Passenger transportation is an integral part of the urban economy to ensure the sustainable development of present-day cities as up to 2/3 of the urban population takes its services. However, along with an undoubtedly positive human effect (providing the vital “home-to-work” travels, access to healthcare, cultural and social facilities, and personal human development, in general), the operation of this transportation mode also results in undesirable consequences (environmental load, traffic noise, road accidents, negative changes in the mental and functional human state, etc.).

As stated above, when traveling on public transport, the passenger's functional state changes for the worse. The worsening can result in the manifestation of several passenger functional states — fatigue, monotony, mental satiety, and stress. The most common, well-studied from a psychological and physiological viewpoint, accompanying and instantly manifesting in every above state is fatigue [1]. In this regard, the question arises on the study of fatigue originated from the public transport use, i.e., transport fatigue.

The examination for the fatigue as well as other functional states can be done with instrumental and psychological methods.

Papers [2, 3] demonstrated a comprehensive review of the medical instrumental techniques to find a human functional state. The undoubted and main advantage of these methods is the objectivity of the human body changes regardless of respondent's gender, age, mood, motivation, etc., at the time of the survey. Nevertheless, the significant disadvantages of the approaches were demonstrated, including the use of expensive medical equipment, special education of the equipment operator to obtain and further interpret the results, the need in special rooms in a clinic or hospital to perform the technique, complicated procedure for instrumental data processing and analyzing, low coverage of respondents compared to the questionnaire methods.
Psychological methods of a human state examination are devoid of the above-mentioned disadvantages, but they are of the serious defects to sufficiently restrict their use in obtaining reliable results. The main technique errors reported are the person's test negligence, the person's inability to objectively express the current state, researcher's difficulties to comprehensively describe a specific state in the test [2 – 4]. The limited approach use also lies in the fact that in the scientific psychological environment, there is no consensus concerning applying these techniques to unambiguously determine the functional state. It is worth saying that the issue has been discussing since the 20s of the twentieth century [4, 5].

However, we believe that the careful sample size substantiation and size stratification, use of well-proven mass techniques, thorough statistical analysis of parameters of interest, ability to process the large amounts of data using modern computer technology and software, and combination of psychological techniques with objective human state monitoring methods to demonstrate a good convergence of the results can eliminate the above-mentioned disadvantages.

There are two groups for the psychological techniques to be used. The first group is presented by a series of simple psychological tests to quickly recognize a functional human state. These are the red and black tables, complete Luscher color test, Schulte tables with a random arrangement of numbers, Bourdon's proofreading, Kraepelin's continuous count [6], etc. The techniques above make it possible to study the human state indirect signs – stability of attention in the various states of the central nervous system, speed of receiving and information processing, visual search performance, etc. However, the simplicity and quickness lead to the fact that these methods partially reflect the human state and are recognized as insufficient to obtain complete information on body mental and physical processes [4, 6].

The second group of tests is the subjective self-assessment techniques. The "Fatigue diagnostics" by Kashiwagi [7], "Physical activity questionnaire" by Kinsman and Weiser [8], and "Well-being, activity and mood" by Doskin [9, 10] et al. are the most widespread techniques. These approaches quickly allow assessing an individual state (fatigue, monotony, stress, etc.) from its components – activity, motivation, well-being, attention, mood, work or study attitude, etc. The latter technique contains the largest number of statements on the human state and is the most studied. The authors reported its validation with 1200 observations and a good correlation between the scores when re-tested and use for psychical, mental, and emotional diagnostic examination of workable adults without any restrictions on gender, social, professional, and educational grounds [4, 9, 10]. A detailed independent qualitative analysis (reliability and validity) of the test material also showed its applicability with some remarks regarding the type of activity in which the respondent is involved [4]. Due to the more thorough research of the technique and recommendations, a modified version of this questionnaire adopted for mass transportation has been used, which consisted of two parts [11].

Part 1 of the questionnaire displays the passenger's age, the travel parameters, and the passenger's subjective assessment of the adaptation time if the adaptation took place. This time is substantiated as a universal transport fatigue indicator for all workers in the production and non-production spheres. The adaptation time is the time to accommodate a human body to a production environment. The workplace adaptation description is based on the signs of fatigue (regardless of the cause) given in the questionnaire that can be observed or felt by a human for a time after a mass transit travel.
Part 2 was the original questionnaire and was a table that contains 30 pairs of opposite characteristics to reflect the studied features of the state (well-being, activity, and mood).

After statistical processing of a test sample of 80 observations from the above-stated questionnaire [11], it has been found that it demonstrated an acceptable quality if assessed by multiple regression and determination factors (average value of 0.83 and 0.69, respectively), and statistical significance $t$-tests ($t_{\text{calc.}} > t_{\text{tab.}}$).

Thus, the conclusions on the applicability of psychological methods for the study of transport fatigue should be done, but with keeping several conditions below: 1) assessment of the statistical significance and non-randomness of the questionnaire results (workplace adaptation time and average score to describe a human functional state); 2) checking for the correlation ratio presence and strength between the indicators of the respondent's functional state expressed in points and the workplace adaptation time, which the respondent indicated; 3) checking for the reliability of the results by retesting; 4) ensuring the required sample size of about 400 observations; 5) checking the questionnaire results for validity, i.e., comparison of the results obtained using a questionnaire with the ones taken through the objective human state monitoring methods (first of all, medical instrumental techniques).

The results of fatigue studies can be used in urban planning, generation of a rational mass transit route network, selection of rational vehicle capacity, and their number on urban lines. These activities should decrease the total travel time and increase travel comfort as the main factors for transport fatigue to arise.

References: