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ESTIMATION OF INFLUENCE OF PSYCHOPHYSIOLOGICAL CONDITION OF THE DRIVER ON SAFETY OF PASSENGER AUTOMOBILE TRANSPORTATIONS

The safety of road passenger transport depends on the main key elements that make up the system: driver-car-road-environment. Failure of any element of this system increases the probability of its exit from the normal-functional state, and most importantly, will increase the risk of an accident (hereinafter - road accident). Therefore, the search for ways to reduce the likelihood of accidents during passenger road transport based on the analysis of the consequences of changes in the psychophysiological states of the driver is an urgent task.

The purpose of the study is to develop recommendations for reducing the probability of accidents during passenger road transportation based on the analysis of the consequences of changes in the psychophysiological states of a driver. The study used the method of expert assessments and the method of "Failure Mode and Effects Analysis" (hereinafter the method "FMEA"), which includes organizational, logical and mathematical and statistical procedures aimed at obtaining from experts the assessment of hazards affecting the change the psychophysiological state of a driver while driving a passenger bus, their analysis and generalization of the results in order to prepare rational decisions.

It is determined that changes in the psychophysiological state of a driver lead to errors in driving a passenger bus and are the main catalyst, which together with various hazards when driving a vehicle and joint interaction of the subject with the object - leads to traffic violations and further - to road accidents.

It is shown that in case of elimination of one of the listed components, the road accident will not occur. It is established that the loss of concentration, changes in emotional state and intensity of the load are the main factors that affect the psychophysiological state of a passenger bus driver. The dependence of the accident on the presence of the catalyst, the hazard, and the interaction of the subject with it is determined. It is proposed to use the driver's reaction as a catalyst, which depends on the change of their psychophysiological state while driving a passenger bus.

Keywords: driver, psychophysiological condition, passenger bus, hazard, interaction, catalyst.

INTRODUCTION

Road transport is a basic component of the state economy and meets the needs of the population to move in space. Growing demand for road passenger transport contributes to economic stability, social development and improving the financial condition of the transport company (TC). The effectiveness of this process depends on:

- the level of road safety of automobile transportations;
- minimization of hazards and occupational risks (OR), which are associated with the human factor (physical and psychophysiological state of health of the driver);
- minimization of logistical losses that TC will receive as a result of violation of traffic regulations (TR) or the occurrence of road accidents (RA).

For example, TC's logistics losses are 9% of GDP for the United States; 11% of GDP for Japan; 12 % of GDP for France, Korea, Germany [1, 2]. This requires TC professionals to make effective management decisions that aim to increase the safety of the road passenger transport process and minimize the hazards and ORs of passenger bus (PB) drivers. Thus, there is a need to solve an urgent problem, i.e. the study of various hazards and assessment of OR, which occur during the performance of transport work by the driver and which affect the change of the psychophysiological state. It should be noted that there are quite a significant number of different incidents on the roads and RA that significantly increase both human losses and TC financial losses.

According to [3], about 1.3 million people die each year as a result of RA. The damage suffered by most countries as a result of RA reaches 3% of their gross domestic product. About 1.3 million people die each year as a result of RA. Another 20 to 50 million people suffer non-fatal injuries, which in many cases lead to disability. According to statistics [4] in the countries of the European Union in 2020, 18,800 people died in RA. Compared to 2019, there was an unprecedented drop of 17% in the number of RA. This means that in 2020, almost 4,000 fewer people died on EU roads compared to 2019. The decline in traffic as a result of the Covid-19 pandemic has had a clear, albeit incredible, impact on road deaths. Fig. 1 shows the data of deaths as a result of RA on the roads of EU countries per million inhabitants for the period 2019-2020 (preliminary data for 2020) [4].

