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# DETERMINATION OF THE PASSENGER TRANSPORT FATIGUE IN URBAN MASS TRANSPORTATION

*The article deals with the determination of the transport fatigue arising in urban passenger transportation to decrease the passengers' labor productivity and quality in a sector of material or non-material production. Considering the passengers' origination from the different population segments and the different results of their job, it has been suggested to use the passenger's workplace adaptation time when estimating the transport fatigue. From the analysis of approaches to obtain the fatigue initial data it has been found that the questionnaire survey combined with the subsequent statistical data processing is the procedure of choice. From the survey on the effect of the travel parameters and the passengers' age on the transport fatigue, it has been revealed that changing the passenger adaptation time at the workplace can best be described by a logarithmic equation. The transport fatigue assessment resulted from the passengers' adaptation time should be used as a part of social effect in planning the operation or improving the quality of urban mass transit and developing the passenger transportation systems in the present-day cities.*

***Keywords:*** *passenger, transport fatigue, survey, regression analysis*

## Problem statement

Passenger transportation is of the main role to provide the vital functions of the present cities. This mode of transportation determines the accessibility of production, educational, cultural and everyday life institutions for the population, in other words, ensuring the sustainable development of urban areas [1]. However, the operation of urban passenger transport comes along with the significant negative effects, among which one of the most important is the transport fatigue [2]. Transport fatigue is the psychological and physiological state of a human, which is the result of uncomfortable travel conditions. Typical manifestation of this kind of fatigue is a loss of labor productivity and job quality of workers in various sectors of the national economy. To estimate the efficiency of passenger's activity at the main workplace of the material or non-material production, the transport fatigue with the working conditions, environmental impact, biomechanical and physiological factors are important to be considered [3].

## Analysis of recent research and publications

For the first time, the effect of transportation fatigue on the productivity and job quality performed could be traced experimentally in the 70s of the last century at the Moscow Silk Plant [4]. It appeared that out of 270 surveyed workers in the weaving department, 47 weavers (17 %) were allowed to decrease the grade of products (instead of the first-class products, the third-class products were made). Thus, it should be noted that the transport fatigue of workers significantly affects not only the productivity but also the quality of job, and can lead to an increased likelihood of illness and occupational injuries in the workplace [5]. A long and constant transport fatigue can lead to overstrain, which is dangerous for a human health.

A generalized estimate of the trip time effect on productivity in labor specialties is given in the study [6]. Thus, the travel time up to 15 minutes practically does not affect the productivity of workers, while the time from 30 to 45 minutes reduces it, on average, by 4 up to 9 %.

Another effect of transport fatigue on the labor characteristics is also given in [7]. Increasing the time of labor trips by 10 minutes from the specified limit (40 minutes for 80 % of the population of large and super-large cities, 30 minutes for other cities) leads to a decrease in labor productivity by 3 – 4 %, and for the persons living within a radius of 5 km from a workplace the level of labor productivity is 12 % lower than those living in the area of pedestrian access to the place of employment. The average weighted decline in worker's productivity is approximately 4 %.

This above-stated technique is of significant disadvantage, since only the travel time is used as an indicator affecting the transport fatigue. Although the studies have established that the transport fatigue occurs with an action of both the travel time and other transportation factors – trip comfort (vehicle capacity rate), number of transfers, and mode of transportation. Another disadvantage of the approach is the negligence of the age of the examined workers, whereas it is known that biological age is one of the important reasons for the different types of fatigue to appear [8].

During the second half of the 1980s and the beginning of the 1990s, further development in the survey of the transport fatigue was the acquisition and study of analytical dependencies on its impact on the productivity of working people that use the services of urban passenger transportation [9].

Experimental studies were conducted to determine the effect of the so-called passenger's "functional state" on the workplace productivity. The functional state, in turn, was a function of 25 socio-economic factors, which, according to the author, fully described the transportation process impact on a human body. But as a result of a large number of factors, the regression model obtained was too inaccurate, so their number was reduced to few ones – the so-called transportation or travel factors (travel time, vehicle capacity rate etc.). The basis to determine the functional state (in points) was the passenger's heart rate variability, which required the use of expensive medical equipment [9].

