The impact of motor vehicle driver behaviour factors on traffic safety

Summary of doctoral dissertation

Technological sciences, transport engineering (03T)

Vilnius Gediminas Technical University
Doctoral dissertation was prepared at Vilnius Gediminas Technical University in 2008–2012.

Scientific Supervisor

Assoc Prof Dr Robertas PEČELIŪNAS (Vilnius Gediminas Technical University, Technological Sciences, Transport Engineering – 03T).

The dissertation is being defended at the Council of Scientific Field of Transport Engineering at Vilnius Gediminas Technical University:

Chairman

Prof Dr Habil Adolfas BAUBLYS (Vilnius Gediminas Technical University, Technological Sciences, Transport Engineering – 03T).

Members:

Dr Raimundas JUNEVIČIUS (Vilnius Gediminas Technical University, Technological Sciences, Transport Engineering – 03T),

Prof Dr Gvidonas LABECKAS (Aleksandras Stulginskis University, Technological Sciences, Transport Engineering – 03T),

Prof Dr Habil Vytautas PAULAUSKAS (Klaipėda University, Technological Sciences, Transport Engineering – 03T),

Assoc Prof Dr Edgar SOKOLOVSKIJ (Vilnius Gediminas Technical University, Technological Sciences, Transport Engineering – 03T).

Opponents:

Prof Dr Habil Jonas SAPRAGONAS (Kaunas University of Technology, Technological Sciences, Transport Engineering – 03T),

Prof Dr Habil Jonas STANKŪNAS (Vilnius Gediminas Technical University, Technological Sciences, Measurement Engineering – 10T).

The dissertation will be defended at the public meeting of the Council of Scientific Field of Transport Engineering in the Senate Hall of Vilnius Gediminas Technical University at 10 a. m. on 21 January 2013.

Address: Saulėtekio al. 11, LT-10223 Vilnius, Lithuania.
Tel.: +370 5 274 4952, +370 5 274 4956; fax +370 5 270 0112;
e-mail: doktor@vgtu.lt

The summary of the doctoral dissertation was distributed on 20 December 2012.

A copy of the doctoral dissertation is available for review at the Library of Vilnius Gediminas Technical University (Saulėtekio al. 14, LT-10223 Vilnius, Lithuania).

© Jurijus Zaranka, 2012
Jurijus ZARANKA

KELIŲ TRANSPORTO PRIEMONIŲ VAIRUOTOJŲ ELGSENOS VEIKSNIŲ ĮTAKOS EISMO SAUGAI TYRIMAS

DAKTARO DISERTACIJOS SANTRAUKA

TECHNOLOGIJOS MOKSLAI, TRANSPORTO INŽINERIJA (03T)
doc. dr. Robertas PEČELIŪNAS (Vilniaus Gedimino technikos universitetas, technologijos mokslai, transporto inžinerija – 03T).

Disertacija ginama Vilniaus Gedimino technikos universiteto Transporto inžinerijos mokslo krypties disertacijos gynimo taryboje:
Pirmininkas
prof. habil. dr. Adolfas BAUBLYS (Vilniaus Gedimino technikos universitetas, technologijos mokslai, transporto inžinerija – 03T).
Nariai:
dr. Raimundas JUNEVIČIUS (Vilniaus Gedimino technikos universitetas, technologijos mokslai, transporto inžinerija – 03T),
prof. dr. Gvidonas LABECKAS (Aleksandro Stulginskio universitetas, technologijos mokslai, transporto inžinerija – 03T),
prof. habil. dr. Vytautas PAULAUSKAS (Klaipėdos universitetas, technologijos mokslai, transporto inžinerija – 03T),
doc. dr. Edgar SOKOLOVSKIJ (Vilniaus Gedimino technikos universitetas, technologijos mokslai, transporto inžinerija – 03T).

Oponentai:
prof. habil. dr. Jonas SAPRAGONAS (Kauno technologijos universitetas, technologijos mokslai, transporto inžinerija – 03T),

Disertacija bus ginama viešame Transporto inžinerijos mokslo krypties disertacijos gynimo tarybos posėdyje 2013 m. sausio 21 d. 10 val. Vilniaus Gedimino technikos universiteto senato posėdžių salėje.
Adresas: Saulėtekio al. 11, LT-10223 Vilnius, Lietuva.
Tel.: +370 5 274 4952, +370 5 274 4956; faks. +370 5 270 0112;
el. paštas doktor@vgtu.lt
Disertacijos santrauka išsiuntinėta 2012 m. gruodžio 20 d.
Disertaciją galima peržiūrėti Vilniaus Gedimino technikos universiteto bibliotekoje (Saulėtekio al. 14, LT-10223 Vilnius, Lietuva).
VGTU leidyklos „Technika“ 2098-M mokslo literatūros knyga

