Management of Sustainable Development of Car Service Enterprises

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Abstract. The effective activity of road transport enterprises depends on the chosen strategy of enterprise management. The urgent role is the effectiveness of the use of a risk-oriented approach to the management and planning of the enterprise. The article, using the method of hierarchy analysis and probabilistic method, identifies and determines the contribution of risks. The factors that form the risks of road transport enterprises' activities are defined for these types of enterprises. It has been found that the application of the hierarchy analysis method is a more time-consuming process and provides a deeper analysis of each risk. The probabilistic method is easier to apply, but it requires a high qualification of experts who will assess the risks. The results of surveys conducted by road transport enterprises indicate the application of elements of a risk-oriented approach. The availability of risk information makes it possible to implement appropriate precautions not only within an individual enterprise, but also on a more global scale.

1 Introduction

The rapid development of road transport enterprises, in particular service stations, affects the modern stage. The analysis of the activities of modern service stations demonstrates, usually, a chaotic management process, without a vision of the development of enterprises in the near and far future. This approach leads to reduced efficiency, degradation and bankruptcy. At first glance, everything is clear, but the approach to planning of activity of enterprise, management of its activity, risk assessment, quality management together will determine the possibility of further development of the enterprise.

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The method of these studies is to find tools that will ensure the sustainable development of road transport enterprises and will take into account not only the needs of customers. These tools will be able to predict future performance. A classic example of applying the hierarchy method is shown in Fig. 1 [1].

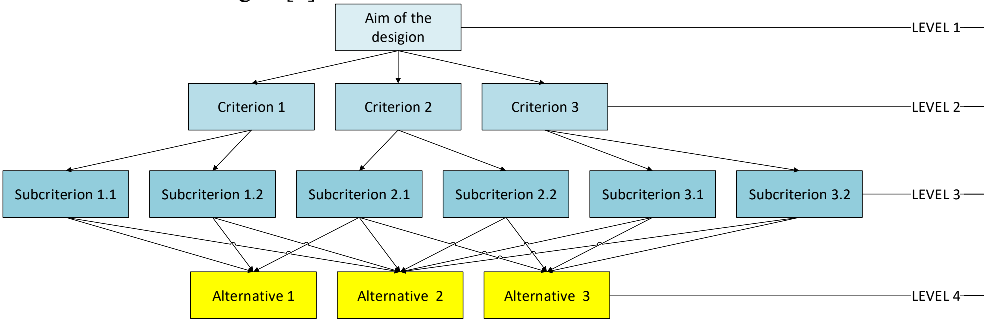

Fig. 1. Scheme of realization of the method of analysis of hierarchies.
Source: authors.

The general scheme of realization of the method of analysis of hierarchies is shown in Fig. 1. The purpose of the solution is usually in the first level, the second and third levels contain criteria and subcriterias, respectively. Possible alternatives are located on the lower level. It is worse noticing that the same alternative can refer to several sub-criteria.

A scheme of realization of the method of analysis of hierarchies (Fig. 1) can be adapted to determine the impact of risks on the functioning of the enterprise. The scheme of the hierarchy analysis method for implementing the risk-oriented approach is shown in Fig. 2.

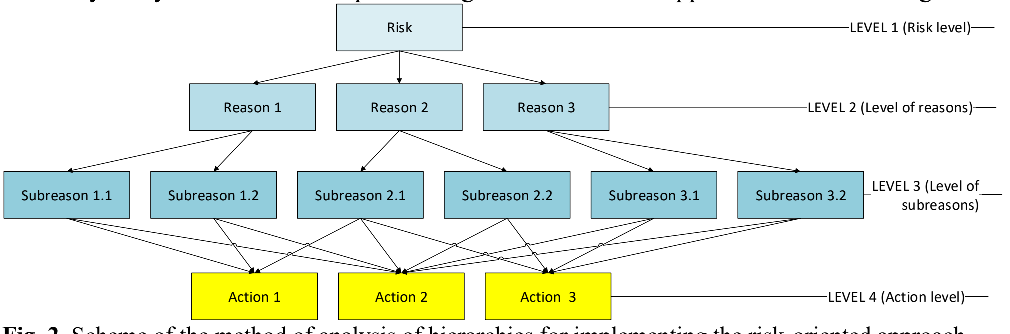

Fig. 2. Scheme of the method of analysis of hierarchies for implementing the risk-oriented approach.
Source: authors.

