S. RUSANOVA

MODELING THE IMPACT OF THE TRANSPORT PROVISION OPTION ON PROJECT RISKS

The **subject** of the research is the formalization of the influence of the option of transport provision of the project on its risks. The **aim** of the study is to improve the efficiency of project management processes by identifying and formalizing the risks associated with the transportation of the project. **Tasks** of the study: to characterize the impact of transportation on the project; to describe formally the dependence of expenses on options for transport provision of projects; to develop a formation scheme and a method for assessing the risks of excess costs and loss of time for the project under the influence of the transport option. The following **methods** are used: system analysis, functional analysis. **Results**: project risks are formed under the influence of many factors, and transport provision is one of the components of this set. The set of characteristics of the project, which are influenced by transport provision - cost, risks, duration, quality, and result, has been established and characterized. At the same time, the alternatives and variability of transport provision form a corresponding impact on the project risks. In this study, under the option of transportation, a combination of a specific type and type of vehicle, its characteristics (for example, carrying capacity) and conditions of use in the project (purchase, lease or service from project suppliers) are accepted. The transport provision of the project is considered for three levels: separate work, time period, and project as a whole. For each of the levels, the following is established: the volume of necessary transport services; the number of vehicles required; costs for each option of transportation. Mathematical expressions are obtained for the magnitude of the potential risks of the project in the form of time losses and additional costs associated with the options for transport provision. Additional costs are determined by the loss of time, the characteristics of the vehicle, the cost structure depending on the conditions for using the vehicles. **Conclusions**: The formalizations obtained make it possible to quantify the impact of transport options on project risks. These results are the basis for the further development of a model for choosing the optimal option for transport provision for the project, implying a set of specific vehicles, terms and conditions of their use in the project.

Keywords: vehicle; risks; project; assessment; costs.

Introduction

Most of the projects being implemented are associated with the creation of material objects, which are, in fact, the products of these projects, which implies the formation of an appropriate logistics system and the need for transportation. Depending on the specifics of the transport infrastructure and the availability of vehicles, the parameters of the project product and the timing of its receipt, that is, the duration of the project life cycle, can be adjusted. For example, in infrastructure projects, the specifics of the terrain and transport infrastructure determine the parameters of the project product and the mode of work on the project. Thus, the development of the project and its planning should be carried out in accordance with the need to transport the logistics of the project.

Transport provision, along with other processes in the project, allows for variation both by the type of vehicles and their characteristics, and by the condition of their use in the project. By the terms of use in the project we mean the purchase of vehicles, their lease for the period of the project or the period of work related to transportation, or the receipt of services from project suppliers. Such combinations – the type of vehicle, its characteristics and conditions of use in the project - form alternative transport options that affect the project as a whole. Establishing this impact on project risks is the crux of the problem addressed in this study. Despite the fact that the issues of transport provision of logistics and optimization of the parameters of the delivery of goods are sufficiently discussed and investigated in modern research, nevertheless, projects are characterized by specific structures and a system of requirements, which determines the specificity of the impact of transport provision on them. Note that this problem, despite its relevance for most of the projects being implemented, is practically not represented in modern studies.

Analysis of literature and research

The theory of project management is enriched with new approaches both in the global aspect (for example, [1, 2]) and in terms of individual areas of knowledge.

The alternative options for transport logistics in terms of the characteristics of vehicles and their use on the example of sea transportation and large exporters was investigated in [3, 4], with the main focus on the exporter's transport costs. Projects related to the development of transport and infrastructure has certain specificity; therefore, this problem is actively addressed in modern research, for example, [5-11]. In addition, the development of the concept of project-oriented management determines the use of a project-based approach to the organization of cargo delivery [12]. Transport provision for projects of logistics systems is mentioned in [13] as an element that may or may not be included in the project product, but further this issue does not receive any development.

Some works that relate to transportation issues in the project are related to field development projects (for example, [14]), but these studies are aimed at optimizing the routes of bypassing drilling platforms by specialized marine vessels, that is, in fact, they are considering the already selected option of transportation for the level of operational management of transportation processes.