© Jurijus Zaranka, 2012
Introduction

**Topicality of the problem.** The causes of traffic events are predetermined by abundant factors that affect simultaneously the driver and the vehicle involved in traffic. The principal task of road transport is increasing the volumes of cargoes transported and the number of passengers upon maintaining the road traffic safety. The said task should be accomplished in an integrated way, i.e. upon taking into consideration all the elements of the system, i.e. the Driver, the Vehicle, the Road and the Environment (DVRE). According to the statistics, the most important is the human factor, i.e. the totality of physical and psychological characteristics predetermining successful activities of a driver. Namely the human factor is the principal potential for increasing a reliability of drivers. Improper behaviour of drivers on driving most frequently is the principal cause of traffic events. One of the ways for minimizing the number of a driver’s errors is an assessment of the factors that predetermine the driver’s behaviour on the road to the maximum possible extent. Emergency situations and their consequences directly depend on proper and well-timed actions of the driver. Increasing a reliability of drivers is the most important task: if it is not accomplished, security of traffic safety is impossible. A majority of road traffic events takes place through a fault of a traffic participant. It was found that about 65% traffic events are caused by drivers of the vehicles.

Vehicle driving is a heavy dynamic process that requires a malleable interaction of all elements of DVRE system. Traffic safety also highly depends on the reliability of all elements of the system. The most important in respect of ensuring road traffic safety is the driver’s fitness for safe controlling the vehicle, i.e. the driver causing the minimum number of traffic events should be chosen. The said fitness is predetermined by formation of his behaviour on the road and the personal qualities as well as his qualification. It is necessary to develop a drivers‘ testing system for assessing the professional aptitude and reliability of drivers.

**Object of the research**
The factors that predetermine the formation of the behaviour of traffic participants.

**Aim and tasks of the work.** The aim to identify (in the theoretical and experimental ways) the key factors that impact a formation of the behaviour of traffic participants upon an assessment of the importance of such factors for the element of DVRE system (a driver) and choosing the most fit professional driver.
In order to achieve the aim of the research, the following tasks need to be accomplished:

1. To assess the key factors that impact a formation of the behaviour of traffic participants and to formulate the preconditions for selection of professional drivers on their base.
2. To carry out an experimental investigation on the principal actions of professional drivers that should foreordain their professional preparedness upon a complicated situation.
3. To develop and approve a method for selection and assessment of the most fit professional driver.

**Methodology of research.** The methodology of research is based on an analysis of works of Lithuanian and foreign scientists in this sphere upon applying linear programming methods as well as methods for statistical data grouping & processing and the method of dispersion analysis of blocked data (Friedman method).

For accomplishment of the set tasks and verification of the initial conditions, a set of analytic methods was applied. On the theoretical level, the following methods were applied: an analysis of references, scientific interpretation and reviewing the data. On the empirical level: engineering and diagnostic methods, monitoring of the tested persons, analysis of their activities, experimental applying of original testing methods were used. The key methods included the ones applicable for investigation of the factors affecting the formation of the behaviour of traffic participants upon using stimulants; expert’s surveys and assessments; consulting the specialists.

In the Thesis, the data from research works completed at Vilnius Gediminas Technical University (Lithuania) and Warsaw University of Technology (Poland) were used.

**Scientific novelty.** The following new results in transport engineering science were obtained when preparing the doctoral thesis:

1. On the base of theoretical and experimental research, the impact of alcohol and fatigue upon formation of behaviour of professional drivers was closer defined.
2. For assessing the formation of behaviour of traffic participants and the reliability of the safe traffic system, the method of dispersion analysis of blocked data (Friedman method) was applied.
3. The method for assessment a qualitative selection of professional drivers that enables to improve the traffic safety on Lithuanian roads was developed and approved.
Practical value
1. The methodology for selecting professional drivers was approved by UAB “Vilniaus viešasis transportas” (JSC “Vilnius public transport”) and recommendations for its practical application were developed.
2. The degree of the impact of the key factors affecting the formation of the behaviour of professional drivers upon their professional aptitude was examined.
3. The methodology for examining the key factors affecting the formation of the behaviour of professional drivers was developed.

Defended propositions
1. The interaction of the system’s “the driver–the vehicle–the road–the environment” (DVRE) elements and the reliability of the system are negatively impacted by the factors predetermining the formation of behaviour of traffic participants.
2. For comparison of averaged psychomotorical reactions of traffic participants, the non-parametric Friedman method is applicable.
3. Taking into account the demographic situation in Lithuania, the most fit professional driver of a vehicle for transportation of passengers should be 52–53 years old with 29–33 year experience in the occupation.