The highest level is the level of risk. The following level characterizes possible reasons that lead to or can lead to the risk. The third level is the level of subreasons, detailing the causes of the third level. The fourth level or action level demonstrates possible actions to completely eliminate or minimize risk. Due to the peculiarities of road transport enterprises, complete elimination of risk will be almost impossible. Most likely, the risk will only be minimized in most cases.

The presented scheme resembles the Ishikawa diagram (or "fish bone") in Fig. 2. Ishikawa diagram (Fig. 3) is well suited for risk identification, but it is somewhat inconvenient to form a risk action plan. The identified causes of risk can be detailed during risk identification in order to have an idea of possible ways to eliminate or minimize the impact. However, if you consider the stage of risk minimization, then one action can lead to the minimization of several causes or even risks. Therefore, it is more appropriate to use the scheme shown in Fig. 2. Given previous judgments, it can be assumed that it is advisable to combine two methods, hierarchy analysis method and Ishikawa method for effective risk management of the enterprise. In addition, the question arises of determining the contribution of each risk to the activities of the enterprise.

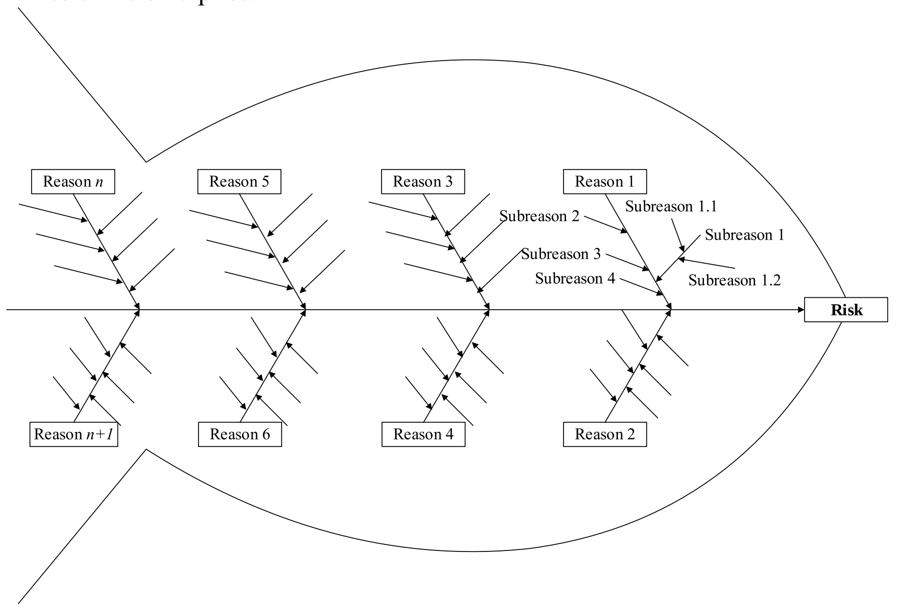

Fig. 3. Ishikawa diagram for realization of the risk-oriented approach.
Source: authors.

2 Literature review

A significant number of studies are based on the development of economic models of activity and development of enterprises [2-6].

The proposed approach of improving the methodology of strategic management of the enterprise, using the eventological analysis, mathematical apparatus of the theory of random events, methods and factor analysis deserves attention [7].

The authors consider a risk-oriented approach to the formation of financial security of a motor transport enterprise in work [8, 9]. At the same time, the authors proposed an author's methodology for assessing financial security. Management accounting and financial planning of Ukrainian enterprises is considered in the article [10].

Therefore, the risk-oriented approach is the most effective tool for ensuring the activity of the enterprise. It should be noted that the use of a risk-oriented approach is quite wide, namely, in the processes of ensuring the reliability of products [11], ensuring the sustainability of products on the market [12-16], the functioning of quality management processes [17, 18], assessing the risks of the product life cycle [19], using renewable energy resources, smart technologies in the conditions of climate change [20,21,22], managing supply chains [23-25], managing the technical condition of objects [26-28].

