

## Risks of a Traffic System: Assessment and Methods of Minimization

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### Abstract

The article presents the author's classification of risks related to the traffic system. Materials of applied sociological research that demonstrate its approbation and contain the assessment are presented. The expert survey and the compilation of a risk rating with the arithmetic average at a 10-point grade system are used as the basic method. The heuristic moments in the evolution of scientific ideas about the category of "risk" are recorded, which allowed to develop the author's classification of risks. An algorithm is proposed for the transition from the theoretical construct to empirical recording that allowed to obtain a comprehensive picture of the state of risks and their impact on the traffic system safety. Methods to minimize the risks of the traffic system in the modern conditions are reviewed.

**Keywords:** Traffic system; Risks; Methods of minimization; Expert survey.



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### 1. Introduction

The traffic system is a multifunctional institutional complex designed to meet a whole range of key social needs related to movement and interaction in the social field of transport, drivers and pedestrians, etc. In the modern conditions, significant changes occur in the development of this system, which increasingly lead to an increase in the number of risks and their variety. A vehicle and its use become an iconic item, the use of individual vehicles is intensified, the imbalance between the level of automobilization and the pace of road construction expands, and the power of the modern vehicles and their speed capabilities gain the effect of maximizing the existing risks on the road.

The safety issue increasingly comes to the fore in the modern society, with its constant striving for technological development and improvement. According to the World Health Organization, 1.25 mln people in the world die every year in traffic accidents. Traffic accidents are the leading cause of death for the young population from 15 to 29 and are far ahead of such causes as murders, infections and other diseases. Half of all deaths on the roads in the world occur among the least protected road users: motorcyclists (23%), pedestrians (22%), and cyclists (4%). At the same time, the Russian Federation ranks second in the world by the number of deaths from traffic accidents, which emphasizes the importance and relevance of the research topic (WHO, 2015); (Traffic Police of the Ministry of Internal Affairs of Russia).

A significant share of risks, their occurrence and development, as well as the preservation of safety in common are related to the general and professional competence of road users. The general safety of the traffic system depends on their skills, patterns of behavior on the road, and attitude to other road users. However, mass violations of the Traffic Rules, a low road transport culture, and an increase in aggression and conflict behavior on the roads can be seen today. At the same time, an increase in the scale of driver training is not accompanied by an increase in its quality, and often leads to a decrease in the level of training, a lack of clarity and unity in managing the training process instead. The society currently needs adequate changes in the structure, forms and methods of training and education, improvement of the material and technical base, and development of new approaches that together will contribute to the formation of socially focused road users, with the key characteristics being the preservation of safety and minimization of risks. These trends determine the dependence of the scientific understanding of the traffic system from the standpoint of sociological science, the paradigms and methods of which will provide a new vision of safety problems and allow to find adequate solutions to reduce risks on the roads.

The risk was initially associated with damage due to advances in technology. The sociological aspect of the risk research is directly associated with the emergence of modernist concepts of risk (Beck, 1994;2000; Giddens, 1994). The basic idea behind these concepts is that risk is a result of satisfying the needs in the modern developed societies and is becoming uncontrolled. N. Luhmann's theory is closer to the author's understanding, as it allows analyzing it as a behavior based on the decision making. Cultural symbolic theories treat risk as a threat to a particular lifestyle. It must also be noted that an approach that measures risk as dangerous/harmless (Luhmann, 2004) is quite popular. Russian sociology is also described by versatility in the study of risk. For example, O. Yanitsky advocates the idea

that risk dependence becomes the social norm of everyday life, and Russian society itself becomes a risk society, where safety plays a leading role (Yanitskiy, 1999;2003). The risk research of A.V. Mozgovaya involves both macro- and microanalysis. On the one hand, the risk is based on a subjective decision. On the other hand, it has institutional and organizational levels of vulnerability (Mozgovaya, 2006). Yu.O. Zubok puts the youth in the center of the analysis. Recognition of the conditions of modernity as conditions with a constant increase in risk is significant in her theoretical and methodological view of risk.

The idea of risk understanding in sociology can generally be expressed in the following provisions: 1) it is always associated with an action that can bring a negative result, 2) risk is based on danger, the level of which is needed for risk assessment, and 3) risk always carries some losses.

## 2. Methods

Risks for the traffic system were assessed through an expert survey. The experts were specialists whose activities are related to road safety. A total of 45 experts were interviewed, consisting of traffic police officers, driving instructors, heads of various traffic safety departments, driving school directors, employees of the Scientific Center of Life Safety and the State Budgetary Institution of Road Safety.

