

Risk modeling in working out the plan of developing the road transport cargo enterprise

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Abstract. Problem. In recent years, there has been a rather stable trend of reorientation of the freight transportation market in Ukraine from the predominant use of rail transport to customers preferring road transport for moving goods. Relying on the indicated trend and the prospect of its preservation in view of the indisputable manoeuvre advantages of road transport in the conditions of martial law, the study of the problematic issues of the development of road transport cargo enterprises, among which the risk modeling of their operational activities occupies a prominent place, becomes relevant. **Goal.** The purpose of the scientific work is to study the methodological and applied aspects of risk modeling when working out a plan for developing a cargo enterprise of road transport. **Methodology.** The method of analysis and synthesis, system approach, observation method, comparative analysis, factor analysis method, simulation modeling method, and experimental method were used in the work to study the methodological and applied aspects of risk modeling when elaborating a plan for developing a road transport cargo enterprise. **Results.** The risk model presented in the study makes it possible to identify the optimal level of risk when elaborating a plan for development of a road transport cargo enterprise based on variants of the key indicator of the volume of cargo transportation (including financial indicators). **Originality.** In the process of modeling in one cycle, you can get up to 24 different options for the values of the optimal level of risk for the implementation of the plan for development of the road transport cargo enterprise, taking into account the differentiation of the parameters of the risk model, in particular, six options for the distance of cargo transportation and four classes of cargo. **Practical value.** The proposed methodical approach to risk modeling when working out a plan for developing a road transport cargo enterprise takes into account the probable change in demand for freight transportation, which gives the enterprise the opportunity to quickly respond to changes in market conditions and successfully plan activities in conditions of incomplete certainty, lack of information and the presence of risk.

Key words: risk modeling, road transport cargo enterprises, development plan, optimal risk, market demand.

Introduction

It is impossible to imagine the modern world transport system without road (automobile) transport: road transport accounts for 70% of the total length of the world transport network, because since the middle of the twentieth century the length of roads has increased by 8 times. On a global scale, road transport is the undisputed leader in the transportation of passengers, but in the segment of cargo transportation it occupies only the 4th place, being inferior to maritime transport, railway transport and pipeline transport [1].

In Ukraine, road transport has traditionally had a more stable competitive position in the freight market than in other countries of the

world, occupying the 2nd place and second only to rail transport [2]. However, in recent years there has been a fairly stable trend of reorientation of the freight market in Ukraine from the predominant use of rail transport to the preference for the road transport in conveyance of goods (Fig. 1).

Based on this tendency and the prospect of its preservation, taking into account the undoubted manoeuvring advantages of road (automobile) transport in martial law, the study of problematic issues of the development of road transport cargo enterprises, among which the main place is occupied by the modeling of the risk of their operational activities, becomes relevant.

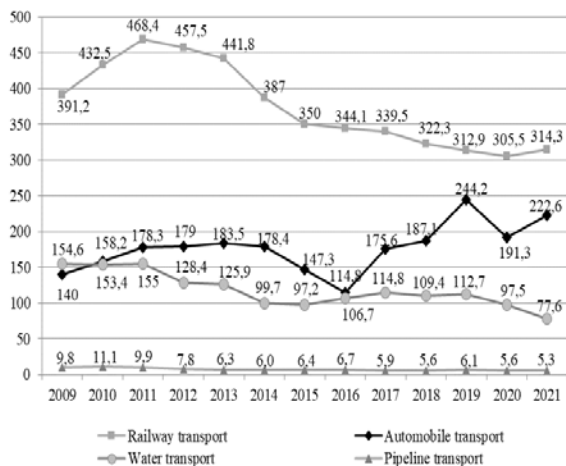


Fig. 1. Cargo transportation by types of transport in Ukraine in 2009-2021, million tons [3]