Risk assessment of road transport activities is also of considerable interest during researches. The authors focus on issues related to passenger transport companies. However, the main focus is on information systems in these studies [29]. An overview of the principles of risk-oriented approach to road safety management in the system "vehicle - driver - road - environment" was carried out in article [30]. A new approach to risk analysis is presented by the management of the transport enterprise in order to facilitate the decision-making process in article [31]. The analysis, identification and distribution of risks of time and space stability in the activities of freight transport enterprises is carried out thanks to the theory of fuzzy logic in the work [32]. The method of minimizing risks of strategic stability of freight transport companies on the basis of strategic outsourcing was proposed by the authors. Considerable attention is paid to the integration of risk management and crisis management related to management, business continuity at the enterprises in the work [33]. The assessment of the estimated key business risks in the transport sector of Slovakia is carried out in the work [34]. The status of risk management at enterprises that carry out activities in the field of transport was identified by the authors on the basis of their own empirical study. Entrepreneurial risk, which is defined as market, financial, personal, legal and operational risks, is highlighted in the work [35]. This approach makes it possible to establish causal relationships and their impact on the future of companies.

The method of analyzing hierarchies, analyzing the methods of organization and decision-making, has proven itself quite well. This method enables efficient analysis of complex solutions using mathematics and statistics. The analysis of scientific researches demonstrates the application of this method for various purposes, in particular, in order to build hierarchically ordered sequences of sections for a certain set of objects [36]. A new sensitivity analysis method based on local partial derivatives is proposed to optimize and facilitate decision-making based on the hierarchy analysis method [37]. The hybrid MCDM method, based on the hierarchy analysis method and taking into account quantitative and qualitative data in a probabilistic environment in the context of group decision-making, is presented in the paper [38]. This method is able to overcome problems when preferences are taken based on heterogeneous and inaccurate inputs, and when uncertainty exists due to imbalances among decision makers. A decision-making structure for professionals in construction and researchers is proposed in document [39]. It involves the integration of life cycle sustainability assessment, multi-criteria analysis of solutions and information modeling of buildings to select suitable materials for the construction of buildings and structures. A multi-criteria model for selecting light artificial aggregates through experimental processes is proposed in studies [40]. The integrated method of fuzzy stochastic analytical hierarchy with limitations is developed and proposed in the work [41]. This method is based on hierarchy analysis. A simplified method of applying the analytical hierarchy method is presented in detail in work [42]. Its goal is to calculate the priorities of each alternative. The method of analyzing hierarchies related to agriculture is considered in article [43]. The models used, data sources and overall accuracy have been achieved with different performance criteria over the past few years. Article [44] shows that the hierarchy analysis method can be used with different techniques. It also includes methods that can be used to calculate a matrix to set criteria. The review of literature on the application of the method of analysis of hierarchies was presented in work [45]. Its application is confirmed in a fairly wide range, including defense industry, business, government agencies, security, ecology, etc. The study's purpose is to explore of methods for the identification of risk contribution of car service enterprises.

3 Methodology

Several types of road transport enterprises are considered during these studies: motor transport enterprises for freight transportation and passengers; car service enterprises, the main activity of which is the maintenance and car repairs; instrumental control lines - check of technical condition and testing of vehicles; trade enterprises selling spare parts, operational materials and accessories for vehicles. The factors that form the risks of their activities are defined for these types of enterprises (Fig. 4).

The main factors that create risks for road transport enterprises in various spheres of activity are presented in Table 1. The main factor is the staff (employees) of the enterprise.

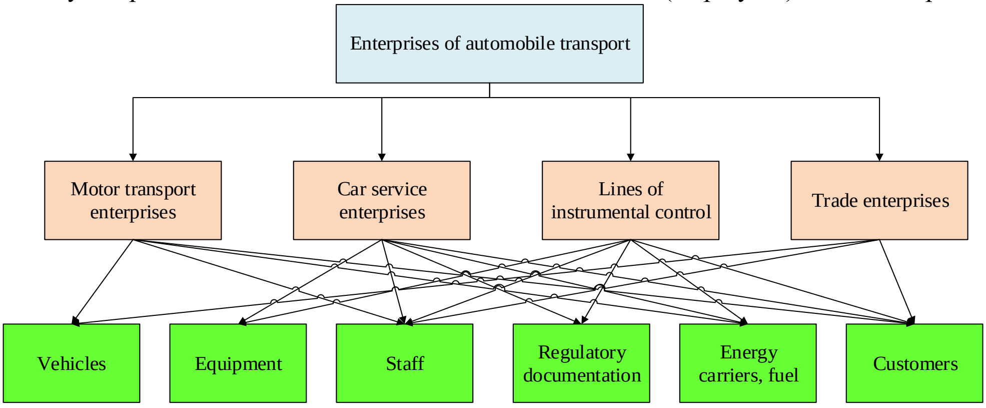

Fig. 4. Main factors that form the risks of road transport enterprises.
Source: authors.

