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## SOCIAL TRAFFIC MONITORING IN THE CITY OF KREMENCHUK

*The algorithm for a vehicle sociological survey of population is developed, which includes the indicators of the survey of families and transport users, the purpose and the method of commuting, description of routes, comparison of labor commuting by districts, satisfaction of population by the work of transport, priority in using transport. The results of the survey allow predicting transport movement of population and develop the related organizational and economic solutions to ensure high efficiency and quality of passenger transportations.*

*Keywords: sociological survey; city transport; passengers.*

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## СОЦІАЛЬНО-ТРАНСПОРТНИЙ МОНІТОРИНГ М. КРЕМЕНЧУК

*У статті розроблено алгоритм соціально-транспортного опитування населення, який містить показники опитування сімей і користувачів транспорту, мету і способи поїздки, порівняння руху пасажирів за районами, задоволеність населення роботою транспорту, пріоритети у використанні транспорту. Представлені результати опитування надають можливість прогнозувати транспортний рух населення та приймати організаційні та економічні рішення, що забезпечуватимуть високу ефективність і якість пасажирських перевезень.*

*Ключові слова: соціологічне опитування; міський транспорт; пасажир.*

*Рис. 12. Табл. 6. Літ. 10.*

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## СОЦИАЛЬНО-ТРАНСПОРТНЫЙ МОНИТОРИНГ Г. КРЕМЕНЧУГ

*В статье разработан алгоритм социально-транспортного опроса населения, который включает в себя показатели опроса семей и пользователей транспорта, цели и способы поездок, описание маршрутов, сравнение движения пассажиров по районам, удовлетворенность населения работой транспорта, приоритет в использовании транспорта. Представленные результаты опроса позволяют прогнозировать транспортное движение населения и принимать организационные и экономические решения, которые обеспечат высокую эффективность и качество пассажирских перевозок.*

*Ключевые слова: социологический опрос; городской транспорт; пассажиры.*

**Introduction.** Kremenchuk is a city of regional subordination, an administrative, industrial and cultural center in the Poltava region. It is situated in the zone of moderate continental climate in the Dnieper lowland and in the middle reaches of the Dnieper River on its left and right banks at the distance of 115 km from the regional center Poltava and 290 km from the capital of Ukraine, Kyiv, at a crossing of railways. The territory of the city is 9600 ha, the population is about 230 ths people.

Sociological research is known (as compared with planned census) to be an efficient method of making population interested in city problems and frequent use of sociological analysis for passenger traffic issues has proved the topicality of this method (Gavrilov et al., 2007a: 90–95; Moroz, 2014: 103–108; Levkovets et al., 2007: 113–115). The population survey was aimed to study of the aspects concerning the supply of services by public transport in both customary mode and minibus mode.

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Three groups of survey participants were involved: families, users of public transport and vehicles owners.

**Literature review.** Social estimation or social transport population survey (STPS) is a system study of passenger traffic social processes and factors that negatively influence the results of social development (Gavrilov et al., 2007b: 25–27).

STPS is used to: determine the dominant participants of transport process and organize their participation in the choice of a project on improvement of passenger traffic (Moroz, 2015a: 44–49); provide the expediency of proposed changes for all interested parties (Moroz, 2015b: 136–140); estimate the investment projects' social influence at municipal passenger traffic and, in case of finding potential negative factors, determine the way to overcome them, preliminary estimate the level of transport service for city population (Soloshych, 2014: 101–104). This paper describes specific features, methods and results of social transport population survey in the city of Kremenchuk.

**Research objective** consists in developing an algorithm for transport sociological survey of population, which includes the indicators of the survey of families and transport users, their purpose and method of transportation, description of routes, comparison of labor commuting by districts, satisfaction of population with the work of transport, priority in using different route and transport.

**Key research findings.** The project was carried out in Kremenchuk according to recommendations from (Moroz et al., 2005: 78–80; Moroz et al., 2006: 77–79). Similar research concerning the prediction of transport needs of population in big cities was performed for the first time in the 1980s in the cities of Moscow and Omsk and a relevant method of transport sociological research was developed for the solution of social transport problem by the Institute of Social Research of the Academy of Sciences of the USSR (Marunich et al., 2009: 153–192).

The survey in the city of Kremenchuk was carried out with the involvement of sociologists and programmers who analyzed the obtained information (1200 surveys) with the help of specifically developed software. During the social research the following actions were taken: the survey was carried out in 120 families by the random choice method in microdistricts proportionally to the number of total city population. The interview included the following questions: the number of family members; the number of employed; income; the number of pupils; availability and use of transport; fares at public and private transport; satisfaction with the work of public transport; family expenditures on purchasing food etc.