Any processes associated with projects correspond to one of the areas of knowledge in project management [15], and, in particular, risk and risk management is one of

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them. Since the variation of transport provision determines not only the costs of the project, but also its risks, it should be noted that this issue, in principle, has not been studied in scientific works. The ideas of the formation of regularities in transport costs presented in [3] can be taken as a basis.

Statement of the purpose of the article. Based on the foregoing, the purpose of this study is to improve the efficiency of project management processes by identifying and formalizing the impact of the transport option on project risks.

Based on the goal, the objectives of the study are:

1) to characterize the impact of transportation on the project;

2) to describe formally the dependence of costs on options for transport provision of projects;

3) to develop a formation scheme and a method for assessing the risks of excess costs and loss of time for the project under the influence of the option of transport provision

Results

So, each project allows for an alternative in transportation, and the choice of the best option should be carried out taking into account the interests of the entire project. In contrast to the problems of choosing transport provision in transport logistics, where, as a rule, the main criterion is transport costs provided that the necessary parameters of transport services are provided, the project arises (fig. 1):

a) *additional requirements* related to the timing of the project and project tasks, that is, taking into account the project life cycle and the duration of project work;

b) the need to take into account the impact of transport services *on the entire project*, and, therefore, on its *cost, risks, quality, and result.*
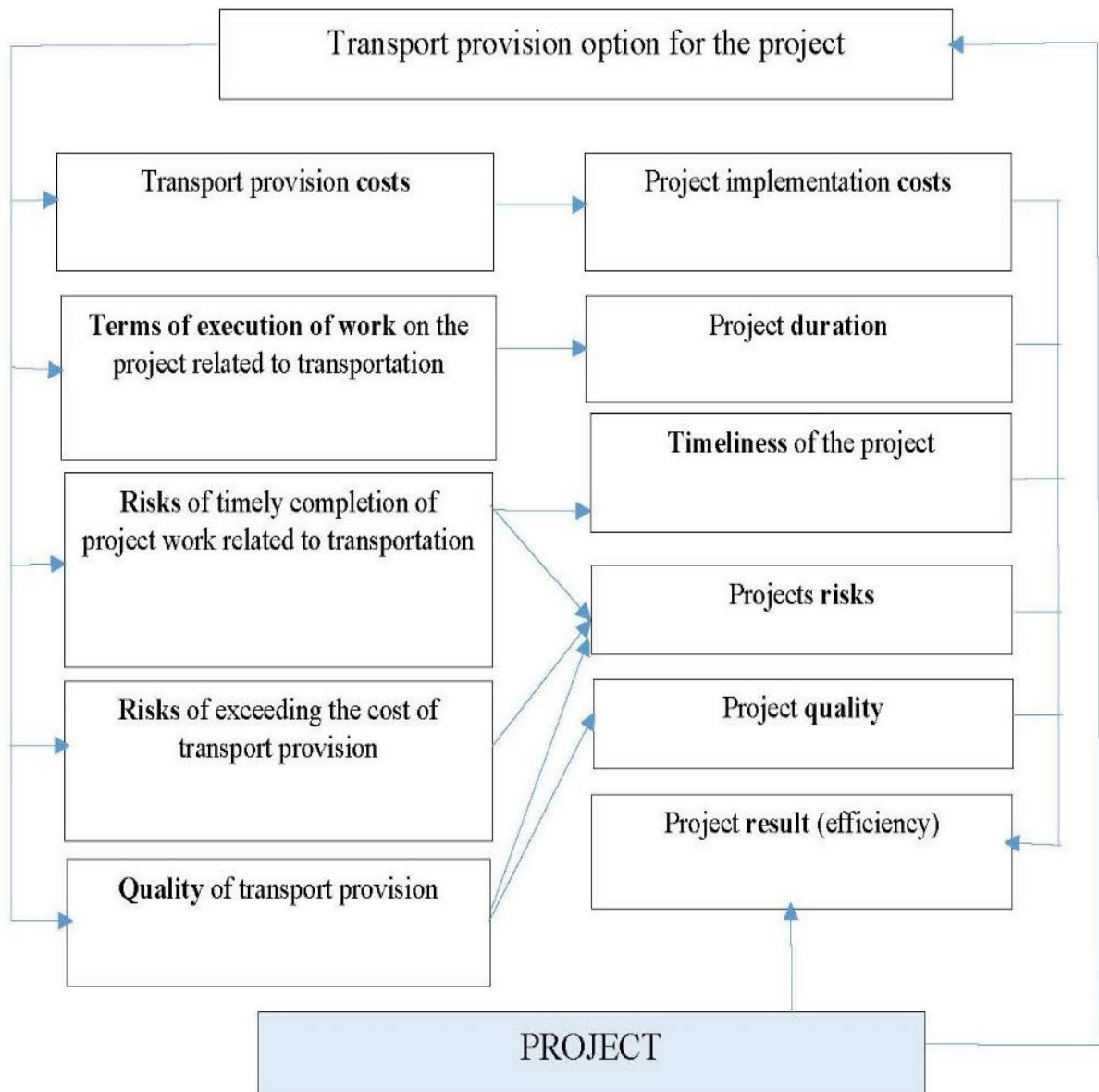