Instrumental control lines carry out their activities in accordance with the ISO/IEC 17025:2017 management system. Therefore, this type of enterprise is chosen for further research.

Table 1. Main factors that create risks for road transport enterprises in various spheres of activity.

Type of road transport enterprise	Factor that forms a risk				
	Vehicle	**Equipment**	**Staff**	**Regulatory documentation**	**Energy carries, fuel**
Motor transport enterprise	+	–	+	–	+
Car service enterprise	–	+	+	+	+
Line of instrumental control	–	+	+	+	+
Trade enterprise	+	–	+	–	

Source: authors.

Risk identification for the following categories of factors is performed for the line of instrumental control: equipment, staff, regulatory documentation, resources and customers. The identified risks are given in Table 2.

Table 2. Risks of the line of instrumental control.

Risk factor	Risk description (possible reasons)
Equipment	Equipment mismatch about measurement limits, accuracy
	Application of uncalibrated equipment
	Unreliable equipment data
	Equipment failure
	Non-compliance with storage conditions, equipment's operation
	Lack of equipment
Staff	Lack of appropriate education regarding the direction of activity
	Lack of qualified staff
	Failure to comply with requirements on impartiality
	Lack of knowledge of the activities for which personnel are responsible
	Ignorance of his duties, responsibilities and powers by the staff
	Ignorance of the enterprise quality system by personnel

Risk factor	Risk description (possible reasons)
	Lack of knowledge to assess the results of inspection of the technical condition of the car
	Lack of knowledge about the features of the inspection object
	Inability to interpret the test results
	Non-compliance with the rules of equipment's operation
	Lack of skills, knowledge of application, use of equipment
Regulatory documentation	Lack of technical documentation
	Not updated technical documentation
Resources	Lack of electricity
	Mismatch of electrical network characteristics to regulatory parameters
	Emergency electric current shutdowns
Customers	Customer dissatisfaction with the quality of services/products
	No customers
	Non-compliance of services/products with customer expectations
	Reduce the number of customers

Source: authors.

Possible risks for a particular enterprise may differ significantly from those given in Table 2. Risks are formed for each particular enterprise, depending on its type, peculiarities of activity, purpose, vision, etc. All the risks shown in Table 2 form 5 subgroups, which together form the complete group. On the one hand, you can note a certain dependence of risks, for example, failure to comply with the rules of operation of the equipment can lead to its failure. On the other hand, the cause of equipment failure will not necessarily be non-compliance with the rules of its operation. At the same time, if you conduct a detailed analysis and identify the root cause of the risk, then, accordingly, all risks can be considered independent. If we consider the process of risk minimization, then there are undoubtedly cases where minimization of one risk will lead to a decrease in the likelihood of the appearance of another. This fact should be taken into account when analyzing risks and forming an appropriate plan for the next period. Since, as noted above, all risks identified in the enterprise form a complete group, it is advisable to apply the theorem on the sum of probability of events [46], then:

$$P(A_1) + P(A_2) + P(A_3) + P(A_4) + P(A_5) = 1 \quad (1)$$

where $P(A_1)$– probability of risks associated with equipment; $P(A_2)$ – probability of risks associated with staff; $P(A_3)$ – probability of risks associated with regulatory and technical documentation; $P(A_4)$ – probability of risks associated with resources; $P(A_5)$ – probability of risks associated with customers.

Usually, it is difficult to determine the contribution of a particular group of risks in the initial stages of risk management for an enterprise. Therefore, it is advisable to proceed from the number of possible reasons (Table 3).

Table 3. Risk probabilities.

Factor name	Designation	Number of	Risk contribution
Equipment		6	0,2308
Staff		11	0,4231
Regulatory documentation		2	0,0769
Resource		3	0,1154
Customers		4	0,1538
		Total	1,00

Source: authors.