Four groups performed the survey. They consisted of three interviewers and a senior member who checked the file forms and randomly carried out a duplicate check. The forms were coded.

The survey was performed during two days off and one weekday (Saturday, Sunday and Monday) in order to provide the maximum presence of people at home.

The survey of transport users was carried out at transport stops at different times of the day. The participants of the survey came up to people who were waiting for transport at stops and asked them questions as to: the period of waiting, duration of trip, type of transport used, fare and aim of commuting, satisfaction with the work of transport, family income and willingness to pay for the service.

Three groups containing three interviewers each performed surveys at stops in different parts of the city. Each group moved on the territory equal to about a third

part of the city. The groups were instructed to choose independently main and secondary stops and to conduct interviews at different times. On the whole, 520 people were surveyed.

The attention of senior members of the groups was focused on traffic intensity and its congestion. Three times with an interval of 5 min they counted passengers who were waiting for transport. Besides, the total number of people at stops and the number of men and women were fixed. As a whole, 27 stops were investigated and 273 estimates were made. Additionally, senior members of the groups also counted the number of vehicles that approached the stop or passed it because they were filled up. As a result, 118 such examinations were made.

In addition to the survey, the research group conducted an informal interview and met family members, transport users, representatives of transport organizations and private transport owners.

The main conclusion of the survey consists in the fact that in most cases people are not satisfied with the work of public transport and so, no matter how the questions were formulated, 65% of the respondents expressed their dissatisfaction.

The reasons for such situation include: insufficient number of vehicles on routes, their unsatisfactory maintenance and operation, poor road infrastructure. However, especial dissatisfaction with minibus service was expressed by population in relation to high fares as compared to low quality of the service proposed.

Thus, the results of the work are to be focused on the problems of transport service improvement for city population so that its quality corresponds to the fare. Another problem worth paying attention consists in creation of a route system optimally satisfying the population demand for transportation. It encouraged conducting a complex examination of passenger traffic flow at the city routes.

***STPS algorithm:***

*A. Indices of the survey of families and transport users.* On average, an interviewed family consists of 2.5 people, 1 of whom is employed.

About 65% of the families are Ukrainians; 25% are Russians and other ethnic groups. Most families live in their apartments – 75.9%, 14.1% own or rent a detached house. According to unofficial sources, an average income of a family is 857 UAH and almost 65% of it is spent on food. Although only 20% of income is left for other everyday expenses, about 38% of the interviewed families own cars. This relatively big value of the index may be caused by the fact that people use popular crediting systems.

The family survey was focused on employed people, so this group singled out into a separate observation. The number of employed men in families does not exceed the number of employed women greatly: 54.7% and 43.5%, respectively. The income of an employed man exceeds the income of an employed woman by 30% on average. Besides, a man works more hours a week, spends more money on transport, works farther from home, but he is more satisfied with transport service than a woman.

People who go to work or other places on foot or by their own cars were not interviewed. It can be predicted that people who do not use public transport, on average, have higher income than public transport users. Thus, improvement of the work of municipal passenger public transport (MPPT) will be useful for people with lower income level.

*B. The aim of commuting and method of transportation.* PT users interviews demonstrated that citizens of Kremenchuk use transport mainly to go to work (54% of the interviewed), to visit friends (15%), to go shopping (8%), to go to study and rest (13%) and to go back home after that (40%).

As the employed are an important group of PT users, their needs were analyzed in more detail. The data of the family survey demonstrated that 20% of all employed (30.2% of all interviewed families) go to work on foot. The average duration of walk is 16–19 min, which is 15 min less than the average duration of a trip by transport (34 min). It confirms the information obtained from unofficial sources that many people prefer to work closer to homes.

Almost 20% of all the families stated that at least 1 employed family member uses only a personal car or combines it with other modes of transport. Out of all surveyed, 13.8% said they partially use their car on their way to work, while 10.2% prefer exclusively private transportation.

Employed population depends on the efficiency of public transport operation to a great extent. On the whole, 60.3% of the employed use trolleybuses or minibuses. Obviously, minibuses are not used more often than trolleybuses. At the same time, about 65% of the employed use a trolleybus in their commuting at least partially. More than 60% use minibuses to go to work and only 38% of them prefer exclusively minibuses.

Comparing the ways of commuting of employed women and men it is possible to determine that most women get to work on foot. Women also use private cars significantly less. At the same time employed women showed somewhat greater dependence on public transport than men.

The analysis of shopping routes proves high dependence on public transport: 75.1% of buyers use trolleybuses or minibuses, while 48.1% – only a bus. At the same time, buyers go on foot more often than employed (it is connected with the fact that it is difficult to put bags inside a crowded vehicle). 30% of respondents of the surveyed families go shopping on foot and do not use public or private transport in comparison, while the same index equals 20% among those who use PT to go to work.