In the 2000s, a continuation of the transport fatigue research as the functional state derivative was the use of obtained and other specified dependencies to assess the passenger's route choice [10–13], the selection of vehicles for the passenger transportation [14, 15], the design of transport hubs and bus stations taking into account the transport fatigue growth and the search for ways to minimize it [16].

The foreign papers, for example [17–23], do not consider the transport fatigue effect on passengers and are mainly related to the study of the fatigue of bus, taxi, truck drivers, aircraft pilots and the resulting generation of recommendations and efforts to reduce the risk of road accidents, to increase the timetable fulfillment, freight safety and passengers' travel conditions.

So, the approaches to the study of transport fatigue have some general disadvantages, namely:

1) the use of valuable and unwieldy medical equipment;

2) the failure to take into account the age of a passenger, which significantly affects the different types of fatigue including the transport one;

3) the calculation of a decrease in productivity as a result of transportation fatigue only among the passengers of working specialties, while for the persons with the higher education, teachers, representatives of "creative" professions this determination cannot be made because of the lack of their labor result quantitative measurement.

Taking into account the disadvantages of the above approaches, in our opinion, the most universal indicator of the transport fatigue would be the use of the passenger's adaptation time in a workplace, regardless of the of material or non-material production.

## Aim of the study

The purpose of the study is to establish the laws of the impact of the transportation process parameters and the passenger's age on the transport fatigue in the urban mass transit.

The object of the study is the formation of passenger fatigue as a consequence of the transport factors and passengers' age to impact.

The subject of the study is the influence of transport factors on the passenger adaptation time in the workplace.

To achieve the research aim, the following tasks should be solved:

- selection of the survey technique to obtain the statistical data;
- experimental studies to disclose the transportation parameters impact on the passengers' transport fatigue in urban mass transit;
- analysis of the study results for the influence of the transportation and biological parameters on the passengers' fatigue;
- obtaining the dependencies to best describe the change in transport fatigue expressed as the adaptation time.

## Study material presentation

Transportation fatigue is accompanied by significant physiological and psycho-emotional changes in the human body during the trip. It can be expressed as the loss of labor productivity of the workers or employees due to staying in urban passenger transport; affects the human body within the first hours of working and depends on the transport factors (travel parameters) and the human biological age [24]. To record the changes and, accordingly, to determine the rate of fatigue there are some medical and test methods [2], a brief analysis of which will be presented below.

Medical instrumental techniques are mostly represented by the encephalogram and electrocardiogram recording as well as the skin galvanic response determination [2]. Advantage of the instrumental methods consists in completely excluding an ambiguous person's opinion and ensuring the reliable fatigue data. The disadvantage is the need to use expensive medical equipment and to have a researcher's special education when obtaining and then correctly interpreting the data.

Test methods should be conducted in the form of a questionnaire survey that is a statistical discontinuous observation, which involves the distribution of special questionnaires with a list of questions [25]. Despite the disadvantages, the most important of which are the subjective and inaccurate assessment of the functional state by the persons to be examined, the use of the test methods in the form of a questionnaire survey is of obvious advantage, namely: it does not require an expensive medical equipment; provides a large coverage of respondents and comparatively low labor consumption of testing and results' processing; allows a verification of the obtained results by the methods of mathematical statistics.

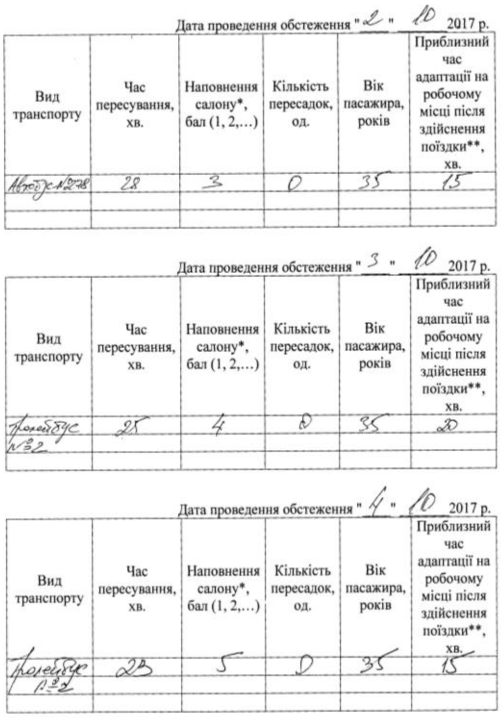
In the case under consideration, the purpose of the questionnaire is to record the travel parameters, the age of the passenger, the mode (or modes) of transport taken for travel, and the adaptation time, that is, the time to accommodate the passenger's body to physical or other (mental, psychoemotional) stress in the workplace [26].