The Paretto diagram (Figure 5), which clearly demonstrates the contribution of each risk group, is built on the basis of Table 3.

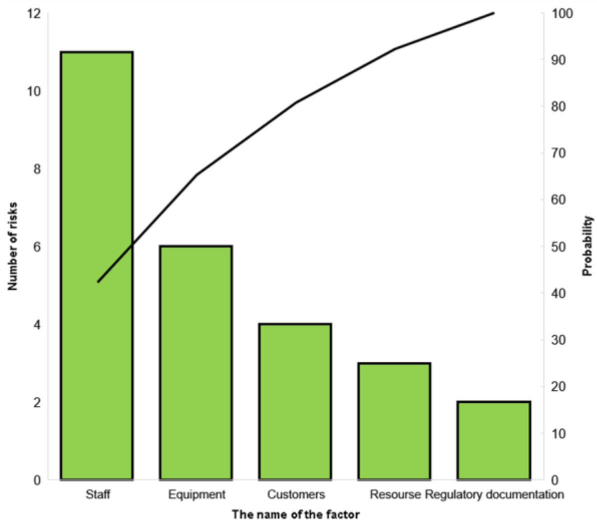

Fig. 5. Pareto diagram for risk groups.
Source: authors.

The greatest impact will be risks associated with the company's personnel, in second place – with equipment (Figure 4). Therefore, it is worth focusing on solving these issues. When using this approach, the contribution of each of the defined reasons will be the same, since:

$$p(a_i) = \frac{P(A_1)}{n_i} = \frac{P(A)}{n} = \frac{1}{26} = 0.038 \quad (2)$$

where $p(a_i)$ – probability of a certain i risk.

The hierarchy method is used to test the applied method for determining the contribution of each risk [37]. Each of the factors is assigned a value from 1 to 5, where 5 - corresponds to the factor that has the largest number of factors, 1 - factor that has the lowest number of factors (Table 4). In fact, each factor is assigned the corresponding rank.

Table 4. Rank of factors.

Factor name	Designation	Number of	Assigned rank
Equipment	A_1	6	2
Staff	A_2	11	1
Regulatory documentation	A_3	2	5
Resource	A_4	3	4
Customers	A_5	4	3

Source: authors.

The matrix of pairwise comparisons for each factor is constructed from assigned ranks. Each factor is compared to each other relative to their rank According to the rule, the value of the rank of factors located on the left of the matrix is compared with the factors at the top in dependence when adding matrices:

$$a_{ij} = \frac{r_{ci}}{r_{ri}} \quad (3)$$

where r_{ci} – assigned rank of i factor, contained in column; r_{ri}– assigned rank of i factor, contained in the row.

The resulting matrix is shown in Table 5 below.

Table 5. Estimated factor indicators.

Evaluation criteria	A1	A2	A3	A4	A5	Priority vector (x_i)
A1	1	0.5	2.5	2	1.5	7.50
A2	2	1	5	4	3	15.00
A3	0.4	0.2	1	0.8	0.6	3.00
A4	0.5	0.25	1.25	1	0.75	3.75
A5	0.67	0.33	1.67	1.33	1	5.00
$\sum C_i$	4.57	2.28	11.42	9.13	6.85	34.25

Source: authors.

The algorithm, based on the given matrix, is used to obtain estimates of factors. The scheme is presented in [47]. The normalized matrix has the form given in Table 6.

Table 6. Normalized factor estimate matrix.

Evaluation criteria	A1	A2	A3	A4	A5	Priority vector (xi)
A1	0.22	0.22	0.22	0.22	0.22	1.09
A2	0.44	0.44	0.44	0.44	0.44	2.19
A3	0.09	0.09	0.09	0.09	0.09	0.44
A4	0.11	0.11	0.11	0.11	0.11	0.55
A5	0.15	0.15	0.15	0.15	0.15	0.73
$\sum C_i$	1.00	1.00	1.00	1.00	1.00	5.00

Source: authors.