Thus, the analysis of the family survey data demonstrated that people extensively use public transport for different purposes. It also illustrates an important role of minibuses in comparison with trolleybuses. These conclusions are confirmed by the results of user survey when passengers on the stops were asked about the mode of transport they were waiting for. 30% of people usually wait for minibuses and prefer them.

When the demand for different modes of transport among the employed members of the family was determined, the attention was focused on social characteristics of different groups of transport users by their priorities in transportation modes when going to a working place. As noted above, about 20% of the employed go to work on foot.

This group contains a bigger part of women (63% of all pedestrians) than the group of users and people who live near homes (54.3% of the employed work in their districts). This result is confirmed by the fact that pedestrians take a shorter route than transport users (19 vs 35 min). Pedestrians also indicated lower monthly income than those who use transport.

On the whole, three factors influence the decision to go to work on foot: a relatively close location of the working place, lack of money to use public or private transport regularly and a considerable traffic interval. It can be predicted that some pedestrians, especially those who do not use public transport because of financial difficulties or not quite reliable operation, will join the group of users as soon as transport operation is more regular and prices are more reasonable for them. More than 80% of pedestrians said that operation of municipal transport needs improvement.

As indicated above, about 38% of the employed use a private car to go to work. The analysis shows that most cars users are men (83%). Besides, these users have higher monthly income than pedestrians and passengers of other transport modes.

It is determined that the choice of transport mode depends on people's income. Users of exclusively trolleybuses (19% of the employed) have a considerably lower income than other workers. It is interesting that people who wait for a minibus have the highest index of income. They may take a trolleybus if it comes first, but can afford a more expensive minibus.

*C. Description of the whole transportation by routes.* Most people get to a transport stop on foot when they go to work, to market etc. On average, a passenger spends 9.2 min on this commuting, 51% of users spend 10 or less minutes on this and only 11% spend more than 20 min.

As the survey results showed, the frequency of appearance of public transport at stops and, correspondingly, the period of waiting for and filling in vehicles varies depending on a day of the week and time of the day.

Senior members of the groups made the analysis of the transport movement frequency: during 15-minute intervals they registered the number and the type of vehicles during morning rush-hours (6.30–9.30) and evening rush-hours (16.30–19.00), as well as during the decrease of the passenger flow and on days off. The analysis demonstrated that during morning rush-hours the number of buses and trolleybuses is 3 times as big as during the evening rush-hours. An average frequency of minibuses during rush-hours is 3–4 times as big as during the decrease of passenger flows.

It is determined that the average duration of waiting during the decrease of passenger flows is less than during the evening rush-hours (11 vs 14 min). Thus, the frequency of public transport movement is satisfactory during the morning rush-hours and gradually deteriorates till the end of the day, and after the evening rush-hours it worsens considerably, which does not meet the transportation demand.

Comparison by gender proves that women wait for transport somewhat longer than men (15 min vs 12 min). It is explained by the fact that women commuting more than men when it is not connected with their work during the decrease of passenger flows, when traffic frequency reduces.

Comparing the indices of monthly incomes of families with monthly transport expenditure, we come to the conclusion that groups with lower income spend a considerably bigger part of their income on public transport than people with high income.

At the same time, passengers who have lower income prefer monthly tickets and comparatively cheaper electric transport. In spite of the fact that they use more economical transport and monthly tickets, they have lower income and the percent of their transport expenditure is higher.

*D. Comparison of labor transportation in districts.* There are several districts in the city of Kremenchuk. People mainly work in the central districts of the city and live in distant residential areas. To understand the schemes of people movement more profoundly the employees passenger flows from different districts were studied. It was found out that 24% work in their district of residence. 70% of them are pedestrians, and 30% use transport.

A considerable majority of the employed (76%) go to other districts. The most crowded part is the center of the city, namely, 60 Rokiv Zhovtnia str, Kyivska str, where there is a concentration of cultural and administrative institutions and other institutions and passenger flows are overcrowded by 45%. Other crowded districts include mini-district Molodizhnyi, Port – 23.3%; residential areas I, II and III Zanasyp, Rakivka (mainly detached houses sector) – 14%; railway station and bus station – 20.3%. Attention should be drawn to the fact that a considerable part of population uses public transport to go as far as 2–4 stops thus significantly overloading vehicles. It especially concerns the central part of the city where buses and electric transport operate.