As it was mentioned, without using the special instruments it is quite difficult for the individual (passenger or employee) to determine this time objectively. From this, for the fatigue characteristic, the concepts and language constructions to describe the person's subjective fatigue perception [3, 8, 20], have been proposed: instability, severity of basic production functions; refusal of some production functions; activity annoyance; attention lost; unwillingness to make the necessary movements, communicating with colleagues, subordinate staff, etc.

It should be noted that in the absence of the possibility to statistically evaluate the required number of experiments and assuming that the population is unknown but large enough, in accordance with the law of large numbers it is necessary to obtain at least 384 results for ensuring a sufficient accuracy of observations at the 95% confidence level [27].

Thus, there were 84 respondents belonging to different strata of the working population aged between 18 and 60 years, who daily use the public transport for journeys to and from working places. Within 5 days 420 questionnaires were received to demonstrate the trip parameters, the approximate adaptation time and the age of passengers as workers in a material or non-material production.

Of the total, 405 questionnaires were completed in accordance with the requirements, which allowed their further statistical processing, and met the above requirements for a minimum number of experiments or observations [27]. An example of the completed questionnaire is shown in Fig. 1.



Дата проведення обстеження "2" 10 2017 р.

| Вид транспорту | Час пересування, хв. | Наповнення салону*, бал (1, 2,…) | Кількість пересадок, од. | Вік пасажира, років | Приблизний час адаптації на робочому місці після здійснення поїздки**, хв. |
|---|---|---|---|---|---|
| Автобус №278 | 28 | 3 | 0 | 35 | 15 |
| | | | | | |
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Дата проведення обстеження "3" 10 2017 р.

| Вид транспорту | Час пересування, хв. | Наповнення салону*, бал (1, 2,…) | Кількість пересадок, од. | Вік пасажира, років | Приблизний час адаптації на робочому місці після здійснення поїздки**, хв. |
|---|---|---|---|---|---|
| Тролейбус №2 | 25 | 4 | 0 | 35 | 20 |
| | | | | | |
| | | | | | |

Дата проведення обстеження "4" 10 2017 р.

| Вид транспорту | Час пересування, хв. | Наповнення салону*, бал (1, 2,…) | Кількість пересадок, од. | Вік пасажира, років | Приблизний час адаптації на робочому місці після здійснення поїздки**, хв. |
|---|---|---|---|---|---|
| Тролейбус №2 | 23 | 5 | 0 | 35 | 15 |
| | | | | | |
| | | | | | |

Fig.1 . Completed questionnaire extraction to survey the trip parameters and the passenger's age

Note: * – 1 – there are seats available in the cabin; 2 – all the seats are unavailable; 3 – all the seats are unavailable, but the passengers are free to stand in the cabin; 4 – the vehicle seating capacity is entirely used; 5 – the vehicle is crowded, some passengers stayed at the bus stop.

** – the approximate workplace adaptation time is to describe by shattering, lack of assimilation, reluctance to perform some appropriate functions, dissipation or attention violation, heaviness or unwillingness to carry any actions, communicate with colleagues, etc.; please, specify in minutes how long you feel this situation after a trip if it is available.

The distribution of passengers by average time of adaptation in the workplace obtained from the of the questionnaire results is presented in Fig. 2.

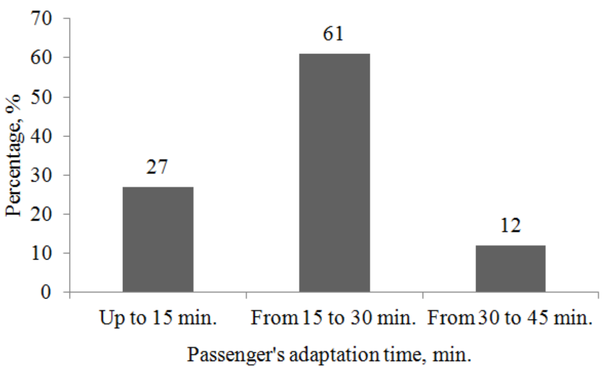


Fig. 2. Passengers' distribution by the average workplace adaptation time

As already noted, the age of passengers significantly affects the fatigue in the workplace regardless of the origin reasons [3, 24]. Distribution of passengers by average adaptation time depending on their age is given in Fig. 3.