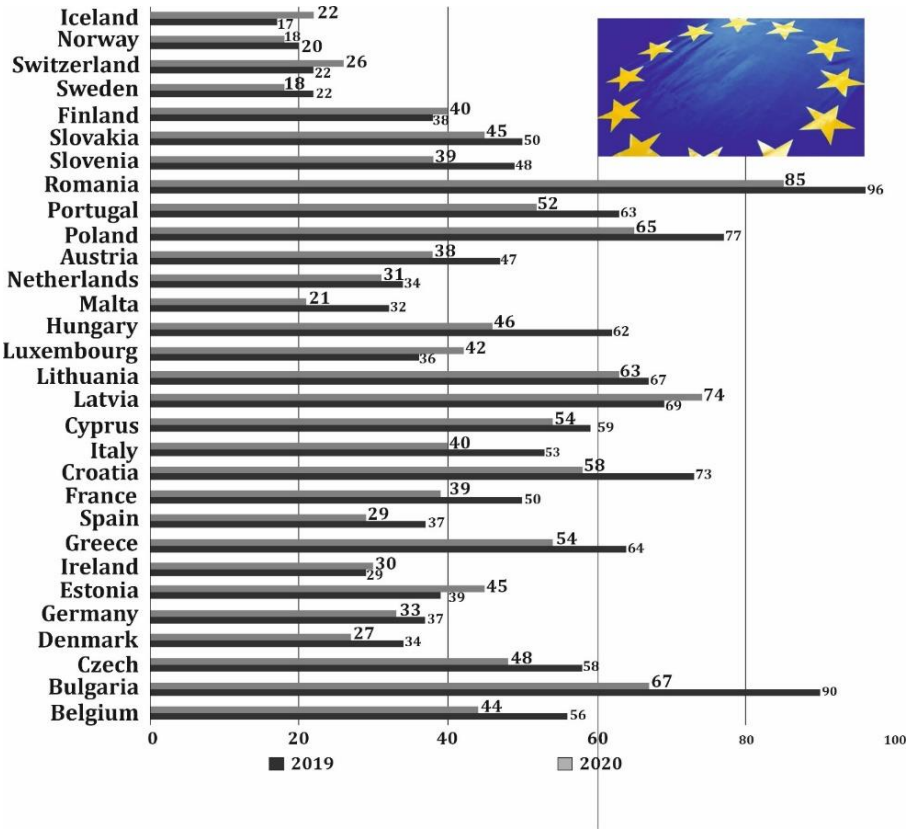

Figure 1 - Data on deaths as a result of RA on the roads of EU countries per million inhabitants for the period 2019-2020 (preliminary data for 2020) [4]

For the conditions of Ukraine according to [5] in 2020 the total number of RA was 168107, in which 3541 people died and 31974 people were injured. For the period from 01.01-31.08.2021, the sad statistics consist of the following data: the total number of RA was 15 613, in which 1914 people died and 19309 people were injured. At the same time, most studies [1, 6, 7] show that security problems are inherent around the world, which requires the construction of appropriate mathematical models that can predict developments, including to reduce or avoid unnecessary hazards and OR.

ANALYSIS OF LITERARY DATA AND PROBLEM STATEMENT

It is known that the safety of road passenger transport depends on the main key elements that make up the system: driver-car-road-environment (hereinafter - the "DARE" system). Failure of any element of the DARE system increases the probability of its exit from the normal-functional state, and most importantly, will increase the risk of RA.

Experts single out the driver as the most important element of the "DARE" system, who needs an appropriate level of control of the psychophysiological state during the performance of professional functions to reduce errors that occur when driving PB [6]. Thus, the study [7] indicates that failures in road transport systems are mostly related to the behavior of the driver while driving a vehicle (V). As the "DARE" system constantly exchanges information: from V technical condition and road conditions to the state of driver's health, who provides control commands and receives information about the results of their actions through feedback channels and, according to changes in the situation, performs corrective actions [8]. Hence, the reliability of the system depends on the ability to perceive and process information. The authors of the study [9] assume that the root cause of errors is related to changes in the psychophysiological state. Correction of this situation is seen in the strengthening of requirements for professional training of drivers [8]. Another study [9] found that most road accidents are caused by a lack of awareness of drivers about the hazards and their health consequences. The authors point out that the technical systems of the car do not often fail, and those minor cases, again, are mostly related to the human factor. Thus, difficult situations on the road in which the driver makes a mistake according to statistics occur once a month on average, which in the general sense leads to an accident once every five years [10, 11]. It is proposed to correct this situation with the help of driver behaviour planning theory, which is based on studies of traffic conditions, cultural habits, which allows finding appropriate methods to supplement and adjust the driver's reaction to difficult situations [12].