The scope of the scientific work. The thesis is presented in the Lithuanian language. It consists of introduction, three chapters and the list of 95 references. The thesis comprises 101 pages, 16 tables, including 31 figures.

1. The impact of the factors predetermining the formation of the behaviour of traffic participants upon a reliability of the system “the driver–the vehicle–the road–the environment”

In the chapter the impact of the factors predeterminining the impact of the formation of the behaviour of traffic participants upon traffic safety is analyzed. Scientific works on the said subject are reviewed and the key factors most important for selection of professional drivers are highlighted.

2. The methodologies for examination of the factors predetermining the formation of the behaviour of traffic participants

In the chapter, the methodologies of theoretical and experimental research are discussed upon. On this base, the chosen methods of research and the used equipment are described and assessment of errors of the latter was performed.
The tests on the properties of traffic participants predetermining formation of their behaviour on the road upon impact of alcohol were carried out at VGTU Transport Engineering Faculty Laboratory for Psychophysiological Tests of Traffic Participants and Warsaw University of Technology Transport Engineering Faculty. The tests included measuring the reaction time of drivers intoxicated by alcohol, the distance assessment and spatial visibility test and simulation of drink-driving upon alcohol intoxication by a driving stimulator.

For regeneration of the actions of a driver upon impact of alcohol, the driving simulator “AutoPW” was used*. It is a laboratory stand for testing drivers upon simulated traffic conditions, including emergency conditions bound with traffic events.

![Diagram of driver's well-being on the road](image)

**Fig. 1.** The factors that impact element “a driver” of DVRE system

The process of development of methodology for assessment of fatigue of professional drivers included collection of general information on the professional activities of a driver and assessment of individual peculiarities. After collection of the required initial data, processing and assessment of the data take place. After analysis of the actions, the methodology is approved in practice and recommendations are developed.

*— ACKNOWLEDGEMENTS: The author sincerely thanks the scientists of the Warsaw University of Technology (Politechnika Warszawska), The dean of The Faculty of Transport, professor Wojciech Wawrzyński, PHD, DSC, Head EUIP Zbigniew Lozia, PHD, DSC, Marek Guzek, PHD, for methodological and practical assistance in conducting research for this doctoral thesis.
At JSC“Vilnius public transport“ (UAB “Vilniaus viešasis transportas”) Bus Fleet Branch, an anonymous questionnaire survey of bus drivers (respondents) was arranged. Its aims included identification of the key factors that impact working capacity of professional drivers (such as fatigue, sleepiness and so on). The questionnaire consisted: examination of the probability of using strong drinks during leisure (recreation). Striving to accuracy and objective character of the results, one of the following blocks: the direct examination of fatigue; examination of physiological changes in course of a working shift; examination of fatigue during the first shift (05:00 a.m. – 02:00 p.m.) and the second shift (02:00 p.m. – 11:00 p.m.) question was an advancement question. It was used to get sure that the answers to questions of blocks were really honest.

Total 243 respondents were involved in the survey. They were randomly chosen from 739 drivers, i.e. 32.8% of the drivers employed at the Branch were interviewed.

The offered system of selection is usable to assess whether a person is fit for training of professional drivers by a complete assessment of all integrals of his tests. Three levels of the assessment are available: fit, conditionally fit and unfit. Three sectors of training and professional activities are covered by the assessment: the knowledge of the principal traffic rules, the skills in vehicle controlling and vehicle driving upon causing no emergency situation.

“A driver”, as an element of DVRE system, is the principal factor predetermining the reliability of operation of the whole system herewith the road traffic safety. In Fig. 1, the key factors that impact this element of DRVE are shown. On the base of their interlinks, it becomes clear that selection of a reliable driver is a task of a great importance.

3. The results of research on the factors that predetermine the formation of the behaviour of traffic participants

Even small doses of alcohol impact the human. Although alcohol quickens the thinking to a certain extent, it deteriorates the efficiency of thinking like-for-like. Alcohol causes declining of the quality of thinking and growing number of errors. In addition, alcohol prevents the person from objective assessment of the own capabilities. The more important a function of the brain, it is more strongly affected by alcohol.