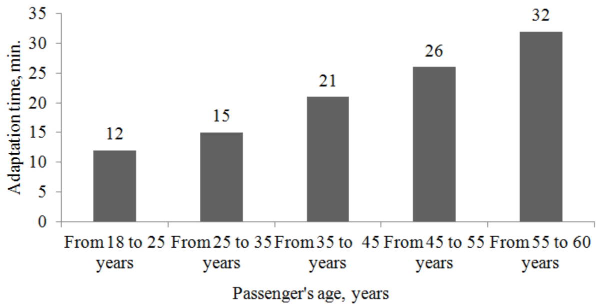


Fig. 3. Passenger distribution by the average age adaptation time

In some papers [6], there was a significant effect of the travel time on the adaptation time. The distribution of passengers according to the average time of adaptation depending on the trip time to the workplace using urban passenger transport is shown in Fig. 4.

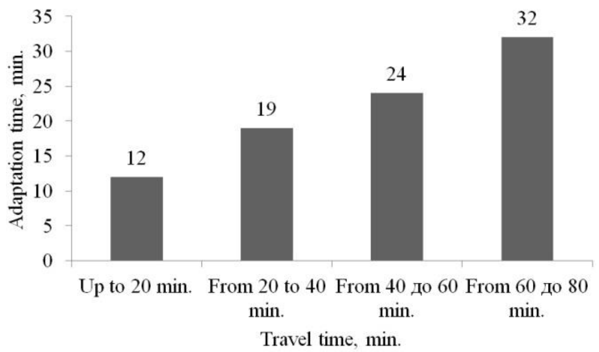


Fig. 4. Passenger distribution by the average adaptation time depending on the travel time

In accordance with the questionnaire data, the average adaptation time was calculated to be equal to 24,18 minutes. However, this value is influenced by random factors, therefore, when using it in further calculations, it is necessary to check its statistical significance by calculating the Student's *t*-test [29]

$$t_{calc.} = \frac{\overline{X}}{\frac{\sqrt{n-2}}{S}}, \qquad (1)$$

where $\overline{X}$ is the adaptation time average value, $\overline{X}$ = 24,18 min.;

$S$ is the adaptation time standard deviation, $S$ = 7,32 min.;

$n$ is the number of observations.

Then

$$t_{calc.} = \frac{24,18}{\frac{\sqrt{405-2}}{7,32}} = 8,82.$$

If the $t_{calc.} > t_{tab.}$ condition is satisfied, then the average adaptation time can be considered as non-random and statistically significant one. In accordance with [28], at the 0,95 confidence level the tabulated *t*-criterion value is 1,965. Since, the average time of adaptation is nonrandom and it can be used in the further research.

To assess the reliability of the data obtained, the sampling limit error is used, which is the maximum possible discrepancy between the mean sample and the total population

$$\Delta_x = Q \times \sqrt{\frac{d^2}{n}}, \qquad (2)$$

where $Q$ is the distribution quartile with the confidence level of 0,95, $Q$ = 1,64;

$d$ is the variance of observations, $d$ = 28,42 min$^2$.

So, for the 95% of the confidence level, the limit error will make

$$\Delta_x = 1,64 \times \sqrt{\frac{28,42^2}{405}} = 2,32 \text{ min.}$$

Thus, it can be stated that with the probability of 0,95, the maximum deviation from the mean adaptation time is 2,32 minutes.

Since the size of the representative sample was not determined because of the too large general population, the relative error of observations would be

$$\Delta_{\%} = \frac{\Delta_x}{\overline{X}} \times 100, \qquad (3.4)$$

$$\Delta_{\%} = \frac{2,32}{24,18} \cdot 100 = 9,5\ \%.$$

According to [29], this value is acceptable, since for too large samples it should not exceed 10%.

To assess the impact of travel parameters and the age of the passenger for the adaptation time, a pair correlation analysis was performed using the Microsoft Office Excel 2010 [30]. However, as with the adaptation time, the correlation coefficient is also affected by a lot of random factors, so it should be verified by calculating the above used *t*-statistics from the results of observations

$$t_{calc.} = \frac{r \times \sqrt{n-2}}{\sqrt{1-r^2}}, \qquad (3)$$

where *r* is the calculated correlation coefficient for the investigated parameter pair.