The authors of the paper [13] sought reasons for the errors using the method of "FMEA", which allowed them to assess the driver's performance using a comprehensive indicator "transport operator specifications". According to this indicator, you can determine the impact of all potential hazards during the transport process on the probability of error. It is also possible to rank hazardous factors during road transportation of goods, presented by the authors of the paper [14]. The authors based on a systematic approach to identifying the hazards that occur during the transport process established the criticality of the system; after crossing it the emergency occurs. On the other hand, an important component of the transportation process is to ensure the reliability of logistics in the supply chain. The authors of the paper [15] showed the relationship between the level of service and safety of the car based on the "FMEA" analysis method. This allowed the development of recommendations to improve the reliability of transportation by reducing the number of failures, which is calculated depending on the severity, occurrence and detection.

A radical solution to this problem of reducing the number of incidents in the "DARE" system is the production by the industry of fully autonomous cars on artificial intelligence, which make independent decisions based on the collection of the maximum amount of information about the environment. At the same time, in order to strengthen the safety of such transportation, it remains possible to control the movement of such V by transport operators [16].

From the analysis we can identify several main causes of RA, where the most significant share is the change in physical or psychophysiological state of the driver during driving V (Fig. 2), characterized by: fatigue from prolonged driving PB; deterioration of psychomotor reactions when driving PB from intense changes in traffic intensity, the manifestation of fatigue from monotonous movements and being in a monotonous working posture; change in emotional mood; loss of concentration; manifestation of aggression towards passengers or other road users; dissatisfaction with the conditions of comfort in the workplace, etc.

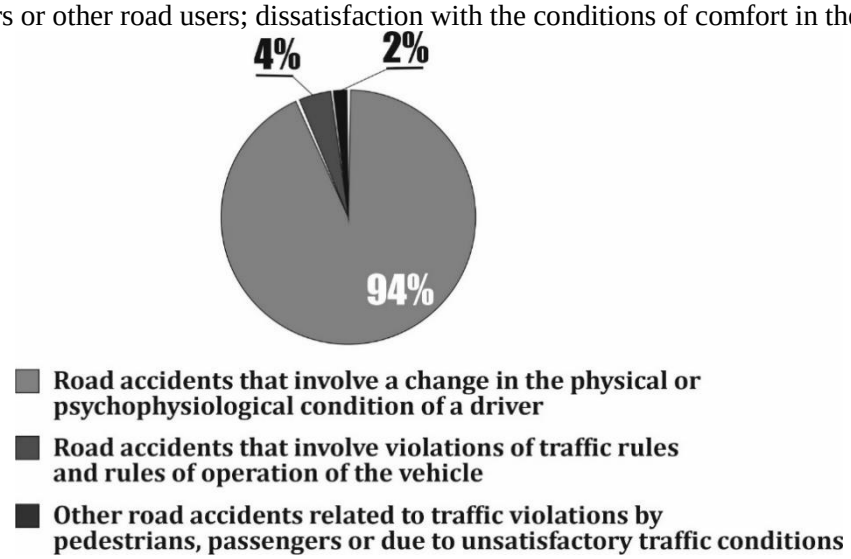

Figure 2 - The groups of main reasons for committing RA

In addition, the deterioration of the physical health of the driver while driving V may change on the basis of the symptoms of chronic disease, the sudden onset of a viral disease; residual signs of alcohol or drug intoxication, from prolonged driving of PB without rest; the influence of harmful production factors during PB driving: vibration, PB cab temperature, noise, dust, etc. [8-12].

AIM AND TASKS OF THE RESEARCH

The object of the research is the transport process of passenger road transportation.

The purpose of the research is to develop recommendations for reducing the probability of accidents during passenger road transportation based on the analysis of the consequences of changes in the psychophysiological states of the driver.

RESEARCH RESULTS

To assess the hazards, OR in the implementation of passenger road transport we will use the method of expert assessments and the "FMEA" method. The use of this method is often the most economical, and sometimes is the only possible way to assess the degree of OR for PB driver, in accordance with the requirements [17-20].

Expert evaluation was performed by ranking, pairwise comparisons, direct evaluation of the constituent factors of OR [17-20]. Ranking is the arrangement of objects (events, facts) in ascending or descending order of OR. In pairwise comparison, experts compare all objects in pairs, select the best for each pair, then form

new pairs and continue the comparison until one find the object with the best value. Pairwise comparison was used in the analysis of a large group of objects. The evaluation was conducted by five experts. Three of them are PB drivers with work experience 11, 17, 22 years respectively. And two other are scientists in the field of transport technologies, with scientific degrees and experience of scientific work 18 and 28 years respectively. After obtaining the results of expert evaluation of the factors that have the most significant impact on the probability of RA, the average weight of the relevant indicators was determined by the relevant evaluation criterion, the severity of the consequences of OR, by the formula [21]:

$$P_i = \left(Y_1 / 2 + Y_2 + Y_3 + \ldots + Y_{n_i - 1} + Y_{n_i} / 2\right) / \left(n_i - 1\right) \quad (1)$$

where P_i is the average weight of the relevant expert evaluations of the relevant evaluation criterion; n_i is the number of expert assessments of the i-th group; Y_1, Y_2, ..., $Y_{ni\ -1}$, Y_{ni} are assessments that are determined by experts in assessing the risk factors for RA.