In the final stage, according to [42], by dependence:

$$A_i = \frac{x_i}{C} \quad (4)$$

where x_i – priority vector of i factor; C – total vector of priorities;

The calculation of generalizing estimating indicators of factors as the sum of products on the lines of estimates of each criterion obtained from Table 6, as well as on the weight of each criterion obtained from Table 6, was carried out. The results of calculation of the estimated factors are given in Table 7.

Table 7. Results of calculation of the estimated factors.

Evaluation criteria	Value of the estimated indicator
A1	0.219
A2	0.438
A3	0.088
A4	0.109
A5	0.146

Source: authors.

4 Research results

The obtained values of the estimates given in Table 7 are compared with the values given in Table 3. The values are obtained when calculating the risk contribution. Comparison results are shown in Table 8.

Table 8. Convergence of evaluation criteria defined by different methods.

Evaluation criteria	Value of the estimated indicator		Deviation
	method of the hierarchies	probabilistic method	
A1	0.219	0.2308	-5.1
A2	0.438	0.4231	3.5
A3	0.088	0.0769	13.9
A4	0.109	0.1154	-5.1
A5	0.146	0.1538	-5.1

Source: authors.

The deviation is not more than 14% (Table 8). It is quite acceptable within the framework of the proposed approach.

The survey of representatives of road transport enterprises about the risks that arise (may arise) during their activities was conducted within the framework of these studies.

A survey of representatives of 14 enterprises was conducted. The distribution by main activity is given below in Table 9 and Figure 6.

Table 9. Number of road transport enterprises taking part in surveys.

Main activity of the enterprise of road transport	Number of enterprises taking part in surveys	
	pcs.	%
Vehicles maintenance and repair	6	33.33
Spare parts trade	1	5.56
Passengers transportation	1	5.56
Goods transportation	7	38.89
Total	3	16.67

Source: authors.

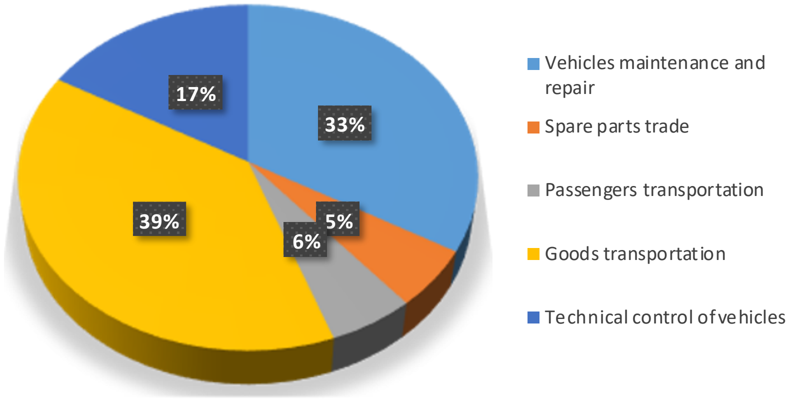

Fig. 6. Number of road transport enterprises taking part in surveys.
Source: authors.

Among the enterprises that took part in the survey, 9 enterprises have a certified management system, another 5 enterprises have such a system, but not certified, 2 enterprises plan to implement the system in the future, 2 more do not plan (Fig. 7).

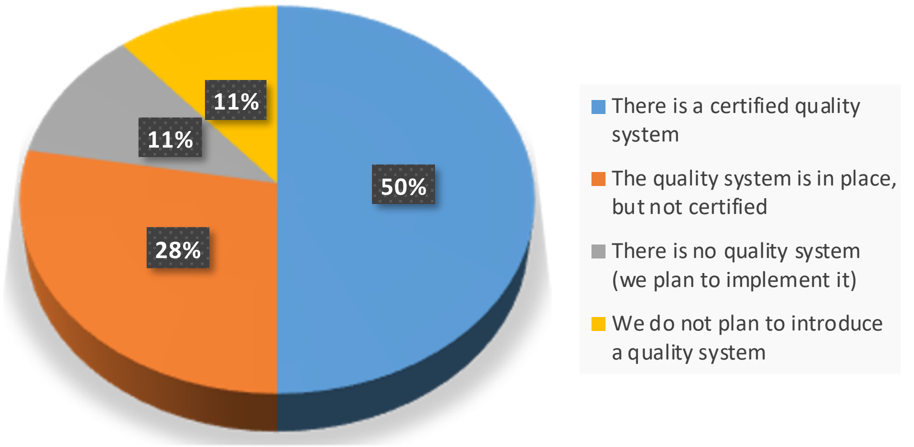

Fig. 7. Availability of management system at the enterprises.
Source: authors.