Analysis of publications

Theoretical, methodological and applied aspects of planning and modeling of risks at road transport enterprises are considered in the scientific works of such Ukrainian scientists as I. Shevchenko, I. Dmytriiev [2, 8, 9], A. Dorosh, Ye. Demchenko [4, 5], O. Taranukha [6], I. Tkachenko [7]. In the previous study [8], the authors have already touched upon the issue of forecasting economic risks (on the example of automobile manufacturing enterprises): a methodological approach was formed, according to which the characteristics of the economic risk of a business entity are the following ratios: initial market demand and production capacity of the enterprise; expected market demand and initial market demand; expected market demand and production capacity of the enterprise. In general, we accept this approach as a basis and believe that correct risk modeling in elaborating a plan for the development of road transport cargo enterprises is impossible without comparing their production capacity (i.e. transportation capabilities) with the existing and current market demand for their freight transportation services.

The issue of risk modeling in the planning of production activities of road transport enterprises in the context of formation of the global market for road transport services was raised by O. Ivanilov, I. Dmytriiev, I. Shevchenko in [9], where the researchers proposed the use of such key risk indicators as: volume of traffic (planned and actual); the level of transportation capacities of the road transport enterprise; demand for road transport services; the level of customer requests for road transport services; random value of additional demand arising in connection with the formation of the global market of road transport

services; penalties for breach of the contract for the provision of transportation services; specific amount of funds invested by the road transport enterprise in the expansion of transportation capabilities; profit rate; cost of transportation; variable costs in the cost of transportation; labour costs of the enterprise personnel in the cost of transportation; coefficient of change of variable costs in the cost of transportation with changes in the volume of transportation; coefficient of change of labour costs of the personnel in the cost of transportation with changes in the volume of transportation; distribution function of a random value of the actual volume of traffic. We consider the presented list of risk indicators of the production activity of road transport enterprises to be quite capacious, but taking into account the peculiarities of the operating activity of road transport cargo enterprises, we propose the following transformation of this list to the following set of risk indicators: transportation capabilities of the road transport cargo enterprise; cost of the rolling stock fleet of the road transport cargo enterprise; average distance of cargo transportation; class of cargo; structure of cargo transportation; cost of cargo transportation; income; dependence of the cost on the distance of transportation and class of cargo; actual weight of cargo shipment; actual volume of cargo transportation of the road transport enterprise for the previous period (the base year); market conditions in the market of cargo transportation by road transport.

Taking as a basis the previously developed methodological approach to forecasting economic risks and the proposed list of risk indicators of the operating activity of a road transport cargo enterprise, we will consider the methodological and applied aspects of risk modeling in working out the plan of developing the road transport cargo enterprise

Purpose and Tasks

The aim of the article is to study the methodological and applied aspects of risk modeling in working out a plan for the development of a road transport cargo enterprise.

When working out a plan for developing a road transport cargo enterprise, the parameters of the risk model are set sequentially, in a certain order: in particular, in the risk model, when concluding an agreement on the implementation of cargo transportation by road transport, the value of the transportation capabilities of the road transport cargo enterprise is set, the demand for freight transport available at the time of working out the development plan

of the road transport enterprise, the value of the rolling stock fleet of the road transport enterprise, the average distance of cargo transportation, the class of cargo and the cost of freight transportation in the past period (the base year).

Variability of risk modeling when working out the development plan for a road transport cargo enterprise is achieved through the alternate task in the risk model of 6 variants of the average distance (we suggest: 20 km; 30 km; 35 km; 40 km; 55 km; 65 km) of cargo transportation and 4 variants of cargo classes (we offer: oversized cargo; oversized cargo; long-dimension vans; hazardous cargo). In this way, consideration of all possible combinations of the conditions for carrying out cargo transportation by the road transport company is ensured.

At the next stage, the weight of the van, which is to be sent according to all the given variants of the average distance, is selected. Accordingly, after receiving the estimated weight of the cargo shipment and entering the tariff fee according to the specified conditions of cargo transportation by road, the cost price of such a service is determined for all 6 options of medium distance and 4 classes of cargo in the form of 3 matrices of size 4x6.