The questionnaire for experts was divided into two parts. The first was focused on obtaining an overall picture of the safety of the traffic system, while the second was focused on assessing the risks of the traffic system according to the classification developed by the author (technological, transport, legal, and social risk). Experts were asked questions to identify factors that reduce the likelihood of such risks. Five main factors were identified in each of the components, which the experts were asked to rate on a 10-point grading system, where 1 meant the minimal impact and 10 meant the maximum impact on the risk minimization. In other words, the higher the score was, the more this factor minimized the occurrence of risk. The experts were asked open-ended questions about the measures of the risk minimization, and they expressed their point of view and offered their own solutions to problems in their responses. Methodological developments of regional researchers were used and taken into account (Makhiyanova, 2013;2014) in compiling the questionnaire and conducting interviews.

## 3. Results and Discussion

According to the classification, the technical equipment of the vehicle, condition of the roads, quality of the road surface, and the climatic conditions were included into the technological risk. In terms of the technical equipment of the vehicle, the correct operation of the brake system of the vehicle was given 5.6 points, the engine volume and the car power were given 5.2 points, the location of the tires and their seasonality were given 4.9 points, the proper operation of lights and wipers were given 3.3 points, and the presence of airbags was given 2.8 points.

The experts suggested the following measures to minimize this type of risk: strengthen the norms and requirements for technical inspection of vehicles, toughen the anti-corruption struggle in the field of technical inspection and the frequency of external audits of organizations that inspected vehicles. The experts made the following statements: "Modern cars, especially those with high power, become a deadly weapon on roads that can carry away many lives in the hands of inexperienced or gambling drivers who like to gun the engine", "The ability to buy a certificate of the vehicle inspection without even visiting the station is the main source of future traffic accidents."

The experts were also suggested to assess the road condition and the quality of the road surface by five parameters. The quality of road surface in the city and outside the city has the maximum effect on reducing risks (7.3 and 6.9). The timely repair of the road surface was given 6.2 points. The separation of lanes for various road users (pedestrians, drivers, cyclists, etc.) was evaluated at 5.4, and the system of junctions and highways was given 3.2 points.

The respondents proposed the following basic measures to solve the existing problems: to increase the severity of punishment for the untimely repair of roads, to increase the number of underground pedestrian crossings, and to apply new technologies in the road surface. The following words of the interviewed experts detail the optimization methods they proposed: "We still lay asphalt using old technologies, refusing to use the global experience", "Patch works dominate, which significantly reduces the quality of the road surface", "We should separate the lanes for pedestrians and drivers, put up barriers, build underground pedestrian crossings so that the people step on the road as less as possible."

The climatic conditions included the following parameters: winter season, precipitation and any formations on the road (frost, ice, etc.), the quality of road maintenance services, and road lighting in the dark.

The quality of road maintenance services, which includes timely removal of snow, icing on roads, etc. have the maximum weight in climatic conditions, according to the 10-point rating system in terms of traffic accidents and breaches of safety in general. In other words, the experts believe that any negative weather and climatic conditions should be promptly eliminated by the high quality of this service, which was given 7.8 points. On this occasion, one of the experts said the following: "Whatever the weather, there will be no accidents caused by bad weather conditions if everything is cleaned on time." Perhaps, this is why the other elements of this risk were given smaller values: winter season – 4.2, road lighting in the dark – 3.8 points, any formations on the road (frost, ice, etc.) – 3.1, and precipitation – 2.3 points.

The experts proposed the following measures for the risk minimization: maintaining evenness and high adhesion qualities of the surface as the main activity of the road maintenance services, which should be strictly controlled, and

making installations with additional information about safe traffic regimes during adverse climatic conditions (Table 1).

**Table-1.** Assessment of technological risks (average by 10-point rating system)

Risk indicator	Empirical indicator of the risk assessment	Value/ average
technical equipment of the vehicle	proper operation of the brake system	5.6
	engine size, power	5.2
	tire location and seasonality	4.9
	proper functioning of lights and wipers	3.3
	Airbags	2.8
road condition and road surface quality	quality of road surface in the city	7.3
	quality of road surface outside the city	6.9
	timely repair of the road surface	6.2
	separation of lanes for various road users	5.4
	system of junctions and highways	3.2
climatic conditions	performance of road maintenance services	7.8
	winter season	4.2
	road lighting in the dark	3.8
	any formations on the road (frost, etc.)	3.1
	Precipitation	2.3

The leading aspect in the assessment of transport risk (traffic intensity) is a conscious control of the vehicle speed by a driver, aimed at minimizing the risk of accidents. The experts gave it 8.9 points. The second place was also taken by the human factor associated with the driver's ability to assess the speed of driving in the traffic flow (6.8 points). The use of mechanical means of speed limits received the average rating (5.2 points), whereas the use of video recording as a method to limit the speed and regulation of standards for vehicle speed in terms of their impact on risk were given 4.7 and 3.1 points.