The next step is to quantify the ORs that occur as a result of changes in the psychophysiological state of the driver, while driving PB by the algorithm of the "FMEA" method, to identify possible inconsistencies and causes of RA. The actions of experts according to the algorithm of the "FMEA" method (Fig. 3) are described in detail in the standard [22].

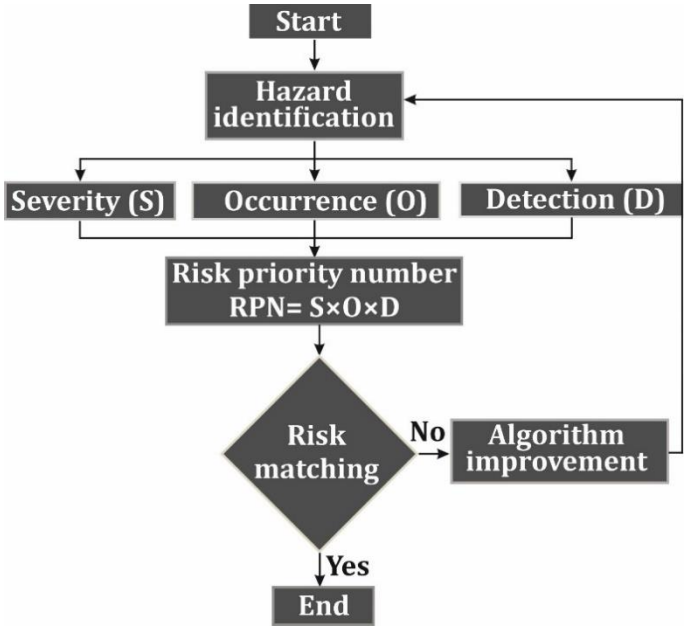

Figure 3 - Algorithm of experts' actions during OR evaluation [22]

The group of experts assesses three main risk factors for the regime of possible potential hazards: failure severity *("S")*, occurrence *("O")* and detection *("D")*. The product of these components *"S"*, *"O"* and *"D"* allows you to determine the value of the priority rank OR ("Risk priority number", hereinafter "*RPN*") by the formula [22]:

$$RPN = S \times O \times D, \quad (2)$$

The OR point obtained by the "FMEA" algorithm continues until the "RPN" priority rank value is fully identified, indicating the highest OR values. The most influential factors are those in which the value of "RPN" exceeds 150 points [22].

DISCUSSION OF THE RESEARCH RESULTS

The analysis of the causes of RA showed that the presence of hazard during movement V, which is due to both internal and external factors, in most cases is only one of the elements of influence that leads to a traffic accident. In most cases, RA occurs if the following condition is met:

$$"RA" = "Hazard" + "Interaction" + "Catalyst", \quad (3)$$

where "*Hazard*" is potentially dangerous phenomenon that may cause harm to humans (weather conditions, road conditions, PB breakdown); "*Interaction*" is compatible action of the subject with the object in which the result of the action of one of them can lead to a dangerous state; "*Catalyst*" is a certain phenomenon that sets the event in motion.

It is impossible to get into RA if all three of these elements do not exist. Of course, to protect the PB driver from an accident, it is usually easiest to eliminate the component "*interaction*", i.e. to refuse to perform transport work. It is more difficult to eliminate the "*hazard*" component, especially if it is related to external factors (weather conditions, other road users, road conditions, etc.). However, the most difficult to predict is the "*catalyst*" component as being related to the psychophysiological state of the driver, which may change due to different scenarios during the driving PB. For example, if you ask about the increase in the number of accidents during driving V in low visibility or difficult weather conditions, the answer requires additional information about the training, experience and psychophysiological condition of the driver to calculate the risk of RA.