According to the legal norms of Republic of Lithuania set for professional drivers (drivers of vehicle for transportation of passengers), the maximum alcohol concentration in biological matrices may be 0.2‰.
On examining the Fig. 2, it may be noticed that the quantile field of the ordinary reaction time of a sober driver and a driver slightly affected by alcohol (up to 0.2‰) is 60 ms, the moda of the results is 12 ms above the median and the range of outliers of quantiles extends up to 210 ms. In course of increase of intoxication by alcohol up to 0.4‰, extension of the range of outliers of quantiles up to 290 ms and increase of the quantile field 2.3 times, as compared to intoxication up to 0.2‰ are observed; however, the moda of the results is only 2 ms above the median. When intoxication with alcohol increases up to 0.6‰, the results of the ordinary reaction slightly differ from the data on the drivers intoxicated up to 0.4‰: the quantile field reduces by 2%, the range of outliers of quantiles – by 3.5%; however, difference of 13 ms between the moda and the median appears. The difference between the moda and the median upon 0.6‰ intoxication may be explained by the circumstance that upon such conditions, a light euphoria, sensation of comfort and relaxation appear in a part of persons under the test.

![The average reaction time, ms](image)

**Fig. 2.** The dependence of ordinary reaction time of traffic participants (not taking into account the number of errors) on the alcohol concentration in biological matrices

In the range between 0.6 and 1.0‰, the median is growing and the moda becomes very close to the median: their difference equals to 1.5 ms only. In course of increase of alcohol intoxication up to 1‰, the ordinary reaction time of drivers increases, as compared to it on the intoxication up to 0.8‰: the quantile field increases up to 6%, the range of outliers of quantiles – up to 2%; however, the difference between the moda and the median remains very small (2.5 ms). It may be explained by the equal growing of the ordinary reaction time of all drivers under the test starting from 0.6‰ intoxication.
On each driving, stimulator “Auto PW” fixed the parameters describing the movement of vehicle under the test and the obstacles as well as the data on the formation of the behaviour of the drivers upon the impact of various factors:

- the reaction time to releasing the accelerator’s pedal;
- the reaction time to pressing the accelerator’s pedal;
- the reaction time to turning the stirring-wheel;
- the number of errors fixed during the tests.

The following average results of the tests (reaction time to releasing the accelerator’s pedal, pressing the accelerator’s pedal, turning the stirring-wheel and the number of errors fixed) were obtained (Fig. 3, Fig. 4, Fig. 5, Fig. 6 and Fig. 7):

- the reaction time to releasing the accelerator’s pedal, p-value = 0.013 (there was a difference between tests);
- the reaction time to pressing the accelerator’s pedal, p-value = 0.454 (there was no difference between tests);
- the reaction time to turning the stirring-wheel, p-value = 0.195 (there was no difference between tests);
- the test on the average number of errors: p-value = 0.252 (there was no difference between tests).

In course of increasing of the intoxication with alcohol (Fig. 3), the average reaction time to releasing the accelerator’s pedal increases up to 16% and the average reaction time to pressing the accelerator’s pedal increases up to 9%; however, the average reaction time to turning the stirring-wheel reduces by
22%. It may be explained by the fact, that using alcohol causes deterioration of the visual acuity, narrowing of the field of vision and distortion of colour sensations and the latter, in its turn, causes a considerable deterioration of the accuracy and rates of visual sensations.

![Graph showing the average number of errors per test against the number of promille.]

**Fig. 4.** The dependence of the number of errors on the number of promille:

\[ k \] – the number of errors

![Graph showing the scatter of the average reaction times to releasing the accelerator’s pedal on a certain test.]

**Fig. 5.** The scatter of the average reaction times to releasing the accelerator’s pedal on a certain test

On the tests, a driver often acts within the maximum limits of his abilities. Although consumption of small dose of alcohol causes an inconsiderable disturbance of the human factors that predetermine the formation of the behaviour of traffic participants, it may cause errors and traffic events. On increa-
sing of the alcohol concentration in the body of the driver between the first test and the third test, the number of errors increased up to 31% (Fig. 4).

![Fig. 6. The scatter of the average reaction times to pressing the braking’s pedal on a certain test](image)

![Fig. 7. The scatter of the average reaction times to turning the stirring-wheel on a certain test](image)

On examining the reaction time to realeasing the accelerator’s pedal (Fig. 5), it was found that its values were the minimum on the first test, when the drivers involved in the experiment were sober. On the tests from the second to the fifth, in course of growing of the alcohol concentration in the body of a driver, the median of the results differed inconsiderably – up to 1%.

The median of the reaction times to pressing the accelerator’s pedal on the fourth test and the fifth test was higher by 9%, as compared to the first test (Fig. 6). The median of the reaction times to pressing the accelerator’s pedal on the second test and the third test was higher by 4%, as compared to the first test. It
may be based on reduction of the accuracy of vision upon increasing alcohol intoxication.

On examining the average reaction time to turning the stirring-wheel (Fig. 7), it was found that the median practically does not change. However, a very large difference between the set ranges on the first test and the fifth test was observed (up to 28%).

