Defining the Directions of Enhancing Vehicle Safety in Ukraine

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Introduction. Year after year the road accident statistics and lack of consolidated and efficient measures to fight high number of deaths and injuries in Ukraine show the need for further research in that field. Also it confirms the need to develop concepts for securing road traffic safety, introduce up-to-date technologies in the relevant field and to promote the “safety” notion to the general public, local and state officials, heads of universities and other institutions [1].

The general formulation of the problem. One of the directions of research is the improvement of vehicle safety.

The following types of accident are being considered:

- Collisions.
- Vehicle turning-over.
- Collisions with stationary obstacles.
- Collisions with pedestrians.
- Collisions with cyclists.
- Collisions with stationary transport vehicle.
- Collisions with cartage.
- Collisions with animals.
- Accidents related to VDFRW [2,4].
- Other accidents (those not included above).

It’s known that the problem of securing the road traffic safety (including the safety of the most vulnerable participant of the road traffic – the pedestrian) is multi-factor and very complex.

The process of accident occurrence is influenced by the following factors:

- human factor (driver psychophysiology, driver perception errors, in particular, errors of vehicle’s velocity perception, the levels of driver proficiency and skills, methods of driver education and training [1 etc.], drunken driving, influence of drugs etc.);
• road conditions factor (road width, number of lanes, width of lane, visibility, lighting [3,4] etc.;
• vehicle factor (vehicle technical state, visibility, fumes and emissions inside the cabin, cabin microclimate [3,5] etc.

In accordance with the chosen direction thorough analysis of vehicle’s safety components were carried out. It should be noted that the vehicle’s safety is defined by number of structural (constructional) and operating characteristics (performance) which directly contributes to the decrease of:
• accident probability;
• the severity of the accident;
• negative impact on environment etc.
• The vehicle safety is divided into following major groups (Fig. 1):
  • Active.
  • Passive.
  • Post- accident.
  • Ecological.

Accordingly, the active safety is vehicle’s property that contributes to preventing of accidents or to lowering the accident probability. The passive safety is vehicle’s property that contributes to significant reduction of accident severity.

Post-accident safety is vehicle’s property that contributes to significant reduction of accident severity immediately after the later have taken place, i.e. such after-effect as gasoline spilling out from fractured tank and its resulting ignition etc.

Ecological safety is not directly linked with road accident and constitutes vehicle’s property that contributes to decreasing its negative impact on environment.

**ROAD TRANSPORT VEHICLE SAFETY**

- **Driver’s working environment**
  - Microclimate
  - Ergonomic parameters
  - Noise and vibration
  - Fumes and emissions

- **Operating characteristics**
  - Dependability of vehicle elements and modules
  - Traction-velocity
  - Braking qualities
  - Steadiness
  - Handling

- **External**
  - Shape of vehicle body
  - Injury preventing elements

- **Internal**
  - Life securing zone
  - Means and measures to reduce impact overloading:
    - safety belts; air-bags;
    - head-rests
  - Injury prevention: steering wheel; control levers; windscreen
  - And all the elements of _______

- Measures aimed at reducing:
  - consumption of energy resources;
  - oxygen consumption;
  - emission levels;
  - noise level, vibration and electrical radiation etc.

![Figure 1. - Structure of road transport vehicle’s safety](image-url)

- visual information acquisition (perception);
• processing of information;
• making of proper actions decision;
• making proper actions (maneuvers) (if needed);
• checking the actions (maneuvers) results.

The efficient (faultless and timely) visual information acquisition (VIA) and processing of information allows the driver to choose particular “safe” mode of driving. The driving process should be characterized as the task in which the VIA is of prime importance (regardless of the time of day). In-turn VIA consists of the following sub-tasks:
• searching (scanning) for the relevant information;
• monitoring the road geometry and for type and condition of the road surface;
• orientation;
• assessment of: its own vehicle velocity; the positioning at the traffic lane and positioning at the roadway; the state of curbs;
• monitoring other participants of road traffic movement (vehicles as well as pedestrians), road signs and signaling etc.

Without a doubt in dark time of day the VIA process becomes much more complicated and impaired by poor visibility and lack of lighting. The erroneous and/or poor attention information acquisition leads to mistakes at further sub-tasks. The visibility distance, which should secure the adequate safety, is defined by the vehicle velocity, by time driver’s response (reaction) time, road friction ratio etc. High velocity of the vehicle leads to frequent changes of road scenery and information objects which get into driver’s visual field (which need to be looked through (visually scanned) with lack of time). Thus experienced drivers tend to acquire needed information at a substantial distance, i.e. when vehicle itself is far away from the source of information. The greater the distance from the information source, the greater time is secured by the driver for oneself to process the information, to make decision etc. But unlike the daytime, at the dark time the information can be picked only from roadway sections, which are effectively lighted or properly equipped for the purpose and picked only at specific the distances – lighted distances.