For example, to prove the correlation coefficient significance in the "adaptation time – travel time" pair, the calculated value of the *t*-statistic is

$$t_{calc.} = \frac{0,78 \cdot \sqrt{405-2}}{\sqrt{1-0,78^2}} = 25,02 .$$

The correlation density between the other parameters under research is given in Table 1.

Table 1

Adaptation time, travel parameters and passenger' age correlation

| Parameter | Travel time, min. | Vehicle capacity rate | Number of transfers | Passenger's age, years |
|---|---|---|---|---|
| Adaptation time, min. | 0,78 | 0,71 | 0,57 | 0,81 |
| Student's test calculated, $t_{calc.}$ | 25,02 | 22,31 | 19,05 | 26,7 |
| Student's test tabulated, $t_{tab.}$ | 1,965 | | | |

As can be seen in the correlation table 1, in accordance with the values of the pair correlation coefficient, all the parameters demonstrate a sufficiently close relationship with the resulting adaptation time, which exceeds 0,5 [31]. For all pairs of variables, the pair correlation coefficient is statistically significant and nonrandom, since the calculated *t*-statistics value exceeds the tabulated *t*- statistics value.

The next stage of the study is to obtain the dependences for describing the change in the adaptation time under the influence of the above parameters. This can be achieved using the mathematical, simulation or economic and statistical modeling [32].

Mathematical modeling uses the strict analytical dependencies as the models. Its advantages are the simplicity and speed of calculations, and the disadvantages are the impossibility to take into account the changes in the parameters included into the model over time, as well as the external environment impact.

Simulation (computer) modeling is based on the use of computer models (programs). The advantage of simulation is the reconstruction of processes and the consideration of many its conditions, the flexibility of the models obtained, however these approach may require a considerable amount of time for the researcher to create them, and also lead to different results if they are used by different researchers due to the lack of standardized procedures.

Economic and statistical modeling uses the models that describe, by means of regression equations, the relationships between the influence factors and the resulting factor. The preference of regression analysis methods includes the ability to quantify the factor influence rate, reproducibility, reliability and visibility of the results obtained, relatively small costs and the implementation time.

Thus, from the analysis of modeling methods, as well as taking into account the time of the survey and the processing of its results, the parameters to be determined, the method labor consumption, it is expedient to use the economic and statistical modeling through the listed above advantages.

Using the regression analysis as a tool for obtaining the models, it is necessary to consider the following requirements [29]: the list of factors into the model must be justified; the list should contain the most important factors that significantly impact on the object under research; the number of factors should not be very large (3–5 factors), because a large number of factors reduces the model accuracy; the factors should be correlatively rather than functionally related, since in this case it is advisable to use strict analytical dependencies; it is necessary to establish the range of each factor in order to justify the limits of the model.

From the practice of regression analysis, it is known that the selection of the model to most adequately describe the process under investigation is done using a variety of linear and nonlinear dependences, from which linear, power, logarithmic, hyperbolic and exponential equations are most widely used. When choosing a model, the main attention should be paid to the simplicity and the results' visual interpretation [29].

From the above-stated recommendations, using the Microsoft Office Excel 2010, the single-factor models were obtained to reveal the impact of each transportation factor (travel time, vehicle capacity rate and number of transfers) and the passenger's age on the adaptation time. The general form of the models and their statistical characteristics are given in Table 2.

