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THEORETICAL ANALYSIS OF FACTORS AFFECTING ROAD TRAFFIC SAFETY

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Abstract
The article examines the main features of the "Driver - car - road - environment" (DCRE) system, as well as the existing problems in describing the system and its components. An approach based on simulation modeling methods is proposed, as well as a theoretical analysis of factors affecting road safety.

Key words: Traffic accident, vehicle, driver, operator, speed criterion, reaction time, professional activity.

Introduction

As you know, the problem of road safety appeared at the same time as the automobile. The increase in the level of motorization around the world is an important component of technological progress, but its dangerous consequences should not be ignored.
A significant increase in the size of the vehicle fleet and the massive inclusion of new drivers in the traffic structure have led to significant changes in traffic conditions. This, in turn, has a negative impact on road safety [1].
According to statistics, the majority of traffic accidents resulting in injuries, deaths and material losses, i.e. 70-80 percent, occur as a result of the wrong actions of the driver that do not correspond to the set goals. Safe use of motor transport depends on the driver, his efficiency and reliability [2].
The results of the analysis of the system of professional training of drivers in the field of traffic safety show that one of the ways to solve the high-level problem of accidents is to pay necessary attention to the professional qualities of driver candidates during educational activities [3].
The analysis of traffic accidents shows that the weak link in the "driver-vehicle-road-environment" (DCRE) system in the "man-machine" system, which limits its effectiveness and reliability, is the person himself. However, new drivers make up less

than 30% of the total number of drivers, but they cause more than half of all traffic accidents in the first three years of driving. [4].

The car driver can be considered as the operator of DCRE complex speaker system [5]. At the same time, it is necessary to emphasize the features of the operator's work that distinguish his work not only from many operators of "man-machine" systems, but also from the activities of operators of some other vehicles. For example, a pilot in flight receives 90% of the coded information from various devices located on the instrument panel. The car driver receives most of the information (up to 95%) from the car, the road, the traffic environment, and only a small part from the devices located on the dashboard of the car in the form of coded information [6]. The pilot can use the autopilot and occasionally relax the tracking mode. It is impossible to slow down the driver's observation of rapidly changing traffic conditions, because this distraction for 1-2 seconds can lead to an emergency situation. However, the driver can reduce or increase the amount of data received and processed by him in a unit of time by changing the speed or route. The effectiveness of any "man-machine" system, including the DCRE system, depends on the reliability of the operator (vehicle driver). The information activity of the driver determines the main stages of perception of the road situation:

• the first stage "reception of information" (identification and designation of necessary signals from the environment);
• the second stage "information processing" (incoming information is received and processed using psychological and physiological qualities);
• the third stage "decision-making" (situation assessment allows to determine the right solutions in complex road conditions);
• the fourth stage "implementation of the decision" (characterized by efforts to influence the vehicle management authorities);
• the fifth stage is "control" of the actions being performed (determined by the exchange of opinions on the results of the actions).

According to the definition of the reliability of the DCRE system, it is possible to distinguish the levels of driver activity, which are characterized by the main parameters that affect road safety: by the speed, accuracy, reliability of the actions performed, by the nature of indicative and control operations. The speed criterion depends on the reaction time and is determined by the expression (1).

$$t_{sc} = r + v\,M, \qquad (1)$$

where r is reaction time;

v – speed of data analysis received;

M is the volume of received data.

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The speed of the driver's reaction is determined by the time of exposure to the control bodies (2).

$$T_r = t_{sc} + \sum_{i=1}^{n} t_i , \quad (2)$$

where T_r is exposure time;

t_i – signal delay time;

n – volume of incoming signals.

During the calculation of T_r, t_i it is necessary to fulfill the condition (3) of the speed of the operator's activity.

$$t_{sc} \leq T_p - \sum_{i=1}^{n} t_i , \quad (3)$$

The time of analysis of incoming signals t_{ns} is determined as follows (4)

$$t_{ns} = t_1 + t_2 + t_3 , \quad (4)$$

where t_1 is the time of receiving information;

t_2 – decision-making time;

t_3 is the time of action.

The professional performance of the driver affects the reliability of the DCRE system and is determined by the analysis of the correct decision made in the traffic conditions within the specified time (5)

$$P_n(t) = P_b \cdot P(T_a \leq t), \quad (5)$$

where P_b is an error-free action;

$P(T_a \leq t)$ – timeliness of the action.