Fig. 1. Influence of transport provision on project characteristics

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Cost indicators, although they are dominant when choosing a transport option, nevertheless, each option contributes to the risks of the project, and in practice, the choice of the best option is based on a cost-risk trade-off. Therefore, it is important to assess the magnitude of the risks from the point of view of the entire project.

As alternative options for transport provision of projects, we will consider the following combination $\left\langle C_k^g, b \right\rangle$:

- kind of vehicle $k = \overline{1, K}$,

- type of vehicle $g = \overline{1, G_k}$,

- vehicle characteristics $C_k^g = \left(C_{k1}^g, C_{k2}^g, ..., C_{kY_k}^g \right)$.

Terms of use in the project: purchase of vehicles $b = 1$, rental of vehicles $b = 2$, transport service as a service from suppliers $b = 3$.

Note that the transport provision of the project involves three levels of consideration: work, time period, project as a whole. This decomposition is determined by the variety of projects, primarily in terms of scale and duration in time. Therefore, depending on the specifics of the project, one or another variant of the level of consideration of the transport provision of the project is selected.

Risk assessment is carried out after the sequential solution of the following tasks: establishing the volume of necessary transport services, determining the number of necessary vehicles, determining the costs for each option of transportation.

Establishing the volume of necessary transport services. The network schedule of the project (work $A_{ij}, i, i = \overline{1, n-1}, j = \overline{2, n}, i \neq j$) is the basis for obtaining information about the volumes of required traffic, as a result, the following is formed: Q_{kij}^g – the volume of transport services for a specific project work for each type and type of vehicle used in the project; $Q_k^g(t_{\alpha_\tau}, t_{\beta_\tau})$ – the volume of transport services for the project for a specific period of time $\left[t_{\alpha_\tau}, t_{\beta_\tau} \right]$; $\tau = \overline{1, \psi}$ ψ – the number of allocated time intervals within the project life cycle;

$Q*_k^g$ – the total volume of transport services for the project with a specific type and type of vehicle.

Determining the number of vehicles required. The characteristics of the vehicle determine its "performance" P_{kij}^g (carrying capacity) in the specific conditions of the considered transport service (transportation distances, empty/ballast trips/transitions, loading/unloading intensity, the need for additional stops, etc.):

$$P_{kij}^g = P_{kij}^g(C_k^g), k = \overline{1, K}, g = \overline{1, G_k}, i = \overline{1, n-1}, j = \overline{2, n}. \quad (1)$$

Carrying capacity $P_{kij}^g(C_k^g)$ determines the number of vehicles of each type and type N_{kij}^g required to perform transport services for the project:

$$N_{kij}^g = \frac{Q_{kij}^g}{P_{kij}^g(C_k^g)}, k = \overline{1, K}, g = \overline{1, G_k}, i = \overline{1, n-1}, j = \overline{2, n}. \quad (2)$$