Table 2

Single-factor models description

| Dependence type | Equation | Multiple regression coefficient value, $R$ | Determination coefficient value, $R^2$ |
|---|---|---|---|
| Travel time | | | |
| Exponential | $y = 13{,}239e^{0{,}0098x}$ | 0,791 | 0,627 |
| Linear | $y = 0{,}1662x + 13{,}15$ | 0,896 | 0,802 |
| Logarithmic | $y = 4{,}3332\ln(x) + 3{,}5457$ | 0,726 | 0,527 |
| Polynomial | $y = -0{,}0049x^2 + 0{,}4342x + 9{,}7392$ | 0,791 | 0,6242 |
| Power function | $y = 7{,}4874x^{0{,}2567}$ | 0,743 | 0,559 |
| Vehicle capacity rate | | | |
| Exponential | $y = 12{,}812e^{0{,}4396x}$ | 0,792 | 0,627 |
| Linear | $y = 7{,}3456x + 12{,}666$ | 0,754 | 0,568 |
| Logarithmic | $y = 5{,}8601\ln(x) + 16{,}094$ | 0,867 | 0,751 |
| Polynomial | $y = -19{,}587x^2 + 38{,}9x + 0{,}9025$ | 0,681 | 0,463 |
| Power function | $y = 19{,}991x^{0{,}3516}$ | 0,801 | 0,641 |
| Number of transfers ( $x \geq 1$) | | | |
| Exponential | $y = 17{,}261e^{0{,}049x}$ | 0,732 | 0,535 |
| Linear | $y = 1{,}1667x + 17{,}583$ | 0,689 | 0,474 |
| Logarithmic | $y = 3{,}242(x) + 7{,}183$ | 0,814 | 0,662 |
| Polynomial, | $y = -1{,}1187x^2 + 18{,}631x + 0{,}8233$ | 0,726 | 0,527 |
| Power function | $y = 15{,}292x^{0{,}718}$ | 0,879 | 0,772 |
| Passenger's age | | | |
| Exponential | $y = 11{,}613e^{0{,}0123x}$ | 0,627 | 0,393 |
| Linear | $y = 0{,}2053x + 11{,}013$ | 0,721 | 0,519 |
| Logarithmic | $y = 7{,}0429\ln(x) + 2{,}5022$ | 0,921 | 0,848 |
| Polynomial | $y = -0{,}0109x^2 + 0{,}957x - 0{,}7951$ | 0,764 | 0,583 |
| Power function | $y = 3{,}9633x^{0{,}4291}$ | 0,831 | 0,69 |

As can be seen in the Table 2, from the values of the multiple regression and the determination coefficients, the influence of the travel time on the adaptation time is better described by the linear function, the capacity rate is logarithmic, the number of transfers is power-law, and the passenger age is also logarithmic.

The next task is to obtain a general dependence between the adaptation time, the trip parameters and the age of the passenger. Resulting from a large number of factors and the above advantages, the regression analysis was also chosen for this purpose.

It should be noted that in the current papers on psychophysiology, experimental psychology and labor physiology to describe such human states as fatigue, irritation, etc. the Weber-Fechner logarithmic law and the Stevens power law can be distinguished [26].

Thus, in order to choose the most appropriate model using the collected statistical material, which would describe the effect of these parameters on passenger fatigue, we have investigated both dependencies. After converting the recommended dependencies to the linear form for regression analysis in the Microsoft Office Excel [30, 33] and performing the inverse transformations, the logarithmic and the power-law models have been obtained as

$$Y = 4{,}172 + 1{,}863 \cdot lnX_1 + 1{,}314 \cdot lnX_2 + \\ +0{,}742 \cdot lnX_3 + +2{,}946 \cdot lnX_4 , \quad (4)$$

$$\mathrm{Y} = 2{,}156 \cdot X_1^{0{,}206} \cdot X_2^{0{,}181} \cdot X_3^{0{,}089} \cdot X_4^{0{,}942} , \quad (5)$$

where $X_1$ is the travel time, min;

$X_2$ is the vehicle capacity rate, points;

$X_3$ is the number of transfers;

$X_4$ is the age of passenger, year.

The obtained model characteristics are presented in Table 3.

Table 3

Regression statistical description

| Parameter | Regression dependence | |
|---|---|---|
| | Logarithmic | Power-law |
| Multiple regression coefficient value , *R* | 0,878 | 0,77 |
| Determination coefficient value, $R^2$ | 0,771 | 0,59 |
| Factor significance:<br>- $X^0$<br>- $X_1$;<br>- $X_2$;<br>- $X_3$;<br>-$X_4$. | <br>0,024<br>0,036<br>0,006<br>0,006<br>0,042 | <br>0,461<br>0,771<br>0,671<br>0,659<br>0,358 |
| Fisher value:<br>- calculated;<br>- tabulated. | <br>21,57<br>0,271 | <br>1,432<br>6,25 |
| Mean approximation error, *A*, % | 8,75 | 30,12 |

As can be seen in table 3, the power-law model is unsuitable for describing the passenger adaptation time. In the meantime, the logarithmic dependence demonstrates the necessary statistical characteristics – multiple regression coefficient, determination coefficient, significance of factors, information capacity and adequacy.