Error-free action P_b and timely execution $P(T_a \leq t)$ determine the following law:

- the shorter the operator's execution time, the higher his error rate P_b;
- the smaller the execution time t, the smaller the number of operations performed as part of the operator's activity.

The described laws make it possible to present the process of changing work operations and the process of assessing the level of activity in the form of a onceptual model, the Cadet-Car-Road-Traffic environment (CCRT) system (Fig.1).

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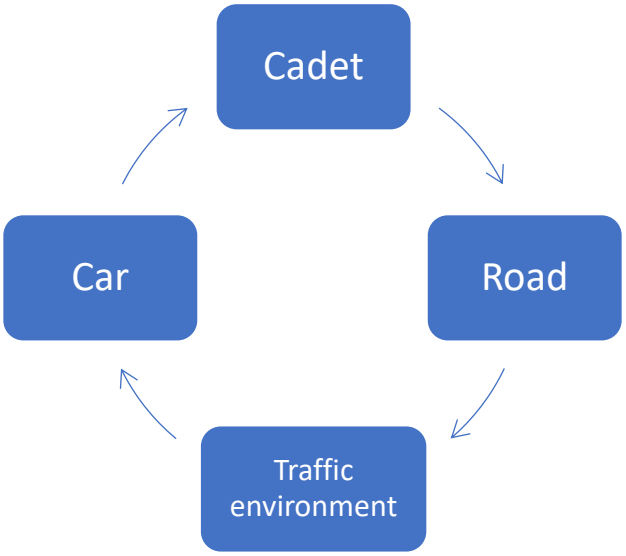
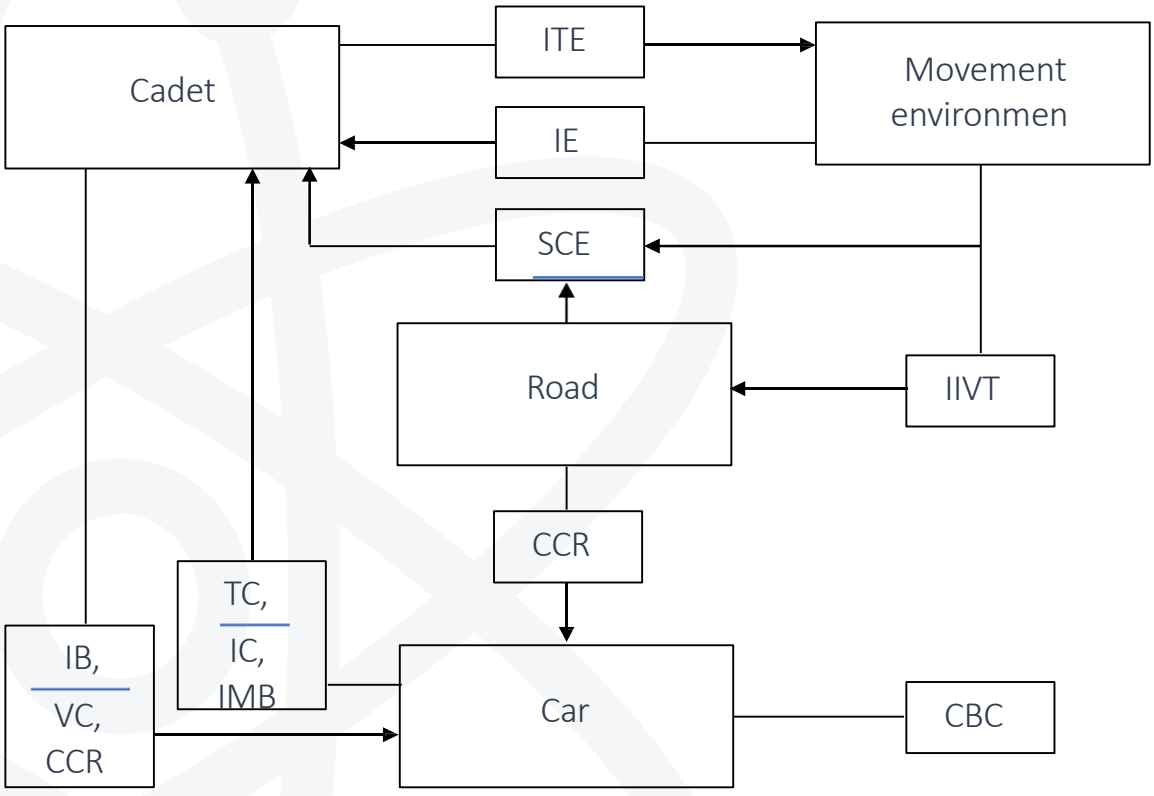


Figure 1. Cadet-Car-Road-Traffic environment (CCRT) system.