As for the level of roads motorization, most experts agreed that the factor of the road infrastructure quality was the most significant and gave it 6.5 points. Traffic jams in rush hour lag behind it (6.2 points). The next largest group included the traffic capacity and the presence of traffic lights that were adjusted to traffic modes in different periods (5.1 and 4.3 points). The number of vehicles was given 2.8 points.

In assessing the technical condition of the vehicle, experts put the greatest emphasis on the overall health of the vehicle and its timely maintenance by the owner (8.2 and 5.5 points). Equipment with devices enhancing the safety of the vehicle operation was given 5.1 points, whereas the year of the vehicle production and the country of origin were given 2.8 points each.

Below are some experts' statements about the factors under consideration: "The driver's personal responsibility for the operable condition of their vehicle should be the starting point of road safety", "No matter how a vehicle is equipped – if it's not in operable condition, it is a source of increased danger." (Table 2).

**Table-2.** Assessment of transport risks (average by 10-point rating system)

Risk indicator	Empirical indicator of the risk assessment	Value/average
traffic intensity	conscious control of the vehicle speed by a driver, aimed at minimizing the risk of accidents	8.9
	driver's ability to assess the speed of driving in the traffic flow	6.8
	use of mechanical means of speed limits	5.2
	use of video recording as a method to limit the speed	4.7
	regulation of standards for vehicle speed	3.1
level of the road motorization	quality of road infrastructure	6.5
	traffic jams in rush hour	6.2
	road capacity	5.1
	presence of traffic lights that are adjusted to traffic modes in different periods	4.3
	number of vehicles	2.8
technical condition of the vehicle (TC)	general operable condition	8.2
	timely maintenance by the owner	5.5
	equipment with devices enhancing the safety of the vehicle operation	5.1
	year of the vehicle production	2.8
	country of origin	2.8

The increase in fines for drunk driving ranked first in assessing administrative sanctions and their efficiency in legal risk (9.2 points). The increase in fines for driving that increases the risk of an accident ("checkers" driving, cut-off, etc.) ranked second, while traffic violations representing the most dangerous consequences for the life and health

ranked third (8.2 and 7.8 points). The increase in fines to pedestrians, whose actions lead to increased risks of an accident, and the expansion of the range of penalties for driver's license revocation were not among the top three leaders (5.4 and 5.1 points).

The next set of factors is presented by the list of the most dangerous violations of the Traffic Rules by road users. The experts gave the maximum value to drunk driving (9.6 points). Violations of the speed limit and rules of overtaking followed the leader (8.2 and 7.3 points). Violations of passing pedestrian crossings and intersections ranked last in this rating (6.2 and 4.3 points).

The final part of legal risk is presented by the analysis of the guilt and punishment ratio. It included the most dangerous violations in terms of the need to strengthen penalties for them. At the same time, the authors proceeded from the theoretical assumption that toughening of punishment led to minimization of actions for its implementation in practice and, thereby, reduced the risk of this type of action (Table 3).

**Table-3.** Assessment of legal risk (average by 10-point rating system)

Risk indicator	Empirical indicator of the risk assessment	Value/average	
administrative sanctions and their efficiency	increase in fines for drunk driving	9.2	7.14
	increase in fines for driving that increases the risk of an accident ("checkers" driving, cut-off, etc.)	8.2	
	traffic violations representing the most dangerous consequences for the life and health	7.8	
	increase in fines to pedestrians, whose actions lead to increased risks of an accident	5.4	
	expansion of the range of penalties for driver's license revocation	5.1	
violation of the Traffic Rules by road users	drunk driving	9.6	7.12
	violations of the speed limit	8.2	
	violations of the rules of overtaking	7.3	
	violations of passing pedestrian crossings	6.2	
	violations of passing intersections	4.3	
guilt and punishment ratio	tougher penalties for poor-quality driver training	7.8	6.82
	tightening of punishment for the death of people in an accident	7.3	
	tightening for violations that lead to accidents and increase the risk of their occurrence	6.3	
	tightening for violations causing disability in the road users	5.5	
	tightening of punishment for parents in case of improper transportation of children	4.2	

Most experts gave the highest score to such a parameter in social risk as tougher penalties for poor-quality driver training (7.8 points). The tightening of punishment for the death of people in accidents (7.3 points) ranked second. Tightening for violations that lead to accidents and increase the risk of their occurrence, as well as those causing disability in the road users took the middle position (6.3 and 5.5 points). The tightening of punishment for parents in case of improper transportation of children (lack of restraints, etc.) was given 4.2 points.