Let's analyse different scenarios during the management of PB to determine the meaning of the term *"catalyst"*.

Common situations that can lead to a PB collision include:

- bypassing an obstacle that is located on the roadway, which requires a quick response of the driver;
- loss of attention at a crossroads due to driver distractions while driving PB;
- PB overtaking manoeuvre to the oncoming lane, which requires driver's clear understanding of the technical capabilities of their and oncoming V, as well as the corresponding emotional state,
- failure of PB technical systems, which requires appropriate control over the emotional state of the driver and a clear algorithm to stop V.
- collision with a pedestrian due to lack of visibility or delay braking reactions to its appearance on the roadway.

Determination of the most influential psychophysiological state of the PB driver, which is most likely to lead to RA by the "FMEA" method and the method of expert assessments are given in tables 1. The mentioned determination of risk factors, which are given in tables 2 were carried out on the basis of the analysis [23-26]. From the analysis of the calculations it can be concluded that the highest level of OR, including the threat to health and life of the driver PB is:

- OR, which is associated with psychophysiological stress due to the fact that PB is V of increased risk, manifestation of fear, anxiety, doubt, insecurity,
- performing discrete work, which is associated with frequent changes in the beginning traffic and stops (congestion of a large number of cars, traffic light regulation, etc.);
- fatigue from prolonged PB driving without rest.

This allows the development of preventive measures that will increase the safety of passenger road transport. Figure 4 shows a diagram of the OR profile of a PB driver.

Table 1 Results of expert assessment of dangerous actions of PB driver

№ п/п	Risk factor for TR violation or RA	Expert evaluation criteria														
		Failure					Consequences					Severity				
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
1.	Psychophysiological stress due to the fact that PB is V increased risk., manifestation of fear, anxiety, doubt, insecurity	6	7	7	7	7	8	9	9	8	9	8	8	7	8	8
2.	Performing discrete work, which is associated with frequent changes at start and stops (a large number of cars, traffic light regulation, etc.)	5	6	6	7	7	9	9	9	8	9	7	7	7	8	6
3.	Change of psychophysiological state as a result of PB driving in the conditions of the imposed rate and deficit of time (execution of the schedule of movement)	7	7	6	6	7	9	9	9	9	9	7	7	6	6	5
4.	Change in psychophysiological state as a result of the temperament of the character of the PB driver	6	5	6	7	7	8	8	9	8	9	8	6	7	8	8
5.	The results of the influence of harmful production factors during the PB driving on the psychophysiological state of the driver	2	4	5	3	3	8	8	8	8	8	7	6	6	7	6
6.	Changes in the psychophysiological state as a result of a sense of high responsibility for the lives of passengers	3	8	7	6	5	8	9	9	9	9	7	8	8	7	8
7.	Manifestations of fatigue from prolonged PB driving without rest	6	8	8	7	7	9	8	9	9	8	9	9	9	7	9
8.	Deterioration of psychomotor reactions to changes in traffic intensity	5	6	5	4	4	8	8	7	8	8	6	7	6	7	6
9.	Manifestation of fatigue from monotonous movements and staying in a monotonous working posture for a long time	3	3	3	3	3	7	7	9	7	9	3	4	3	2	5
10.	Change in emotional mood as a result of a constant and high degree of readiness for action in case of an unexpected change in the traffic situation	3	6	3	3	3	6	7	5	9	9	4	4	4	4	5
11	Loss of concentration due to uneven flow of information	5	6	5	4	4	8	8	7	8	8	6	7	6	7	6
12	Dissatisfaction with the conditions of comfort in the workplace	3	3	3	3	3	7	7	9	7	9	3	4	3	2	5
13	Changes in psychophysiological state as a result of active search for missing information during PB driving in poor visibility (at night, in fog, rain, snow).	8	6	6	7	6	6	7	5	9	9	7	7	8	8	7
14	A change in the psychophysiological state due to the lack of PB driver's confidence in that in the next moment there will be a pre-known element and there will be a pre-known traffic situation.	5	6	5	4	4	8	8	7	8	8	6	7	6	7	6