It involves activities related to driving a vehicle and includes the work of the cadet, the interaction of the vehicle with the environment and the mechanical impact it has on the road. The relationship between the CCRT system and its elements [7] is presented in Figure 2.



2 – расм. КАЙҲ тизими ва унинг элементлари

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"CCRT" system includes the following components (elements):
CBC - control bodies of the car;
CCR – the condition of the car on the road;
IC – information coming from the car;
IE – information from the environment;
SCE – is the state of the car in the environment;
TC – technical condition of the vehicle and control bodies;
IMB – impact on management bodies;
IB – influence on management bodies,
VC – vehicle operation control;
CCR - car condition on the road, traffic environment;
ITE –information from the traffic environment;
IIVT is information from the interaction of the vehicle with the traffic environment.
The criteria for evaluating the reliability of the "CCRT" system are shown in the table.

table

Reliability criteria of "CCRT" system		
Car	Cadet	"Court-Car" system
Possibility of continuous operation during working hours t-$P_t(t)$	The probability of error-free operation of the operator P_{OP}	The probability of fulfilling the tasks of the "CCRT" system
Car readiness coefficient K_c	Training coefficient of the cadet K_{CC}	
Probability of restoring uninterrupted operation of the vehicle P_{uov}	Probability of performing operator activities on time P_{OA}	
	Possibility of error correction P_{PEC}	

In the process of managing the "CCRT" system, the level of continuity of cadets' participation is characterized by three levels:

➢ The first-level system of the reliability of the "Cadet - Car" complex is characterized by the continuity of the car control process (trainer training) and is determined by expression (6).

$$P_{CC1} = P_t(t) + [1 - P_t(t)]\, K_{OA}\, [P_{OA}\, P_{CA} + (1 - P_{OA})\, P_{CP}], \qquad (6)$$

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where P_t (t) is the probability of error-free operation of the simulator complex during the training time (t);

K_{OA} - cadet readiness coefficient for operator activity;

P_{OP} is the probability of the cadet's error-free performance in the analysis of the accident situation;

P_{CA} - the probability of timely completion of operator activities by the cadet;

P_{CP} is the error correction probability.

➢ The secondary system of the reliability of the "Cadet - Car" complex is continuous, and the activity consists of periodically solving a number of discrete tasks that constantly follow each other (motorway training) and is defined by expression (7).

$$P_{CC2} = K_{OA} [P_t P_{OA} P_{CA} + (1 - P_T) P_{ACC} P_{OA} P_{CA} + (1 - P_{OA}) P_T P_{CP}], \quad (7)$$

where P_{ACC} – is the probability of timely recovery of the necessary actions related to the control of the car and the cadet;

P_T is the probability that the vehicle will operate during the training period.

➢ The system of the third level of reliability of the "Cadet - Car" complex is characterized by clear discreteness in solving operator tasks (real-time control of the car) and is defined by expression (8).

$$P_{CCD} = K_C P_T P_{OA} P_{CA} + (1 - P_T K_C) P_{CV} P_{OA} P_{CA} + (1 - P_{OA}) P_T P_{CP}, \quad (8)$$

where K_C – is the operating characteristic coefficient of the vehicle;

P_{CV} – is the probability of restoring the operational characteristics of the vehicle.

Conclusion

The analysis of the formation stages of the cadet's activity allowed us to draw the following conclusions:

- The cadet's actions include a set of directed and control operations, as well as performance of labor operations related to driving a vehicle and are characterized by actions that ensure their error-free operation.
- The characteristics of the driver's candidate's activity are determined by the level of perception, analysis, decision-making, implementation of the decision, and control of the actions performed during the professional training stage.

- Differences in the stages of formation of activity, manifested in the content of indicative control operations, are determined. The content of the work operation is unchanged and corresponds to the standard algorithm of the activity.
- During the period of mastering a new type of activity of the cadet, it differs from the standard algorithm and is a variable part.

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