S. 124-140.

5. Zvit pro naukovo-doslidnu robotu «Obstezhennya pasazhyropotokiv na mis′kykh avtobusnykh ta trolleybusnykh marshrutakh zahal′noho korystuvannya v m. Kherson»; KHNTU dohovir vid 23.07.2021r. № 148. 2021. 51.