Table 2 The results of the evaluation of drivers' OR by the "FMEA" method

The item being evaluated	Function	Failure		Reason		Consequences		("RPN"="S"×"O"×"D")	
		Description of symptoms	"S"	Reason description	"O"	Description of consequences	"D"	"RPN"	Priority actions
The state of psychophysical health of the PB driver	PB driving when transporting passengers	Deterioration of psychophysiological condition (manifestations of fatigue) during the performance of production activities during the transportation of passengers	7	Psychophysiological stress due to the fact that PB is V increased risk., manifestation of fear, anxiety, doubt, insecurity	9	Very hazardous	8	450	A
			6	Performing discrete work, which is associated with frequent changes at start and stops (a large number of cars, traffic light regulation, etc.)	9	Very hazardous	8	409	A
			7	Change of psychophysiological state as a result of PB driving in the conditions of the imposed rate and deficit of time (execution of the schedule of movement)	9	Very hazardous	8	463	A
			6	Change in psychophysiological state as a result of the temperament of the character of the PB driver	8	Hazardous o	7	380	B
			3	The results of the influence of harmful production factors during the PB driving on the psychophysiological state of the driver	8	Moderate	6	155	D
			6	Changes in the psychophysiological state as a result of a sense of high responsibility for the lives of passengers	9	Hazardous	7	373	B
			7	Manifestations of fatigue from prolonged PB driving without rest	9	Very hazardous	8	489	A
			5	Deterioration of psychomotor reactions to changes in traffic intensity	8	Moderate	6	236	C
			3	Manifestation of fatigue from monotonous movements and staying in a monotonous working posture for a long time	8	Low	5	126	D
			4	Change in emotional mood as a result of a constant and high degree of readiness for action in case of an unexpected change in the traffic situation	7	Low	5	140	D
			5	Loss of concentration due to uneven flow of information	8	Moderate	6	236	C
			3	Dissatisfaction with the conditions of comfort in the workplace	8	Low	5	126	D
			7	Changes in psychophysiological state as a result of active search for missing information during PB driving in poor visibility (at night, in fog, rain, snow).	7	Hazardous	7	328	B
			5	A change in the psychophysiological state due to the lack of PB driver's confidence in that in the next moment there will be a pre-known element and there will be a pre-known traffic situation...	8	Moderate	6	236	C

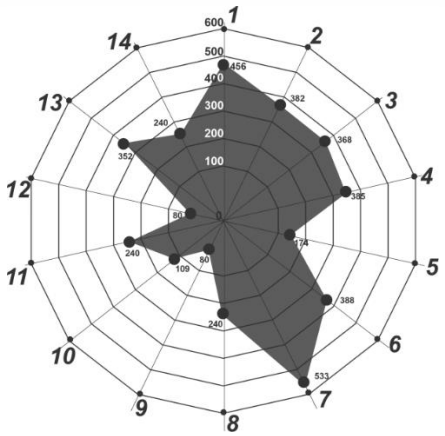

Figure 4 - The OR profile diagram of the driver PB figures from 1 to 14 correspond to the risk factors for occurrence / violation of RA shown in table 1, 2

Without road safety measures it is impossible to reduce injuries caused by RA. In general, RAs occur due to insufficient driver qualifications, carelessness, and inability to organize safe traffic due to the specifics of PB driving, which is a complex problem that can be reduced by raising the awareness of road users. Thus, most of the world's transport companies to address this issue implement various traffic safety management systems (programs), which are based on three steps: plan, act, check that meets the requirements of the standard [28].

Identifying the hazards associated with driving a car and assessing the associated ORs are key road safety planning measures. These steps allow you to set priorities to ensure appropriate security measures. This process should begin with the formation of the driver's understanding of the importance of anticipating certain developments of situation, followed by the choice of tools that will avoid accidents or at least reduce OR. This, in turn, will allow you to plan resources, actions, identify those responsible, control dates and track the implementation of tasks.

From the above analysis it can be concluded that obtaining a driver's license is not a sufficient condition for PB safe driving, it is necessary to check at least three other indicators: attitude, behaviour and understanding of the dangers the driver will face while driving PB and the ability to avoid them. To do this it is recommended to implement a program to monitor the effectiveness of solutions aimed at improving the safety and comfort of PB drivers for the timely implementation of corrective decisions based on the assessment of intensity and intensity of work.

Based on the analysis for determining the psychophysiological hazardous conditions of the PB driver, the authors developed a checklist (Fig. 5) to assess the accumulation of fatigue through the definition of an

integrated assessment of the severity of work. Improving working conditions slows down the development of fatigue of employees and improves their productivity.