When the driver’s fatigue is less, his working capacity and the efficiency of his activities become better, and a risk of accidents is reduced. If a driver worked nightlong, his abilities of safe driving the vehicle are reduced considerably. Similar functional changes take place in the body, when the driver is ill. When the work is not bound with a strong psychological stress, the working capacity of the driver depends also on the day of a week, not only on the time of a day. Changes of the working capacity in course of a day are bound with the human life rhythm.

![Fig. 8. The distribution of traffic events among the working hours](image)

A reduced working capacity is observed in three phases of a working shift. In the first working hour, the working capacity of an employee is reduced, because the person has not got into the swing of the work yet. In labour physiology, this phase is referred to as “running-up”. The phase of running-up lasts from 30 minutes or one hour. The key factor impacting the duration of the said phase are the previous rest-days. If the driver had not a good rest, the run-up of the processes of the body responsible for his professional activities will be slower and less intensive, so the duration of the running-up phase will increase.

Within the first hour of driving, there is an increased risk of causing a traffic event. In this period, the driver should be particularly careful. The second
and the third hours of driving distinguish themselves for sufficiently high level of working capacity (Fig. 8).

![Fig. 9. The distribution of traffic events among working days](image)

![Fig. 10. The results of the survey on the physiological changes in professional drivers within a working shift](image)

If a driver has not a proper rest, this working capacity sometimes does not achieve its optimum level within the whole working day (Fig. 9). The working capacity is highly impacted by the level of the motivation of the professional driver for working. If the driver is not satisfied with his work and his activities cause negative emotions to him, the running-up phase increases considerably.

In course of analysis of the results of the anonymous survey carried out at UAB “Vilniaus viešasis transportas” Bus Fleet Branch, it was found that certain
parameters (such as fatigue or sleepiness) highly impact the working capacity of a driver (Fig. 10).

If a driver is tired, only his simplest skills having achieved the level of automatism, i.e. causing the correct actions in well-known standard situations, remain. First of all, disturbance of complicated mental activity appears that deteriorates the preparedness for actions upon emergency and extraordinary traffic situations. It causes worsening of the quality of the work of the drivers and appearance of errors that lead to traffic events. So, the key factor for ensuring traffic safety is preservation of working capacity of drivers.

Selection of professional drivers is determined by a number of factors, such as the experience in driving the vehicle, the character traits expressing themselves by the number of the caused traffic events, the adequate perception of the situation on driving, the psychomotorical reaction, the ability to focus the attention, the ability to process large volumes of information and to distribute them according to the priority, the operative thinking and so on.

All above-listed factors affect a probability of a traffic event that may be caused by a professional driver. The key factor related to a traffic event is the possible loss caused to the enterprise where the driver responsible for the event is employed. It is the key factor that shows the factual expenses of the enterprise bound with the traffic event.

As it is known from the theory of probabilities and statistics, the accuracy of the estimate (in this case – the probability) grows upon increasing the sample, i.e. the number of professional drivers in the relevant age group. Because of this, on establishing the dependence of the probability on the age, will use the ranges between 40 and 65 years.

For a calculation of square trinomial upon applying the method of least squares, the following function is formed ($a_i$ – the parameter of the method of least squares corresponding to the linear equation):

\[
\begin{align*}
5a_0 + 265a_1 + 1.43 \cdot 10^4 a_2 &= 2.461 \\
265a_0 + 1.43 \cdot 10^4 a_1 + 7.841 \cdot 10^5 a_2 &= 130.8 \\
1.43 \cdot 10^4 a_0 + 7.841 \cdot 10^5 a_1 + 4.369 \cdot 10^7 a_2 &= 7.088 \cdot 10^3.
\end{align*}
\]

After its solution, the following function of the probability of a traffic event dependently on the age of a professional driver is obtained ($x_1$ (age) and $x_2$ (experience) peculiarities of physiological working capacity):
\[ p(x_1) = 3.776 - 0.128x_1 + 1.219 \cdot 10^{-3} x_1^2. \] (2)

For closer definition of the above-mentioned function, the following cubic quadrinomial is calculated:

\[
\begin{align*}
5a_0 + 265a_1 + 1.43 \cdot 10^4 a_2 + 7.841 \cdot 10^5 a_3 &= 2.461 \\
265a_0 + 1.43 \cdot 10^4 a_1 + 7.841 \cdot 10^5 a_2 + 4.369 \cdot 10^7 a_3 &= 130.8 \\
1.43 \cdot 10^4 a_0 + 7.841 \cdot 10^5 a_1 + 4.369 \cdot 10^7 a_2 + 2.469 \cdot 10^9 a_3 &= 7.088 \cdot 10^3 \\
7.841 \cdot 10^5 a_0 + 4.369 \cdot 10^7 a_1 + 2.469 \cdot 10^9 a_2 + 1.413 \cdot 10^{11} a_3 &= 3.909 \cdot 10^5.
\end{align*}
\] (3)