The experts made the following statements during the assessment of legal risks: "Only monetary punishments have an effect in our country", "Driving schools often stand aside from the results of their work, but this is not right", "If parents do not think about the safety of children, they should be severely punished."

The authors included such factors as the level of conflict in social interaction, the quality of training in driving schools, and the social profile of the driver in the social risk. According to the results obtained in assessing the quality of driver training in driving schools, the highest score in terms of impact on risk minimization was given to the quality of practical driving skills and the theoretical foundations of the Traffic Rules (9.5 and 9.1 points).

The experts pay no less attention to raising the requirements for technical equipment of driving schools (availability of simulators, practice grounds of high quality, etc.) (8.7 points). Stricter requirements to teaching staff and instructors, as well as the arrangement of regular inspections of driving schools for their compliance with licensing requirements were given 7.8 and 7.2 points, respectively.

The most frequent experts' statements are the following: "Driving schools should be fined if their graduates have accidents in the first year after training", "Driving schools should be ranked by the training quality, and the number of hours to train future drivers should be increased", "The requirements for the driving exams should be increased."

When considering the driver's social portrait, factors such as driving experience and the number of administrative penalties for violation of the Traffic Rules were given 8.3 and 6.1 points. Gender took the average position in the ranking (5.2 points), while age and marital status were given the lowest values (3.8 and 3.3 points).

Almost all parameters were given quite high scores in the third, final parameter of assessing social risk by the level of conflict of social interaction on the roads, thus, one cannot say there are any leaders and outsiders in the rating: driving style – 9.5, behavior in the event of a road conflict – 9.3, attitude to other drivers – 8.9, attitude to pedestrians – 8.7, and attitude to the traffic police officers – 8.5 points (Table 4).

**Table-4.** Assessment of social risk (average by 10-point rating system)

Risk indicator	Empirical indicator of the risk assessment	Value/average
quality of driver training in driving schools	quality of practical driving skills after training	9.5
	quality of the theoretical foundations of Traffic Rules after training	9.1
	requirements for technical equipment of driving schools	8.7
	increase in requirements for teaching staff and instructors	7.8
	arrangement of regular inspections of driving schools for their compliance with licensing requirements	7.2
social portrait of the driver	driving experience	7.3
	number of administrative penalties for violation of Traffic Rules	7.1
	gender	5.2
	age	4.8
	marital status	4.3
level of conflict of social interaction	driving style	9.5
	behavior in the event of a road conflict	9.3
	attitude to other drivers	8.9
	attitude to pedestrians	8.7
	attitude to the traffic police officers	8.5

Next, the value of each risk was estimated using the mean observation formula. Calculation of the values for each index was as follows:

$$\begin{aligned} \text{technological risk} &= \frac{4.36 + 5.8 + 4.24}{3} = 4.8 \\ \text{transport risk} &= \frac{5.74 + 4.98 + 4.88}{3} = 5.2 \\ \text{legal risk} &= \frac{7.14 + 7.12 + 6.22}{3} = 6.82 \\ \text{social risk} &= \frac{8.46 + 5.34 + 9.98}{3} = 7.92 \end{aligned}$$

As such, according to the expert opinion, factors causing social risk are more significant. It consists of such indicators as the quality of driver training in driving schools, social portrait of a driver and level of conflict of social interaction on the roads. At the same time, the obtained values do not reduce the effect of other factors, and their influence should be taken into account when analyzing safety issues.

## 4. Conclusions

The author's systematization of the risks related to the traffic system was empirically tested in the article using the expert survey. The use of a 10-point rating system and the calculation of their average value allowed to compile the following ranking, headed by the social risk. The most significant factors that minimize its development included driver training in driving schools (theoretical and practical), technical equipment of driving schools, driving style, and driver's behavior in conflict situations. The fines for drunk driving and driving leading to an increased risk of an accident should be increased, and penalties for poor-quality driver training and death in accidents should be toughened to minimize the legal risk that ranked second in the rating. The transport risk ranked third in the ranking, and the human factor dominated its assessment. In other words, the ability to regulate the vehicle speed, the correct assessment of the driving speed in the traffic flow, and the responsibility for timely maintenance will facilitate the minimization of this risk. The technological risk ranked last and was determined by the quality of the road surface, its timely repair, high-quality road maintenance services, separation of lanes for various road users (pedestrians, drivers, cyclists, etc.), and proper operation of the brake system of the vehicle. Overall, the quality and timeliness of technological support of these factors underlined the minimization of this risk.

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