Step 1 Hazard identification	Step 2 Determining the risk level					Step 3. Risk control	
Hazard factors	Risk level					Results	
	No Risk 1	Low 2	Medium 3	High 4	Critical 5	Actual value	Defined score
LOAD							
The magnitude of the force compared to the maximum value,%	1-20	21-40	41-60	61-80	> 80		
Perception of effort	Inconspicuous						
	Obviously						
	Significantly						
	Heavy						
	Very Heavy						
LOAD DURATION							
Duration of effort for one working shift, (hours / per shift)	1-20	21-40	41-60	61-80	> 80		
PACE OF WORK							
Effort frequency, (number of movements per hour)	< 10	10-15	16-29	30-59	> 60		
RATE OF WORK							
Speed of operations in comparison with the maximum value	< 50	50-60	60-70	70-90	> 90		
Perception	Inconspicuous rhythm						
	Slow rhythm						
	Normal rhythm						
	Intense rhythm						
	Unbearable rhythm						
WORK TIME							
Load duration, (hours per shift)	< 1	1-2	2-4	4-6	> 6		
TOTAL SCORE							
WORK INTENSITY INDEX							

The overall estimate of the intensity rate is determined by the formula. According to the integrated indicator we determine the category of intensity of work (IW) in compliance:

$$IW = L + LD + PW + R + WT,$$

where L is load; LD is load duration; PW is pace of work; R is rate; WT is work time.

After calculating the JSI index, we obtain a general index of work intensity, the interpretation of which is carried out using the appropriate criteria:
1. 18-27 - points: the production task is unlikely to lead to occupational diseases;
2. 28-44 - points: the production task will contribute to the gradual development of occupational diseases;
3. 45-54 - points: the production task will probably cause occupational diseases.

а)

STEP 1. HAZARD IDENTIFICATION	STEP 2. DETERMINING THE RISK LEVEL					STEP 3. RISK CONTROL	
HAZARD FACTORS	RISK LEVEL					RESULTS	
	No Risk 1	Low 2	Medium 3	High 4	Critical 5	Actual Value	Defined score
1.1 Number of hours of driving per day, hours	< 4	4-6	6-7	7-9	> 9		
1.2 Number of hours of driving per week, hours	< 35	35-40	40-45	45-50	> 50		
1.3 The driver's job is subject to a clear and understandable work schedule	Fully						
	In most cases						
	Partially						
	There are certain sings						
	No schedule						
1.4 Work shifts occur (variability)	Only in the daytime						
	In most cases						
	Only in the evening						
	Only in the daytime and in the evening						
	Irregular work (evening shifts)						
	Unforeseen at any time						
1.5 Rest time between work shifts, day (hours)	2 days	1 day	14-15 hours	12-13 hours	< 12 hours		
1.6 The driver's job is subject to a clear and understandable work schedule	In summer, normal temperature						
	In summer, temperature > 28°C						
	In autumn, in spring						
	In winter, normal temperature						
	In winter, temperature > -30°C						
1.7 Task speed	Relaxed						
	Slowly						
	Normally						
	Quickened						
	With intensity						
1.8 Monotony of work: duration of repeated operations, s	> 100	31-100	20-30	10-20	5-10		
1.9 Number of movements per hour	< 250	250-500	500-700	700-1500	> 1500		
1.10 Work intensity. Unforeseen	Normal work						
	Completing of a simple (typical) task						
	Completing of difficult tasks						
	Completing of difficult tasks in conditions of time						
	Special responsibility (there is time shortage)						
1.11 Concentration, duration of concentration, %	< 50	25-50	50-75	75-80	> 85		
1.12 Exercise, kg×m/min	< 100	115-220	225-335	325-435	> 435		
1.13 Vibration, MPC	< MPC	up to 1,07 MPC	up to 1,17 MPC	up to 1,23 MPC	up to 1,44 MPC		
1.14 Noise, dB	< 68	68-75	75-80	80-90	> 90		
1.15 Illumination, MPC	up to 1,5 < MPC	1-1,2 < MPC	1,5-2,0 < MPC	three times < MPC	five times < MPC		
1.16 Temperature of working environment, °C	20-22	21-22/ 17-19	23-28/ 16-15	29-32/ 13-14	33-35/ 8-12		
1.17 Concentration of toxic substances, MPC	< 0,8 MPC	0,8-1 MPC	1-2,5 MPC	2,5-6 MPC	> 6 MPC		
TOTAL SCORE							
PSYCHOPHYSIOLOGICAL LOAD							

Integral assessment of of psychophysiological load (PL), which involves determining the impact of various harmful factors on the loss of ability to work according to the following formula:

$$PL = 19{,}7x - 1{,}6x^2,$$

where x is the average score of all significant harmful factors in the workplace, which can be ranked based on the table. According to the integrated indicator, we determine the category of psychophysiological load in accordance with:

1. < 18 points; 2. 19-33 points; 3. 35-45 points;
4. 46-54 points; 5. 55-59 points; 6. > 59 points.