An important aspect when working out a development plan for a cargo enterprise is taking into account the possibility of additional demand or, on the contrary, the transfer of customers to another cargo enterprise. In order to take into account the factor of change in the demand for cargo transportation by road transport, 9 possible variants of the volume of additional customer demand are set in the form of intervals, and the probability of each of the given variants is determined. After that, from the 9 variants of the volume of additional customer demand for cargo transportation by road transport, the most probable one is selected, which is entered into the risk model for further calculations.

After entering all parameters into the risk model, the optimal risk level of the cargo enterprise of road transport is calculated:

$$Q_{opt}=W^{-1}(P_{opt}), \quad (1)$$

where W^{-1} is the inverse function of the distribution function of the random variable of the freight transportation plan actual implementation (implementation of the development plan) by the road transport enterprise and the corresponding income, expenses, profit or loss.

We will apply the proposed methodical approach for modeling the risk of a conventional

cargo transport enterprise when working out a plan for its development.

Simulated output data will be presented in the form of Table 1.

Table 1 Indicators characterizing the activity of the simulated cargo enterprise of road transport at the time of working out its development plan [compiled by the authors]

Indicators	Value
Carrying capacity of the road transport cargo enterprise, thousand tons	164
Actual market demand for the services of road transport enterprises for the transportation of goods, thousand tons	170
Cost of cargo transportation in the base year, UAH/t	23.2
Average distance of cargo transported, km	55.8
Cargo capacity utilization factor	1
The cost of the rolling stock fleet of the road transport cargo enterprise, UAH mln.	130

At the time of working out the plan of the road transport cargo enterprise, the actual market demand exceeds the transportation capabilities of the enterprise. In this case, there is a need to determine the minimum and maximum sizes of additional demand for the services of the cargo enterprise of road transport and the probability of its occurrence (Table 2).

Table 2 Probability of additional demand for the services of a simulated road transport cargo enterprise [developed by the authors]

Variants	Interval of changes in additional demand for cargo transportation, thousand tons		Probability of emergence
	Minimum	Maximum	
№ 1	2	6	0.9
№ 2	6	8	0.8
№ 3	8	10	0.7
№ 4	10	12	0.6
№ 5	12	15	0.5
№ 6	15	18	0.3
№ 7	18	22	0.1
№ 8	22	25	0.05
№ 9	25	27	0.01

After determining the probability of additional market demand for the services of a road transport cargo enterprise in the amount of 2 to 27 thousand tons, the option corresponding to the marginal probability is selected, after which the emergence of greater additional market demand for cargo transportation seems unlikely.

The level of risk of non-fulfilment of contractual obligations for the transportation of goods by road is also subject to consideration. At the same time, "0" is an attempt to avoid any risk; "1", on the contrary, is a very high risk, which, however, does not mean that there will necessarily be a failure to fulfil contractual obligations for transportation of goods by road. For the simulated road transport cargo enterprise under study we will accept $P = 0.3$.

The results of modeling the optimal risk for a simulated road transport cargo enterprise in working out its development plan for the given parameters are presented in Table 3.

Table 3 Levels of optimal risk for a simulated road transport cargo enterprise under different variants of additional demand [calculated by the authors]

Indicators	Options for additional demand for cargo transportation, thousand tons					
	6	8	10	12	18	22
Level of risk	0.31	0.38	0.39	0.42	0.43	0.44
Volume of cargo transportation in relation to the development plan, thousand tons	168.6	171.03	173.05	174.06	175.5	175.9
Profit, thousand UAH	3462	3544	3597	3832	3865	3873
Possible minimum profit losses in case of non-fulfilment of the given plan, thousand UAH.	3099	2856	2877	2894	2896	2894

The data obtained indicate that with the increase of the distance of cargo transportation both the optimal level of risk and the volume of cargo transportation in accordance with the development plan are reduced, confirming that, on the one hand, it is more profitable for a simulated cargo enterprise of road transport to carry out cargo transportation over longer

distances, and on the other hand, in this case the planned volume of cargo transportation is smaller and, accordingly, the probability of its implementation is higher.