Taking into consideration the fact that electric transport is the cheapest mode of transport and also the fact that its routes, as a rule, cross the center of the city, this mode of transport is widely used by population for trading manufactured goods and food. As sociological research demonstrates, most people (68.9%) think it inexpedient to locate most consumer services and trading establishments in the center of the city and only 20.3% (basically people who trade) are of different opinion. All other people do not hold a certain position as to this question. Also, when people were asked if unsatisfactory operation of transport was connected with location of markets, most of them (60.7%) answered affirmatively.

*E. Satisfaction of population with the work of transport.* During the survey the people were asked if they were satisfied with the current state of transport service or not. The results showed that 59% of the employed in families and 87.4% of MPPT users were not satisfied with it. Women showed more dissatisfaction than men. Women's more critical attitude to MPPT operation is not surprising as they wait at stops more often and spend more time in transport.

As the people were not always satisfied with the work of transport, they were asked what improvements they would like to see. Every respondent gave own answers but was restricted by three proposals. Similar answers were later grouped. In both surveys the list of measures contained the proposals to increase the frequency of buses, then to make buses more capacious and comfortable. Other proposals included: "additional new routes", "cleaner buses".

Some proposals were expressed not in the same succession: "more frequent movement of buses (trolleybuses)", "shorter traffic intervals", "more capacious buses", "control of fare payment", "possibility to buy tickets in advance", "new routes", "better service for distant districts", "better commuting to the market".

The basic conclusion of these observations consists in the fact that the city population wants an increased traffic frequency, especially for trolleybuses, it is necessary to keep the schedule and the routes. Additional new routes are very important for the residents of distant residential areas who suffer from the faults of transport service more than people who live in the central part.



Also, there was a survey in the Internet. The form was created to be distributed in some social networks. The form included 4 questions and variants of answers.

The first question was "What mode of transport do you use?" and one of the modes was to be chosen from the listed. The following question was "What is your age?" to determine the categories of population who took part in the survey, namely, schoolchildren, students, workers, pensioners. The third question was connected with the criteria used by people when they choose the mode of transport. They were proposed the basic criteria of transport choice, namely, price, speed, safety, convenience and possibility to get to a destination. Several criteria could be chosen. The last question concerned inconveniences in transport. It contained a list of main inconveniences and an option to add own answer.

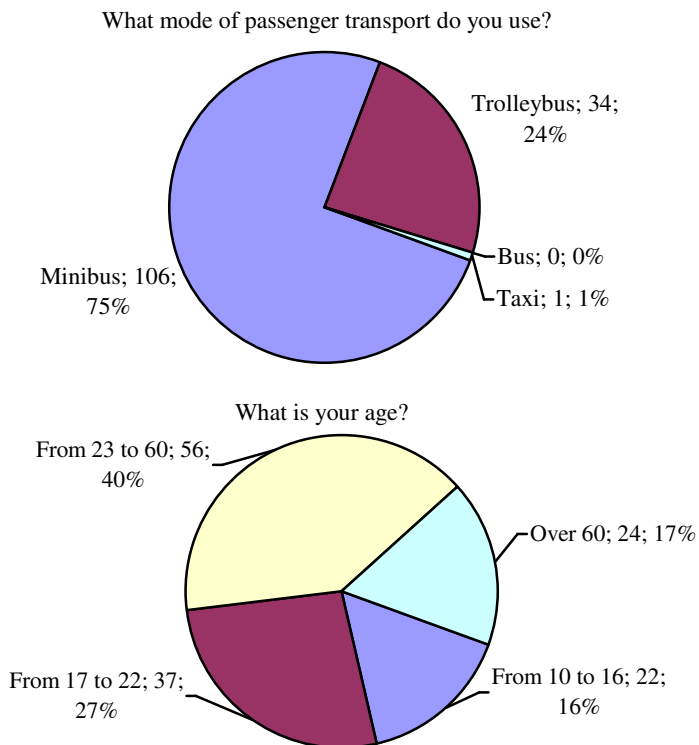


Figure 1. The analysis of municipal transport choice, authors' construction according to the Internet survey

According to the survey results, most population prefers minibuses – 75%, including: 13 schoolchildren – 9%; 37 student – 26%; 55 workers – 40%. Some people prefer trolleybuses – 24%, including 9 schoolchildren – 6%; 1 worker – 1%; 24 pensioners – 17%.

As to the following question, concerning the choice criteria, the most answers (37%) were "speed", which is one of the reasons for minibuses choice. Another reason in favor of minibuses is the possibility to get to destination – 30%, as trolleybus routes do not cover most streets of the city, they mostly run in central streets.

"Fare" was another priority criterion – 35%, most answers were in favor of trolleybuses. "Commuting convenience" was the following criterion – 21%, most respondents chose minibuses. Some people, but not many, chose "safety" as a criterion.