The vast majority of enterprises identify the risks of their activities (Fig. 8).

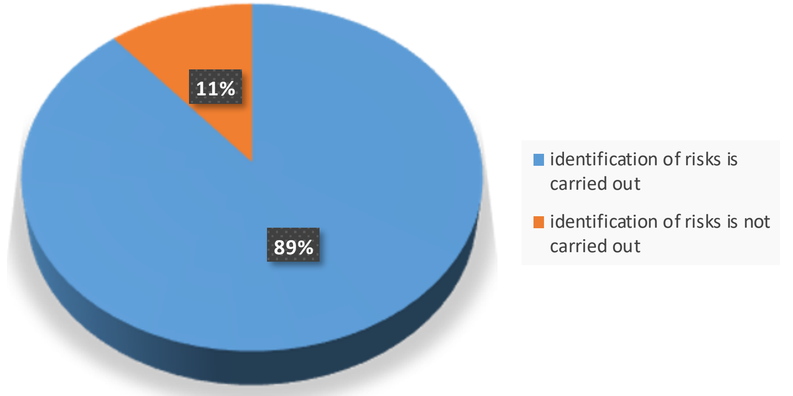

Fig. 8. Presence of the process of identification of risks of enterprise activity.
Source: authors.

Enterprises carried out risk assessment using the expert assessment method. The results of risk assessment by types of road transport enterprises are given in Table 10.
are shown in Table 8.

Table 10. Risk assessment by road transport enterprises.

Main activity type of the motor vehicle enterprise	Evaluation criteria	Number of the respondent					
		1	2	3	4	5	6
Vehicles maintenance and repair	Staff	5	5	5	5	5	2
	Equipment	4	3	4	2	4	3
	Regulatory documentation	1	4	3	1	1	5
	Resource	2	1	2	4	2	1
	Customers	3	2	1	3	3	4
	Staff	3	3	4	–	–	–

Technical control of vehicles	Equipment	3	2	5	–	–	–
	Regulatory documentation	3	5	3	–	–	–
	Resource	2	1	2	–	–	–
	Customers	4	4	1	–	–	–
Goods transportation	Staff	1	1	2	3	4	5
	Equipment	4	4	3	2	3	2
	Regulatory documentation	2	3	1	1	1	1
	Resource	5	5	4	4	2	4
	Customers	3	2	5	5	5	3

Source: authors.

Based on the analysis of the results of the survey of road transport enterprises regarding the assessment of the risks of their activities, the following was established:

– almost 90% of enterprises carry out risk identification for planning their further activities, regardless of the presence of a certified quality management system,

– specificity of the activities of enterprises of road transport and, accordingly, the established estimates indicate a significant range of opinions. This makes it impossible to apply a universal mechanism for improving the efficiency of their activities. However, some convergence is observed in certain cases. In particular, the main risk is the availability of qualified personnel for Vehicles maintenance and repair. For enterprises engaged in freight transportation - availability of customers and resources.

It is worth noting that the survey was conducted in autumn 2022, in the conditions of war in Ukraine. Therefore, obtained results suggest risks taking into account the current situation rather than general trends.

5 Conclusions

Risk identification is one of the important stages in introducing a risk-oriented approach. The risk assessment of the enterprise was carried out using the hierarchy analysis method and the probabilistic method. At the same time, the maximum difference in the assessment of the risk contribution by the selected methods is 14%. This is acceptable for practical applications. It has been found that the application of the hierarchy analysis method is a more time-consuming process and provides a deeper analysis of each risk. The probabilistic method is easier to apply, but it requires a high qualification of experts who will assess the risks. Therefore, the human factor will play a significant role here. The use of the method of hierarchy analysis to assess the risks of road transport enterprises is more appropriate according to the authors.

The results of surveys conducted by road transport enterprises indicate the application of elements of a risk-oriented approach. The availability of risk information makes it possible to implement appropriate precautions not only within an individual enterprise, but also on a more global scale. The conducted case studies provide preliminary results aimed at finding mechanisms to increase the efficiency of road transport enterprises.

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