The taken logarithmic model is valid under the following restrictions (the actual parameters of the transportation process and the age of the passenger)

$$\begin{cases} 15 \le X_1 \le 90; \\ 1 \le X_2 \le 5; \\ 0 \le X_3 \le 2; \\ 18 \le X_4 \le 60. \end{cases}$$

The above model limitations are significant for the existing transport system of the city of Kharkov and can be revised when changing the public transport services.

## Conclusions

Using the "workplace adaptation time" as the general indicator and taking into account all the transportation factors that are significant for the passengers (travel time, travel comfort, number of transfers) and the biological indicator – the age of the passenger allows determining the transportation fatigue regardless of the material or non-material production, to which the passengers are to be assigned as the workers.

It has been determined that the general effect of all the travel parameters and the passenger's age for the time of adaptation is best to describe by a logarithmic equation that demonstrates the acceptable basic statistical characteristics – the regression and determination coefficients, significance of factors and adequacy.

Considering the transportation fatigue originated from the adaptation time can be used as a component of the social effect when planning or improving the quality of public transport services and developing the passenger transportation systems in the present cities.

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# ВИЗНАЧЕННЯ ТРАНСПОРТНОЇ ВТОМИ ПАСАЖИРІВ ПРИ МІСЬКИХ ПАСАЖИРСЬКИХ ПЕРЕВЕЗЕННЯХ

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*Робота міського пасажирського транспорту, разом з позитивними, супроводжується й значними негативними наслідками, серед яких одним з найважливіших є транспортна втома. Вона характеризується як втрата продуктивності праці робітників, що позначається в перші години роботи на виробництві і залежить від дії транспортних факторів.*

*Використання універсального показника "час адаптації на робочому місці" та врахування всіх транспортних чинників, що є вагомими для пасажирів (час пересування, комфорт поїздки, кількість пересаджень), а також біологічного показника – віку пасажира, дозволяє визначити транспортну втому незалежно від галузі матеріального або нематеріального виробництва, до якої належать пасажири як робітники.*

*Ґрунтуючись на аналізі підходів щодо визначення транспортної втоми, можна дійти висновку, що медичні інструментальні методи мають низку значних недоліків, а саме:*

- *використання коштовного медичного обладнання;*
- *потреба у спеціальній медичній освіті для отримання і правильного тлумачення даних, отриманих у вигляді кардіограм або електроенцефалограм.*

*В той же час, використання анкет має переваги, тобто – не потребує коштовного медичного обладнання, дозволяє охопити великі групи людей, забезпечує формалізацію результатів; оперативність; економію коштів і часу, а також перевірку надійності отриманих результатів методами математичної статистики.*

*Шляхом анкетного опитування та наступної статистичної перевірки його результатів, встановлено, що середній час адаптації пасажира на робочому місті складає 24,18 хв., й це значення є статистично значущим.*

*З метою подальшого моделювання часу адаптації визначено силу кореляційного зв'язку між транспортним параметрами, віком пасажира та його часом адаптації на робочому місці. Встановлено, що всі параметри мають достатній зв'язок ( $r = 0,5 – 0,7$) з часом адаптації, й можуть бути включені до моделі, а значення коефіцієнту кореляції є також невипадковим та статистично значущим.*

*За допомогою методів регресійного аналізу оцінено вплив одиничних параметрів перевізного процесу на час адаптації пасажира на робочому місці. Виходячи зі значень коефіцієнту множинної регресії та коефіцієнту детермінації, можна зробити висновок, що вплив часу пересування на час адаптації краще описується лінійною функцією, вплив ступеня наповнення – логарифмічною, вплив ступеня наповнення кількості пересаджень – ступеневою, вплив віку пасажира – логарифмічною функціями.*

*Визначено, що загальний вплив всіх параметрів пересування та віку пасажира на час адаптації найкраще описується логарифмічною залежністю, що демонструє прийнятні основні статистичні характеристики – коефіцієнт множинної регресії (0,878), коефіцієнт детермінації (0,771), значущість чинників, адекватність (21,57 > 6,25), середню похибку апроксимації (8,75 %)/*

***Ключові слова:*** *пасажир, транспортна втома, обстеження, регресійний аналіз*.