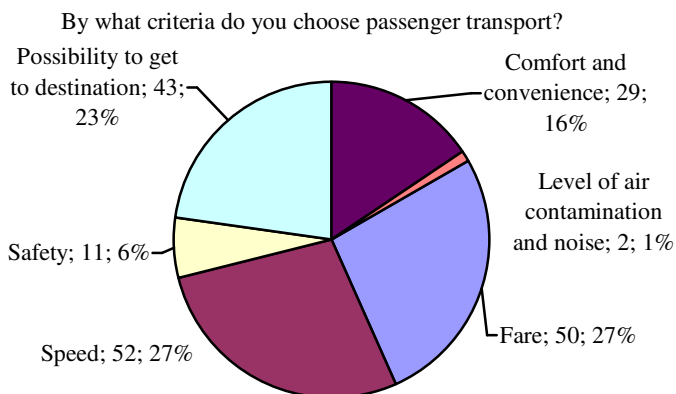


Figure 2. The transport modes priorities, authors' construction according to the Internet survey answers

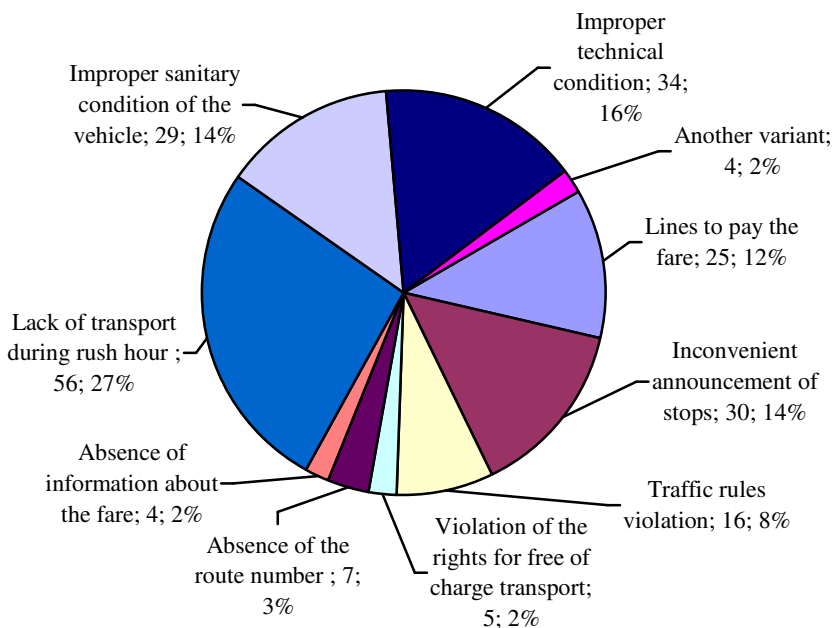


Figure 3. What inconveniences do you come across in public transport, authors' construction according to the Internet survey answers

The following question concerned the inconveniences of transport. The population considered "lack of transport during rush hours" the most important inconvenience – 40% of the respondents. "Improper technical condition" was the second – 24%; this is caused by maladjustment of minibuses for public conveyance and outdated trolleybus carbarns. The third one consists in inconvenient announcement of



stops – 21%. This is an inconvenience of minibuses as in trolleybuses every stop is announced. Another complaint – 21% is about insufficient sanitary condition of vehicles and passenger saloon. Most vehicles are not properly cleaned. One more inconvenience – lines to pay the fare, 18%, also concerns minibuses, because in trolleybuses there is a conductor who walks along the saloon. Other inconveniences are connected with minibuses: traffic violation – 11%, absence of route numbers – 5%, violation of the rights of social groups (which have the right for free of charge transportation) – 4%, absence of information about the fare – 3%.

*F. Priority of the minibuses use.* The research demonstrated that 6.4% of the respondents use minibuses for the distance of less than 5 km; 21.3% – up to 7 km; 42.5% – up to 10 km; 29.8% – over 10 km. Minibus routes connect residential areas (28.2%); bus station and railway station, port (31.8%); medical institutions (11.8%); suburbs (8.2%); educational institutions (13.6%); production facilities (16.4%).

A question was asked about the number of people who enjoy the benefits of fare in public transport. The answer was that, on average, 29.6% of the passengers receive such benefits. The output data and the obtained results of the sociological transport survey of the population in Kremenchuk city are shown in Tables 1–4 and Figures 1–8.