The closer defined function:

\[ p(x_1) = -0.96 + 0.146x_1 - 3.996 \cdot 10^{-3} x_1^2 + 3.279 \cdot 10^{-5} x_1^3. \] (4)

After solving the equation 2, find the minimum age of professional drivers (52.4 years) that corresponds to the probability of causing a traffic event equal to 0.431, and after solving the equation 4, find the minimum point (53.51 with the probability of causing a traffic event equal to 0.431) and the maximum point (27.71 with the probability of causing a traffic event equal to 0.713). The error between the theoretical and the experimental results was \(7.156 \cdot 10^{-3}\), i.e. 3.3% less than on the calculation of the square trinomial.

The dependences of the probability of causing a traffic event on the general work experience of the professional driver are obtained in an analogous way. In this case, the square trinomial is calculated as follows:

\[
\begin{align*}
6a_0 + 183a_1 + 6.019 \cdot 10^3 a_2 &= 2.973 \\
183a_0 + 6.019 \cdot 10^3 a_1 + 2.103 \cdot 10^5 a_2 &= 91.92 \\
6.019 \cdot 10^3 a_0 + 2.103 \cdot 10^5 a_1 + 7.689 \cdot 10^5 a_2 &= 3.077 \cdot 10^3.
\end{align*}
\] (5)

After its solution, the function:

\[ p(x_2) = 1.076 - 4.465 \cdot 10^{-2} x_2 + 7.787 \cdot 10^{-4} x_2^2. \] (6)
For closer definition of the function, the following cubic quadrinomial is calculated:

\[
\begin{align*}
6a_0 + 183a_1 + 6.019 \cdot 10^3 a_2 + 2.103 \cdot 10^5 a_3 &= 2.973 \\
183a_0 + 6.019 \cdot 10^3 a_1 + 2.103 \cdot 10^5 a_2 + 7.689 \cdot 10^5 a_3 &= 91.92 \\
6.019 \cdot 10^3 a_0 + 2.103 \cdot 10^5 a_1 + 7.689 \cdot 10^5 a_2 + 2.909 \cdot 10^8 a_3 &= 3.077 \cdot 10^3 \\
2.103 \cdot 10^5 a_0 + 7.689 \cdot 10^5 a_1 + 2.909 \cdot 10^8 a_2 + 1.129 \cdot 10^{10} a_3 &= 1.1 \cdot 10^5.
\end{align*}
\] (7)

The closer defined function:

\[p(x_2) = -0.544 + 0.131x_2 - 5.265 \cdot 10^{-3} x_2^2 + 6.606 \cdot 10^{-5} x_2^3.\] (8)

After solution of the equation 6, find the minimum general work experience of professional drivers (28.7 years) with the probability of causing a traffic event equal to 0.436, and after solution of the equation 8, we find the minimum point (33.13 with the probability of causing a traffic event equal to 0.431) and the local maximum point (20.00 with the probability of causing a traffic event equal to 0.505).

**General conclusions**

1. After analysis of the works of other authors, it can be maintained that 78.5% of drivers are completely fit to drive vehicles, 13.4% are temporarily unfit and 8.1% of drivers are completely unfit to drive. After realization of tests set out in the thesis it emerged that timely elimination of the drivers unfit to drive due to lack of required personal qualities allows to reduce the road accident rate by approximately 20%.
2. The literature analysis and the experimental studies have revealed that the following factors have the greatest impact on formation of the road users’ behaviour and further selection of professional drivers: alcohol consumption and fatigue.
3. With the increase of alcohol concentration in biological matrices of road users the simple reaction time remains unchanged, meanwhile the complex reaction time increases by 11.5%.
4. At 0.7‰ alcohol concentration in biological matrices a driver is turning the steering wheel up to 3.6 times more than it is necessary to avoid traf-
fic accident, as compared to a sober driver. Meanwhile, this indicator between sober drivers and up to 0.4‰ alcohol-intoxicated drivers is less or equal to 1.1.

5. Having analysed the road accident statistics of the Joint Stock Company “Vilnius Public Transport” (Lith. – UAB „Vilniaus viešasis transp-ortas“), it can be asserted that probability of causing a road accident on the first working day after off-duty days is 4.6 times higher than on the last working day. This is related to a long duration of the run-in phase, typical of a driver’s work, as well as to the fact that 46% of the respondents noted that, according to their opinion, consuming insignificant amounts of alcohol can partially relieve fatigue after a work shift.