The lighted distance \( L_l \) could be defined for the pre-condition that visibility distance equals the breaking (stopping) path \( (L_V=L_{brek}) \):

\[
L_l = \frac{V_a}{3,6} T + Ke \frac{V_a^2}{254 \phi} + \mu V_a,
\]  

(1)

where: \( V_a \) – the velocity of automobile , \( \mu \) – empirical factor, which takes into account the decrease of visibility range (distance) of the object; \( \phi \) – road friction ratio; \( T \) – time of breaking system response, sec.

The later \( T \) equals:

\[
T = t_1 + t_2 + 0,5t_3,
\]  

(2)

where: \( t_1 \) – situation driver’s reaction time period, sec; \( t_2 \) – time response lag of breaking mechanism, sec; \( t_3 \) – deceleration time, sec.

The driver achieves the safety level if the following condition is met \( L_V/L_{brek} \geq 1 \).

The above equation allows calculating the safety factor in term of visibility conditions.

Theoretical analysis and practical research [3,5] allow to define the typical factors influencing the safety at dark time of day and which are directly linked to driver’s perception:

1) Absence of proper lighting of particular road sections with stationary lighting or complete absence of lighting.

2) Non-efficient lighting provided by custom front-lighting equipment, in particular, side visibility; non-adaptation lighting equipment.

3) Blinding by the lighting of oncoming traffic. Blinding by the lighting of vehicles moving behind in the same direction.

4) Faulty lighting equipment or inadequate use of the later.

5) Inadequate road traffic control means (road signs, road marking, directing posts, additional means of information).

6) Lack or absence of night time driving skills (absence of adequate driver training principles and methods and training techniques, absence of driver simulator training).
7) Psycho-physiological limitations of human, in particular, limitations of visual apparatus (vision), psycho-physiological needs of the driver (human).

8) Deterioration of working ability and tiredness of driver.

Recent research in many countries is directed at nighttime road traffic safety by studying items 1, 2, 3, 5 factors (see above) strictly in terms of technical-lighting characteristics of lighting equipment [5]. This article promotes the research of items 1, 2, 5, 6 factors (in particular, comprehension of technical-lighting characteristics of lighting equipment), but strictly from the perspective of driver’s psycho-physiology and driver’s specific visual needs, VIA algorithms and tendencies [2, 3, 4, 5]. Firstly, those factors are the less studied in the light of proposed aspect, secondly, they are highly likely to increase safety significantly.

Conclusions. Further research should be directed at vehicle enhancement and vehicle safety with special emphasis on its active and passive components; new types of safety features should also be probed.

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РЕФЕРАТ

У статті автори розглядають практичні пропозиції щодо підвищення безпеки дорожнього руху та оцінюють найбільш перспективні напрямки підвищення безпеки транспортних засобів в Україні. Одне з рішень в області активної безпеки транспортних є підвищення інформативності (інформативне зміст), зокрема, в темний час доби (це особливо важливо, беручи на увагу величезну кількість ДТП з пішоходами). Одним з важливих аспектів цієї проблеми є створення належних умов для водіїв (так само як і для інших учасників дорожнього руху) для збору необхідної зорової інформації. Були проаналізовані п’ять основних етапів функціонування водія (пов’язано зі збором інформації). Відповідно до обраних напрямком та завданнями дослідження проведено детальний аналіз аспектів безпеки транспортного засобу (зокрема, автомобіля). Слід зазначити, що безпека транспортного засобу визначається числом структурних (конструкційних) та експлуатаційних характеристик (продуктивності), якій безпосередньо вносить свій внесок у: зниження їмовірності аварій; важкості аварії; негативний вплив на навколишнє середовище і т. д. Показано, що безпека транспортних засобів може бути розділена на наступні основні групи (активну, пасивну, післяаварійну і екологічну). Так активна безпека - властивість транспортного засобу, яка сприяє запобіганню аварій і зниження їмовірності аварій; пасивна безпека - відповідно властивість транспортного засобу, яка сприяє істотному зниженню тяжкості аварії. Розглядається також післяаварійна безпека, що сприяє значному зниженню тяжкості аварії відразу після здійснення ДТП. У завершенні проаналізовано екологічна безпека, яка співвідноситься з можливим виникненням ДТП, а є властивістю автомобіля, що сприяє зменшенню його негативного впливу на навколишнє середовище. Виходячи з актуальності поставленого завдання і, з урахуванням статистичних даних ДТП, запропоновано рекомендації щодо підвищення ефективності (точності та своєчасності) збору зорової інформації (ЗЗІ) та обробки інформації, які дозволяють водієві вибирати конкретний "безпечний" режим керування автомобілем. Показано, що процес керування автомобілем повинен бути охарактеризовано як задача, в якій ЗЗІ має першорядне значення (незалежно від часу доби). З урахуванням проведенного аналізу, а також грунтувуючи на результатах попередніх досліджень авторів, передбачається, що подальші дослідження повинні бути спрямовані на підвищення конструктивної безпеки транспортного засобу пов’язаної саме з його активною і пасивною безпекою.