*Table 1. Data of family survey (average), authors'*

Number of family members	2.5 people
Number of employed in the family	1.5 people
Number of employed men	0.8 people
Number of children	0.8 people
Number of schoolchildren	0.8 people
Number of pensioners	0.4 people
% of families living in apartments	85.9%
% of families living in detached houses	14.1%
% of the family income spent on food	69.3%
% of families who own a car	34.1%

*Table 2. Mode of transportation of the population by gender, %, authors'*

Mode of transportation	men	women
Only on foot	13.6	28.3
Part of the way by car	19.7	6.5
Bus or trolleybus	59.3	64.5
Only bus and/or trolleybus	24.6	31.8

*Table 3. Mode of transportation (everyday purposes), authors'*

Mode of transportation	%
Only on foot	34.5
Bus or trolleybus	65.2
Only minibus	34.8

*Table 4. Priority in public transport use, authors'*

Transport mode	%
Trolleybus	48.3
Route minibus	19.8
Taxi (car)	0.3
Passing transport	–

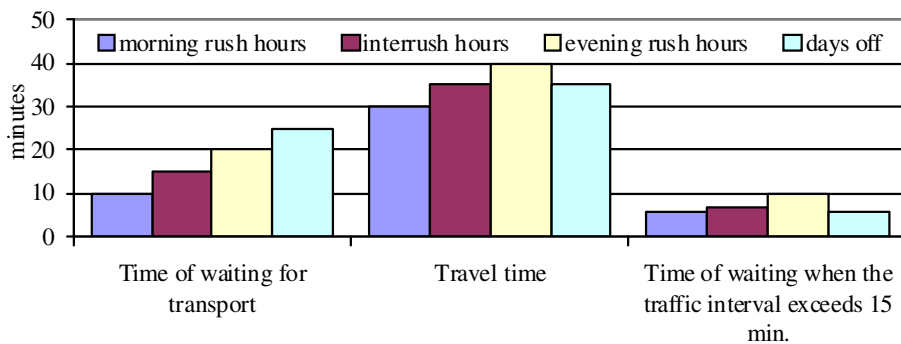


Figure 4. Special features of city transportation motion during the day, authors' construction

Income spent on transport equals 34% of the free part of income

Free part of the family income equals 15% of the total income

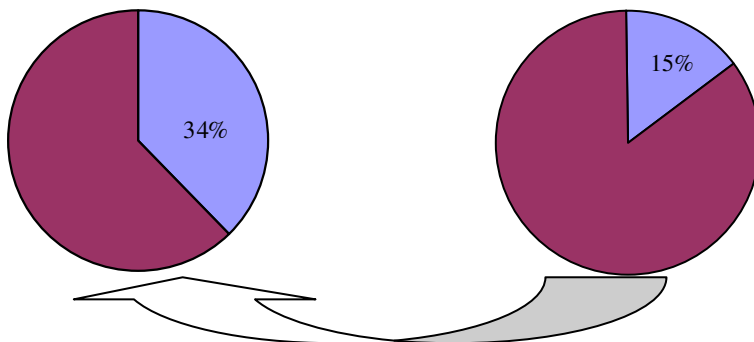
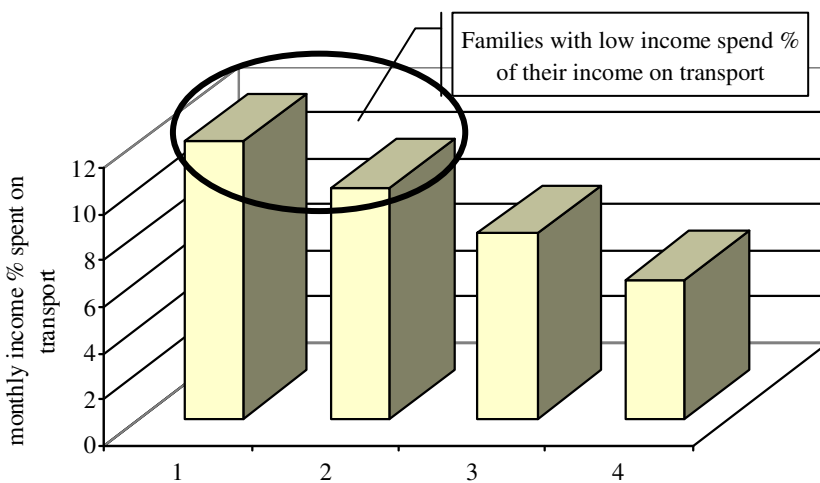


Figure 5. Family expenditures on transport, authors' construction



where 1 – 1st income group (up to 150 UAH); 2 – 2<sup>nd</sup> income group (150–250 UAH); 3 – 3<sup>rd</sup> income group (250–350 UAH); 4 – 4<sup>th</sup> income group (over 350 UAH).