6. Mathematical calculations performed in order to establish the optimum age and working experience of a professional driver for driving safety show that these are 52–53 and 29–33 years, correspondingly.

7. Taking into account the demographic situation in Lithuania, the average age of professional drivers working in transport companies, as well as the fact that the majority of drivers start their professional career being 21 years old, it can be claimed that the safest professional driver in Lithuania is 50–54 years old.

8. When searching for the most suitable professional driver according to the age criterion, statistical methods have been applied for assessing the drivers of the Joint Stock Company “Vilnius Public Transport” and have served as a basis for certifying a methodology for professional selection of drivers.

9. The compiled professional selection methodology can be further improved by applying it to drivers of other transport vehicles, as well as to railway locomotive drivers, staff of various operative services and other persons, whose job characteristics set particularly high standards for personal traits determining the formation of their behaviour.

List of published works on the topic of the dissertation article in a scientific journals


**In the other editions**


**About the author**


**KELIŲ TRANSPORTO PRIEMONIŲ VAIRUOTOJŲ ELGSENOS VEIKSNIŲ ĮTAKOS EISMO SAUGAI TYRIMAS**

**Mokslo problemos aktualumas**


Automobilio vairavimas – sunkus dinaminis procesas, reikalingas glaudžios visų sistemų VAKA grandžių sąveikos. Saugus eismas taip pat labai priklauso nuo to, kaip patikimai veikia visos šios sistemas grandys. Svarbiausia, užtikrinant saugų eismą, yra vairuotojo tinkamumas saugiai valdyti transporto priemonę, t. y. toks vairuotojas, kuris sukelia mažiausia eismo įvykių. Šis tinkamumas nusakomas jo elgesio formavimasis kelyje ir asmeninėmis savybėmis, taip pat jo kvalifikacija. Būtina sukurti vairuotojų testavimo sistemą, leidžiančią nustatyti transporto priemonių vairuotojų profesinį tinkamumą ir patikimumą.

**Tyrimų objektas**
Veiksniai, turintys įtakos eismo dalyvių elgesio formavimuisi.

**Darbo tikslas ir uždaviniai**
Teoriškai ir eksperimentiškai nustatyti pagrindinius veiksnius, turinčius įtakos eismo dalyvių elgesio formavimuisi, įvertinant šių veiksninių svarbą VAKA sistemas grandžiai (vairuotojui), parenkant tinkamiausią vairuotoją profesionalą.

Darbo tikslui pasiekti darbe reikia spręsti šiuos uždavinius:

1. Išskirti pagrindinius veiksnius, turinčius įtakos eismo dalyvių elgesio formavimuisi, ir, jais remiantis, sudaryti priešuodo vairuotojų profesionalų atrankai.
2. Eksperimentiškai ištirti pagrindinius veiksnius, leminčius vairuotoją profesionalą pasirengimą imtis veiksmų sudėtingose situacijose.
3. Sukurti ir aprobuoti tinkamiausia vairuotojo profesionalo atrankos ir vertinimo metodą.

**Tyrimų metodika**
Tyrimų metodika pagrįsta Lietuvos ir užsienio šalių mokslininkų atlikų darbų šioje srityje analize, pritaikant tiesinio programavimo metodus, statistinių duomenų grupavimo ir apdorojimo, blokuotųjų duomenų dispersinės analizės (Frydmano kriterijaus) vertinimo metodus.

Iškelto užduotims spręsti ir pradinėms sąlygoms patikrinti buvo taikytas analitinių metodų kompleksas. Teoriniu lygmeniu buvo pritaikyti šie metodus: literatūros analizė, mokslinė interpretacija ir duomenų apžvalga. Empiriniu
lygmeniu buvo taikyti inžineriniai ir diagnostiniai metodai, testuojamų žmonių monitoringas, jų veiklos analizė, eksperimentai pagal originalius testavimo metodus. Pagrindiniai taikyti metodai buvo šie: veiksniių, turinčių įtakos eismo dalyvių elgesio formavimuisi naudojant simuliatorių, tyrimas; ekspertinės apkalos ir įvertinimai; konsultacijos su specialistais.

Darbe panaudoti tyrimų, atliktų Vilniaus Gedimino technikos universitete ir Varšuvos technologijos universitete (Lenkija), duomenys.

**Mokslinis naujumas**
Rengiant disertaciją buvo gauti šie transporto inžinerijos mokslui nauji rezultatai:

1. Remiantis teoriniais ir eksperimentiniais tyrimais patikslinta alkoholio ir nuovargio įtaka vairuotojų profesionalų elgesio formavimuisi.