КЛЮЧОВІ СЛОВА: БЕЗПЕКА ТРАНСПОРТНОГО ЗАСОБУ, АКТИВНА БЕЗПЕКА, ПАСИВНОЇ БЕЗПЕКИ, ЗБІР ЗОРОВОЇ ІНФОРМАЦІЇ.
ABSTRACT


The article deals with the authors’ practical proposals to improve road safety and defining the most promising directions of enhancing vehicle safety in Ukraine. One of active safety solutions is the increasing of self-descriptiveness (info content), in particular at dark part of the day (it’s especially important taking in view the huge number of pedestrian related accidents). One of important aspects of the problem is creation of proper conditions for drivers (as well as for other participants of road traffic) to perceive and acquire relevant visual information. Five major stages of the driver’s task (related to information acquisition) were considered. In accordance with the chosen direction thorough analysis of vehicle’s safety components were carried out. It is noted that the vehicle’s safety is defined by number of structural (constructional) and operating characteristics (performance) which directly contributes to the decrease of accident probability; the severity of the accident; negative impact on environment etc. The vehicle safety is divided into following major groups (these were as follows: active, passive, post-accident and ecological. Accordingly, the active safety is vehicle’s property that contributes to preventing of accidents or to lowering the accident probability. The passive safety is vehicle’s property that contributes to significant reduction of accident severity. Post-accident safety is vehicle’s property that contributes to significant reduction of accident severity immediately after the later have taken place, i.e. such after-effect as gasoline spilling out from fractured tank and its resulting ignition etc. Ecological safety is not directly linked with road accident and constitutes vehicle’s property that contributes to decreasing its negative impact on environment. The efficient (faultless and timely) visual information acquisition (VIA) and processing of information allows the driver to choose particular “safe” mode of driving. The driving process should be characterized as the task in which the VIA is of prime importance (regardless of the time of day). In-turn VIA consists of the following sub-tasks:

As the result of the initial research it is proposed that further research should be directed at vehicle enhancement and vehicle safety with special emphasis on its active and passive components; new types of safety features should also be probed.

KEY WORDS: VEHICLE SAFETY, ACTIVE SAFETY, PASSIVE SAFETY, VISUAL INFORMATION ACQUISITION.
предложены рекомендации по повышению эффективности (точности и своевременности) сбора зрительной информации (СЗИ) и обработки информации, которые позволяют водителю выбирать конкретный "безопасный" режим вождения. Показано, что процесс управления автомобилем должен быть охарактеризован как задача, в которой СЗИ имеет первостепенное значение (независимо от времени суток).

С учётом проведенного анализа, а также основываясь на результатах предыдущих исследований авторов, предполагается, что дальнейшие исследования должны быть направлены на повышение конструктивной безопасности транспортного средства связанной именно с его активной и пассивной безопасностью.

КЛЮЧЕВЫЕ СЛОВА: БЕЗОПАСНОСТЬ ТРАНСПОРТНОГО СРЕДСТВА, АКТИВНАЯ БЕЗОПАСНОСТЬ, ПАССИВНАЯ БЕЗОПАСНОСТЬ, СБОР ЗРИТЕЛЬНОЙ ИНФОРМАЦИИ

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DEVELOPMENT OF METHODS TO IMPROVE THE LOGISTICS IN UKRAINE: PROBING THE MATHEMATICAL MODEL FOR ROAD TRAFFIC AND FREIGHTS SHIPMENT FLOWS

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Introduction. Needless-to-say that the task of improving the logistics in Ukraine is of great importance and of high priority. Much is being done in this field by local logistics and transportation professionals, academics etc. More recently powerful boost to the efforts of significant enhancement of the logistics in Ukraine was provided by the European Commission via its TEMPUS projects.

For example, in accordance with TEMPUS Project Guideline wider objectives are as follows: - the improvement of co-operation between universities and companies with respect to education and training offers of practical relevance, that meet labour markets needs; - transfer and adaptation of European experiences in e-learning methods to Ukrainian universities. The specific project objectives include: - composition of a network of Ukrainian and European universities and companies for joined development of management training courses for transport and logistics; - joined development of management courses for advanced vocational education and training of Ukrainian specialists and executive staff of the transport and logistics branch including education of professional trainers, - qualification of university teachers and staff in positions of responsibility in professional training methods for the education of specialists and executive staff.

The above objectives are very important, but at the same time one should not underestimate the needs for development of logistics theory itself (which can later be used as component of training course).

The main goal of this article is the development of logistics mathematical model and specifically the creation of mathematical model for simulation of highway transportation and traffic flow for the logistics purposes.

The general formulation of the problem. Let’s discuss the safety of transport logistics at highways. We’ll consider the strip of highway equalling „one automobile + safety distance“. The appearance of automobile at the entry of the above strip shell be considered as the request for servicing and the coming of automobile through the strip will mean – satisfying the request. Thus the discussed strip can be considered as queuing system (QS) with breakdowns, which structurally can be presented as follows:

The research of such QS with breakdowns by means of classic methods is unsuitable due to high dynamics of events: statistical indices of the volume of coming-in requests significantly differ from Poisson distribution. Further more the collisions of vehicles, delays etc. lead to sharp changes of the event’s dynamics and lead to unpredictable changes in the state of QS with breakdowns. For effectively researching the dynamics of functioning of considered QS let us create the following mathematical model and the principles of its research.