Figure 6. The analysis of family expenditure on transport, authors' construction

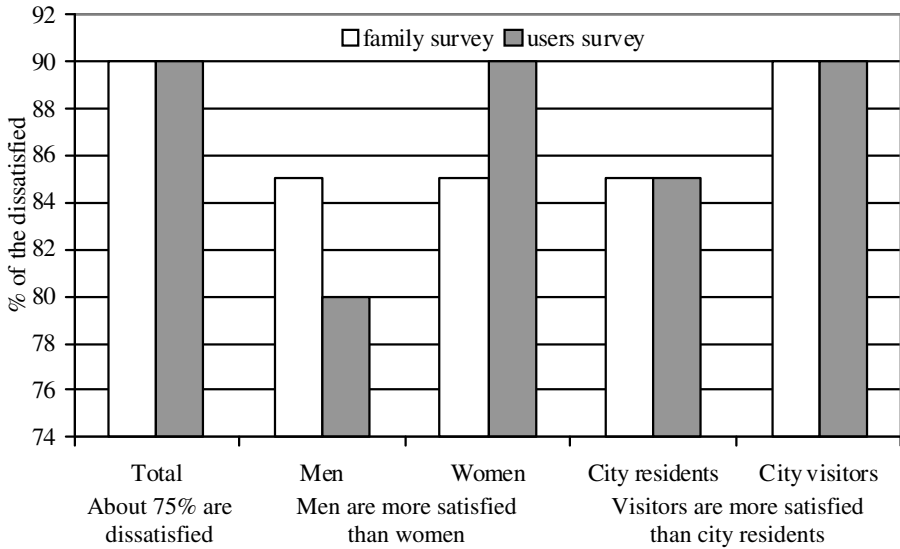


Figure 7. The analysis of passengers' dissatisfaction with transport operation, authors' construction

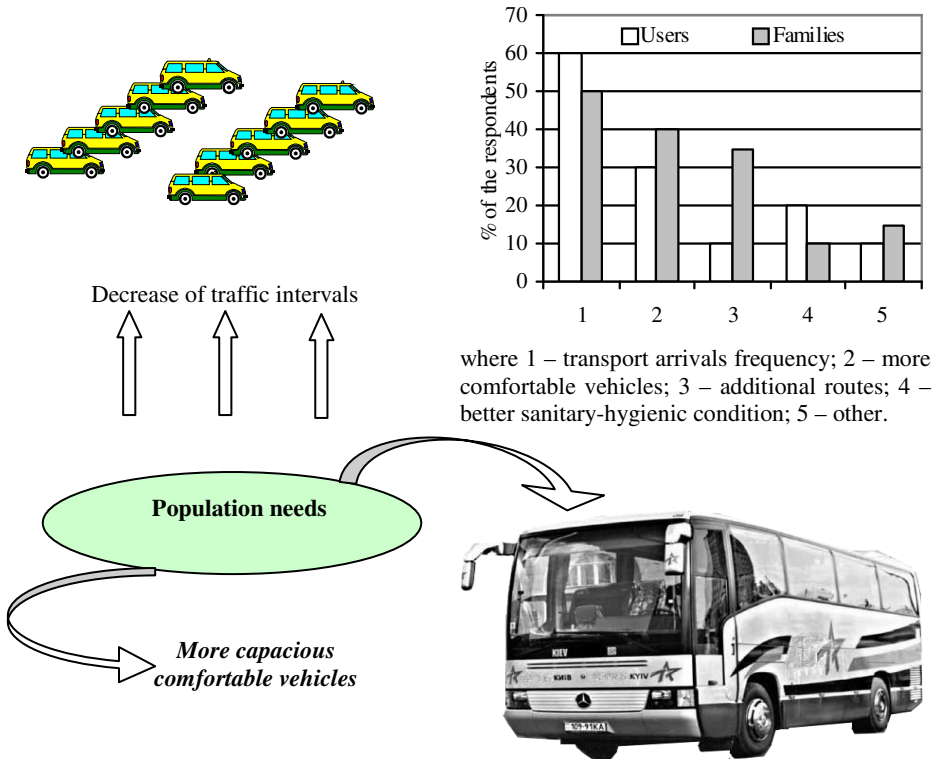


Figure 8. Transport service improvements proposed by the population, authors' construction

