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DRIVER REACTION TIME AS A FACTOR AFFECTING ROAD SAFETY

У роботі розглянуто питання часу реакції водія та його складових. Він є одним із ключових психомоторних показників, що безпосередньо впливає на безпеку дорожнього руху. Проаналізовано структуру та компоненти часу реакції, виявлено чинники, що зумовлюють його варіативність. До найпоширеніших із них можна віднести дорожні умови, рівень уваги, втому, використання мобільних пристроїв тощо. Встановлено, що значні розбіжності у нормативних показниках часу реакції ускладнюють проведення судових експертиз та можуть впливати на визначення ступеня вини водія. При цьому встановлено, що на час реакції водія значною мірою впливає його функціональний стан.

***Ключові слова**: час реакції, водій, транспортний засіб, безпека дорожнього руху, функціональний стан, умови руху.*

This thesis examines the issue of driver reaction time and its components. It is one of the key psychomotor indicators that directly affects road safety. The structure and components of reaction time are analyzed, and factors contributing to its variability are identified. The most common of these include road conditions, level of attention, fatigue, use of mobile devices, etc. It has been established that significant discrepancies in standard reaction time indicators complicate the conduct of forensic examinations and may influence the determination of the driver's degree of fault. It has been established that a driver's reaction time is significantly influenced by their functional state.

***Key words**: reaction time, driver, vehicle, road safety, functional state, traffic conditions.*

Driver reaction time is one of the key indicators of professional driving performance. Information processing is not passive; rather, it involves active decision-making to find the optimal response. This is especially evident under actual road traffic conditions. At the same time, standard reaction time values vary by country and driving environment. For example, in Switzerland, the accepted reaction time for urban traffic conditions is 0.75 s, whereas for rural traffic conditions – this indicator reaches 2.5 s. In Ukraine, highly trained drivers demonstrate a reaction time of up to 1.16 s during emergency braking maneuvers [1, 2]. Furthermore, reaction time is significantly influenced by the driver's level of attentional focus. In urban traffic conditions, the driver's attention is generally more engaged and sustained. Consequently, reaction time tends to be shorter. According to the literature [3], in a state of readiness for braking, this indicator ranges from 0.6 to 0.8 s, whereas under distracted attention, it increases to 1.1–1.7 s.

As reported in literature [3, 4], under rural driving conditions – particularly on extended straight highway sections – driver reaction time tends to increase. For instance, while driving on motorways, driver reaction time may reach 3.5–4 s with a reliability level of 95%. This phenomenon can be attributed to the driver's adaptation to stable and relatively favorable road conditions, which gradually reduces vigilance and readiness for rapid response. Should an obstacle suddenly appear or road conditions deteriorate, the driver experiences additional psychological-emotional stress, potentially leading to a marked increase in reaction time.

In the forensic and road safety literature, driver reaction time is considered a key parameter in expert analysis. However, scientific and applied studies demonstrate considerable variability in these indicators. This variability, in turn, gives rise to significant discrepancies in expert conclusions. From a practical standpoint, this issue is of considerable importance, as the selection of specific reaction time values can directly affect the outcomes of expert analyses. Consequently, this may influence the determination of the driver's degree of fault in a road traffic accident. The root causes of such discrepancies are primarily due to differences in methodological approaches in the organization of research [4]:

9. the tools that were used;
10. the conditions under which the experiments were conducted;
11. the conceptual foundations of the testing;
12. the characteristics of the test subjects;
13. the methods used to interpret and summarize the data obtained.

Driver reaction time is one of the key parameters that determine braking effectiveness and safety in emergency situations. This term refers to the time interval between the moment a hazard appears and the

driver's first active response. Such responses may include both braking and a change in the vehicle's trajectory. This indicator consists of three main sequential components [4, 5]:

perception time, which covers the period from the appearance of a hazard to its acknowledgement;

basic psychological reaction time, which includes situation analysis, decision-making, and the transmission of a nerve impulse;

motor reaction time, which corresponds to the physical performance of an action, such as, for example, moving the foot from the accelerator pedal to the brake pedal.

It should be noted that the first and second components represent the mental aspect of the reaction, while the third component characterizes its motor phase. Therefore, the total psychomotor reaction time is defined as the sum of all aforementioned components [4, 5].

A driver's reaction time directly affects the safety of all road users. According to statistics, most traffic accidents are caused by the actions or inaction of drivers. This clearly underscores the practical significance of this factor. At the same time, it depends on driving experience, psychophysiological state, fatigue level, and the influence of stress factors.

While driving a vehicle, drivers are exposed to various distractions. These distractions reduce concentration and impair control over the road situation. Any activity not directly related to driving increases reaction time and raises the risk of a traffic accident. The most common sources of distraction are [4, 6]:

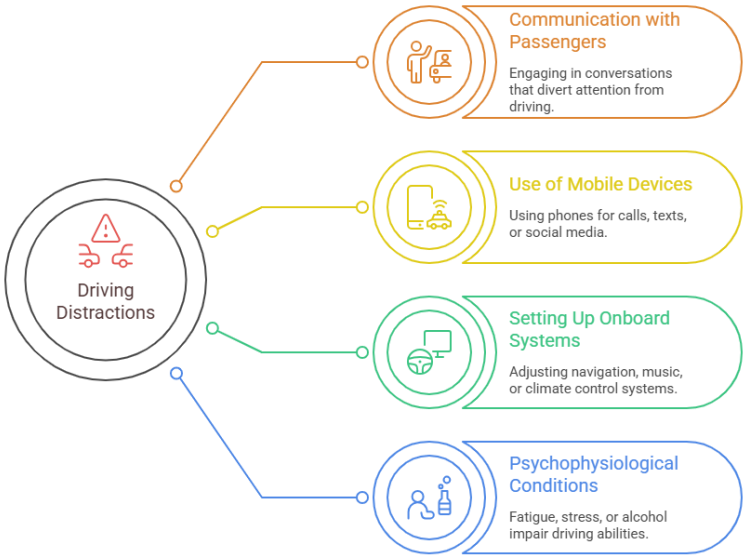

Fig. 1. The most common sources of a driver's distraction [4, 6]

Distractions from paying attention to the road lead to delayed reactions and an increase in the overall reaction time to changes in traffic conditions.

The study [7] notes that a driver's use of a mobile device increases their reaction time, particularly by +0.33 seconds when traffic lights change, +0.29 seconds when a pedestrian crosses the road, and +0.63 seconds when an obstacle falls onto the road, etc.

Among other factors influencing a driver's reaction time, the authors of [5] identified a human's functional state. In particular, the research results indicate the influence of both the activity index of the body's regulatory systems and the drivers' gender and age.

A range of other functional and situational factors also significantly affect a driver's reaction time. The most notable of which include a decrease in concentration due to:

the use of a mobile device [8, 9];

listening to audio content [10], which naturally leads to a longer reaction latency period;

increased cognitive load and emotional stress [11];

deteriorating weather conditions [12];

deterioration of the operator's physiological state, alcohol intoxication, etc. [2, 13].

In summary, driver reaction time is a critical psychomotor parameter that directly determines the effectiveness of driver responses in emergency situations and, consequently, the safety of all road users. The analysis presented demonstrates that this indicator is highly variable and depends on a range of factors – including driving environment, attentional focus, fatigue, cognitive load, mobile device use, etc.

Therefore, driver reaction time should be regarded not merely as a physiological characteristic, but as a fundamental safety parameter requiring careful consideration in traffic regulation, driver training, and road accident investigation.

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