With the growth of the risk of non-fulfilment of contractual obligations, the value of the optimal level of risk, which should the simulated road transport cargo enterprise be guided by in the development plan, increases. At the same time, it is fair to note that this value does not have a significant impact on the value of the optimal level of risk of implementing the development plan of the road cargo enterprise, given the generally low level of penalties for breach of contractual obligations.

The probability of additional demand for cargo transportation sharply decreases with the growth of its volume. In the "risk – plan" coordinate system the risk growth rate exceeds the growth rate of cargo transportation plan. At the same time, the rate of profit growth exceeds the growth rate of the volume of transportation carried out by a particular cargo enterprise of road transport in accordance with its development plan.

Conclusion

The risk model presented in the study allows identifying the optimal level of risk in the development plan of the road transport cargo enterprise according to the options of the key indicator of the cargo transportation volume (including financial indicators). In the process of modeling in one cycle, it is possible to obtain up to 24 different options for the optimal level of risk of implementing the development plan of a road transport cargo enterprise, taking into account the differentiation of risk model parameters, in particular, such as six options for the distance of cargo transportation and four classes of cargo. In addition, the proposed methodological approach to risk modeling in working out a development plan for a road transport cargo enterprise takes into account the probabilistic change in demand for cargo transportation, which provides the enterprise with the ability to quickly respond to changing market conditions and successfully plan its activities in conditions of incomplete certainty, lack of information and risk.

Conflict of interests

The authors declare that there is no conflict of interest concerning the article publication.

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Моделювання ризику при розробленні плану розвитку вантажного підприємства автомобільного транспорту

Анотація. **Проблема.** Останні роки спостерігається досить стабільна тенденція переорієнтації ринку вантажних перевезень в Україні з переважного використання залізничного транспорту на віддання клієнтами переваги автомобільному транспорту для переміщення вантажів. Спираючись на вказану тенденцію та перспективу її збереження з огляду на безперечні маневрені переваги автомобільного транспорту в умовах військового стану, отримують актуальність дослідження проблемних питань розвитку вантажних підприємств автомобільного транспорту, серед яких чільне місце посідає моделювання ризику їх операційної діяльності. **Мета.** Метою наукової роботи є дослідження методико-прикладних аспектів моделювання ризику при розробленні плану розвитку вантажного підприємства автомобільного транспорту. **Методологія.** В роботі для дослідження методико-прикладних аспектів моделювання ризику при розробленні плану розвитку вантажного підприємства автомобільного транспорту використано метод аналізу та синтезу, системний підхід, метод спостереження, порівняльний аналіз, метод факторного аналізу, метод імітаційного моделювання, експериментальний метод. **Результати** Представлена в дослідженні ризик-модель дозволяє ідентифікувати оптимальний рівень ризику при розробленні плану розвитку вантажного підприємства автомобільного транспорту за варіантами ключового індикатору обсягу перевезення вантажів (у тому числі і за фінансовими показниками). **Оригінальність.** У процесі моделювання за один цикл можна отримати до 24-х

різноманітних варіантів значень оптимального рівня ризику реалізації плану розвитку вантажного підприємства автомобільного транспорту з огляду на диференціацію параметрів ризик-моделі, зокрема таких як шість варіантів відстані перевезення вантажів та чотири класи вантажу. **Практичне значення.** У процесі моделювання за один цикл можна отримати до 24-х різноманітних варіантів значень оптимального рівня ризику реалізації плану розвитку вантажного підприємства автомобільного транспорту з огляду на диференціацію параметрів ризик-моделі, зокрема таких як шість варіантів відстані перевезення вантажів та чотири класи вантажу.

Ключові слова: моделювання ризику, підприємства вантажного автомобільного транспорту, план розвитку, оптимальний ризик, ринковий попит.

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