2. Eismo dalyvių elgesio formavimuisi ir saugaus eismo sistemos patikimumui įvertinti taikytas blokuotųjų duomenų dispersinės analizės – Frydmano kriterijus.


**Praktinė vertė**

1. Sukurta vairuotojų profesionalų parinkimo metodika aprobuota UAB „Vilniaus viešasis transportas“ ir parengtos jos taikymo rekomendacijos.

2. Ištirtas pagrindinių veiksniių, darančių poveikį vairuotojų profesionalų elgesio formavimuisi, įtakos profesiniam tinkamumui laipsnis.

3. Parengta vairuotojų profesionalų pagrindinių veiksniių, turinčių įtakos elgesio formavimuisi, tyrimo metodika.

**Ginamieji teiginiai**


2. Eismo dalyvių psichomotorinių reakcijų laiko vidurkiams palyginti gali būti taikomas neparametrinis Frydmano kriterijus.
3. Tinkamiausias keleivinės transporto priemonės vairuotojas profesionalas, atsižvelgiant į esamą demografinę situaciją Lietuvoje, yra 52–53 metų amžiaus, turintis 29–33 metų stažą.

**Darbo apimtis**

Darbo apimtis – 101 puslapis, neskaitant priėdų. Tekste panaudotos 33 numeruotos formulės, 31 paveikslas ir 16 lentelių. Rašant disertaciją naudotasi 95 literatūros šaltiniais.

Įvadiname skyriuje aptariai tiriamoji problema, darbo aktualumas, aprašomas tyrimų objektas, formuluojamas darbo tikslas bei uždaviniai, ginamieji teiginiai. Įvado pabaigoje pristatomos disertacijos tema autorius paskelbto publikacijos ir pranešimų konferencijose bei disertacijos struktūra.


Antrajame skyriuje pateikta veiksnų, lemiančių eismo dalyvių elgesio formavimą, tyrimų metodika.

Trečiajame skyriuje analizuojami veiksnų, lemiančių eismo dalyvių elgesio formavimą, tyrimų rezultatai ir pasiūlyta tinkamiausio vairuotojo profesionalo paieška naudojant matematines priklausomybes.

**Bendrosios išvados**

1. Išanalizavus kitų autorių darbus galima teigti, kad visiškai tinkami vairuoti automobilis yra 78,5 %, laikinai netinkami – 13,4 % ir visiškai netinkami – 8,1 % vairuotojų, o atlikus disertacijos apstruktūros tyrimus paaiškėjo, kad netinkamų dėl asmeninių savybių vairuotojų eliminavimas leidžia sumažinti eismo įvykių skaičių apie 20 %.

2. Atlikus literatūros analizę ir eksperimentinius tyrimus nustatyta, kad didžiausią įtaką eismo dalyvių elgesio formavimui bei tolesnėi vairuotojų profesionalų atrankai turi šie veiksniai: alkoholio vartojimas ir nuovargis.

3. Didėjant alkoholio koncentracijai eismo dalyvių biologinėse terpėse, paprastoji reakcija išlieka nepakitusi, tačiau 11,5 % pailgėja sudėtingosios reakcijos laikas.

4. Kai biologinėse terpėse yra 0,7 ‰ alkoholio koncentracijai, toks vairuotojas, palyginti su blaivių, iki 3,6 karto daugiau negu reikia suka vairaratį.
norėdamas išvengti eismo įvykio. Perteklinis vairo pasukimo rodiklis tarp blaivių ir iki 0,4 ‰ apsvaigusių nuo alkoholio vairuotojų siekia iki 1,1 karto.

5. Išanalizavus UAB „Vilniaus viešasis transportas“ eismo įvykių statistiką, galima teigti, kad tikimybė sukelti eismo įvykį pirmą darbo dieną po poilsio dienų yra 4,6 karto didesnė nei paskutinę darbo dieną. Tai susiję su vairuotojo darbui būdinga ilga įsidirbimo fazės trukme ir tuo, kad 46 % apklaustų respondentų pažymi, jog labai mažas alkoholio kiekis, jų manymu, gali iš dalies nuslopinti nuovargį po darbo pamainos.

6. Atlikus matematinius skaičiavimus gauta, kad tinkamiausias vairuotojo profesionalo amžius ir stažas saugiai vairuoti transporto priemonę yra atitinkamai 52–53 ir 29–33 metai.

7. Įvertinus Lietuvos demografinę padėtį, vežimo įmonėse dirbančių vairuotojų profesionalų amžiaus vidurkį ir tai, kad dauguma vairuotojų profesionalų savo profesinę karjerą pradeda nuo 21 metų, galima teigti, kad saugiausiai Lietuvoje dirba 50–54 metų vairuotojas profesionalas.


Trumpos žinios apie autorių