б)

Figure 5 - Checklists to determine the psychophysiological state of a PB driver from the intensity and intensity of work of drivers:
a) checklist to determine the intensity of work;
b) checklist to determine the psychophysiological load (developed by the authors)

CONCLUSIONS

1. It has been determined that the psychophysiological states of the PB driver in most cases lead to errors and are the main catalyst, which together with the influence of hazard during the PB driving and the joint action of the subject with the object to the incident. It is shown that in case of elimination of one of the given components RA will not occur. Analysis of the causes of RA showed that the most likely catalyst for their occurrence is the overestimation of their capabilities by the PB driver.

2. It is established that the psychophysiological stress, which is due to the fact that PB is the V of increased risk, manifestation of fear, anxiety, doubt, insecurity; performing discrete work, which is associated with frequent changes in the start of motion and stops (accumulation of a large number of cars, traffic light regulation, etc.); change in the psychophysiological state as a result of PB driving in the conditions of the imposed pace and lack of time (execution of the movement schedule) and manifestations of fatigue from prolonged PB driving without rest.

3. Checklists are offered to check the psychophysiological condition of the PB driver from the stress and intensity of drivers' work, which take into account the influence of dangerous physical and psychophysiological factors. They will provide for the provision and implementation of measures aimed at eliminating and reducing the psychophysiological load, the emergence of occupational risks of the driver in the performance of production activities.

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С.І. Чеберячко, Ю.І. Чеберячко, О.В. Дерюгін, О.О. Третяк, І.К. Бас *Оцінка впливу психофізіологічного стану водія на безпеку пасажирських автомобільних перевезень*

Безпека автомобільних пасажирських перевезень залежить від основних ключових елементів, які утворюють систему: водій-автомобіль-дорога-навколишнє середовище. Відмова будь-якого елементу цієї системи збільшує ймовірність виходу її з нормального-функціонального стану, а головне, спряє підвищенню ризику виникнення дорожньо-транспортної пригоди (далі – ДТП). Тому пошук шляхів, які спрямовані на зниження ймовірності виникнення аварійних ситуацій під час пасажирських автомобільних перевезень на основі аналізу наслідків зміни психофізіологічних станів водія є актуальним завданням.

Метою дослідження є розробка рекомендацій щодо зниження ймовірності виникнення аварійних ситуацій під час пасажирських автомобільних перевезень на основі аналізу наслідків зміни психофізіологічних станів водія. Для проведення дослідження використано метод експертних оцінок та метод "Failure Mode and Effects Analysis" (далі метод "FMEA"), який включає організаційні, логічні і математико-статистичні процедури, що спрямовані на отримання від фахівців-експертів оцінки про фактори небезпеки, які впливають на зміну психофізіологічного стану водія під час керування пасажирським автобусом, їх аналіз і узагальнення отриманих результатів з метою підготовки раціональних рішень.

Визначено, що зміни психофізіологічного стану водія призводять до здійснення помилок при керуванні пасажирським автобусом і являються основним каталізатором, який разом з різноманітними небезпеками під час управління транспортним засобом та сумісною взаємодією суб'єкта з об'єктом - призводить до порушення правил дорожнього руху і в подальшому - до ДТП. Показано, що у разі усунення однієї з наведених складових, ДТП не відбудеться.

Встановлено, що втрата концентрації уваги, зміна емоційного стану та інтенсивність навантаження є основними факторами, які впливають на психофізіологічний стан водія пасажирського автобусу. Визначено залежність виникнення ДТП від наявності каталізатора, небезпеки, та взаємодії з нею суб’єкта. Запропоновано, в якості каталізатора використовувати реакцію водія, що залежить від зміни його психофізіологічного стану під час керування пасажирським автобусом.

Ключові слова: водій, психофізіологічний стан, пасажирський автобус, небезпека, взаємодія, каталізатор

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