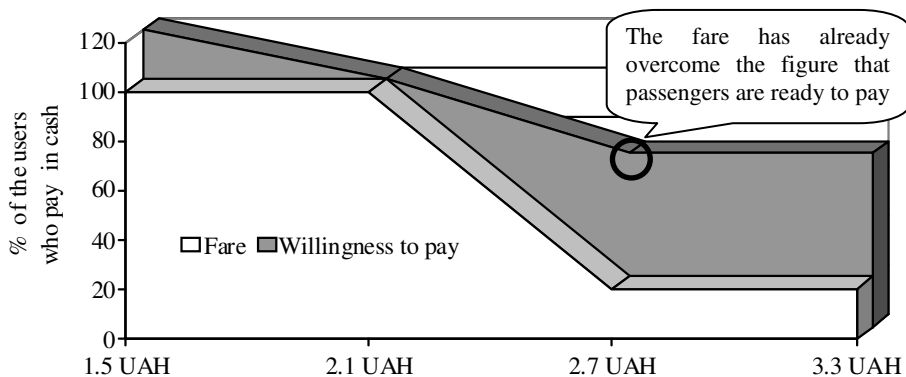


Figure 9. The fare and the willingness to pay more, authors' construction

The results of the analysis of information about the priority of buses use in the mode of route minibuses at public transport city routes are given below.

Table 5. Time of waiting for traffic, authors'

Time of waiting at a stop	% of the respondents
5 min or less	29.4
5–10 min	21.3
10–20 min	29.8
Over 20 min	22.4
Average time of waiting	17.3

Table 6. Duration of commuting, authors'

Duration of commuting	% of the respondents
5 min or less	11.3
15–20 min	27.3
20–30 min	30.4
30–min	27.5
Over 60 min	7.4
Average duration of commuting	33.6

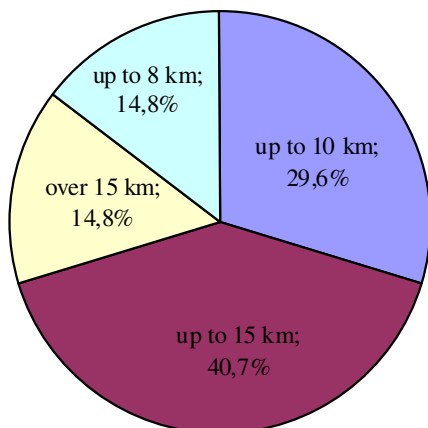


Figure 10. Distribution of minibuses routes depending on the distance of respondents' travel, authors' construction

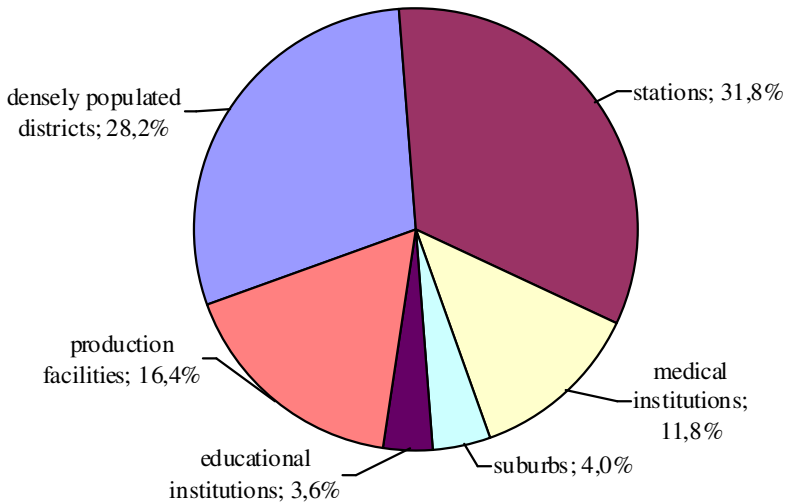


Figure 11. **Distribution of minibus routes, authors' construction**

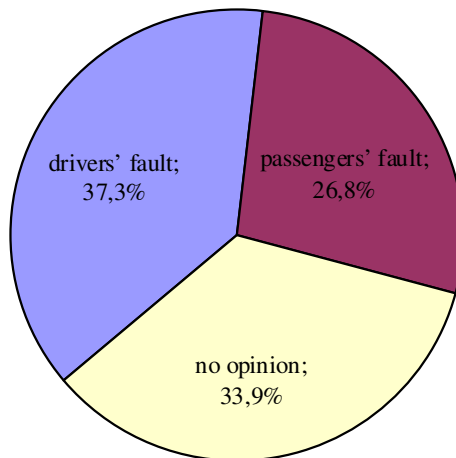


Figure 12. **Respondents' opinions as to dissatisfactory service level, authors' construction**

**Conclusions.** The obtained data make it possible predict transport movement of population and make corresponding organizational and economic decisions to provide high efficiency and quality of passenger transportation.

The research results on passenger flows and sociological transport survey of population are the output data for working out measures on the improvement of efficiency of particular routes operation.

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