If the conditions of transport services for works of one time interval $\left[t_{\alpha_\tau}, t_{\beta_\tau} \right]$ are practically the same, that is $P_{kij}^g = P_k^g, A_{ij} \in \left[t_{\alpha_\tau}, t_{\beta_\tau} \right]$, the number of vehicles for the project time period (taking into account rounding):

$$N'^g_k(t_{\alpha_\tau}, t_{\beta_\tau}) = \left\lceil \frac{Q_k^g(t_{\alpha_\tau}, t_{\beta_\tau})}{P_k^g(C_k^g, t_{\alpha_\tau}, t_{\beta_\tau})} \right\rceil, \quad (3)$$
$$k = \overline{1, K}, g = \overline{1, G_k}, \tau = \overline{1, \psi}.$$

In this case, the carrying capacity naturally depends on $\left[t_{\alpha_\tau}, t_{\beta_\tau} \right]$. The total number of vehicles of each type and type for the project as a whole:

$$N*_k^g(C_k^g) = \left\lceil \sum_{i=1}^{n-1} \sum_{j=2}^{n} N_{kij}^g(C_k^g) \right\rceil = \left\lceil \sum_{\tau=1}^{\psi} N_k^g(C_k^g, t_{\alpha_\tau}, t_{\beta_\tau}) \right\rceil, \quad (4)$$
$$k = \overline{1, K}, g = \overline{1, G_k}.$$

The formalization of transport costs is summarized in table 1.

Table 1. *Costs by options for project transportation*

Transport support costs of the project	Transport support costs of work A_{ij}	Transport support costs over a period of time $\left[t_{\alpha_\tau}, t_{\beta_\tau} \right]$
$b = 3$		
$R*_{kb}^g(C_k^{g\gamma}, Q*_k^g)$, $k = \overline{1, K}, g = \overline{1, G_k}$, $\gamma = \overline{1, \Gamma_k^g}$	$R_{kbij}^g(C_k^{g\gamma}, Q_{kij}^g)$, $k = \overline{1, K}, g = \overline{1, G_k}$, $\gamma = \overline{1, \Gamma_k^g}, i = \overline{1, n-1}, j = \overline{2, n}$	$R_{kb}^g(C_k^{g\gamma}, Q_k^g, t_{\alpha_\tau}, t_{\beta_\tau})$, $k = \overline{1, K}, g = \overline{1, G_k}$, $\gamma = \overline{1, \Gamma_k^g}, \tau = \overline{1, \psi}$

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The end **Table 1.**

$b = 2$		
$R *_{kb}^{g}(C_k^g, Q *_k^g, T_k^g) =$ $= R *_{kb}^{og}(C_k^g, Q *_k^g) +$ $+R *_{kb}^{rg}(C_k^g, T_k^g),$ $k = \overline{1, K}, g = \overline{1, G_k}$	$R_{kbij}^{g}(C_k^g, Q_{kij}^g, t_{ij}) =$ $= R_{kbij}^{og}(C_k^g, Q_{kij}^g) + R_{kbij}^{rg}(C_k^g, t_{ij}),$ $k = \overline{1, K}, g = \overline{1, G_k},$ $i = \overline{1, n-1}, j = \overline{2, n}$	$R_{kb}^{g}(C_k^g, Q_k^g, t_{\alpha_\tau}, t_{\beta_\tau}) =$ $= R_{kb}^{og}(C_k^g, Q_k^g) +$ $+R_{kb}^{rg}(C_k^g, t_{\alpha_\tau}, t_{\beta_\tau}),$ $k = \overline{1, K}, g = \overline{1, G_k}, \tau = \overline{1, \psi}$
$b = 1$		
$R *_{kb}^{g}(C_k^g, Q *_k^g, T_k^g, F) =$ $= R *_{kb}^{og}(C_k^g, Q *_k^g) +$ $+R *_{kb}^{pg}(C_k^g, T_k^g) +$ $+R *_{kb}^{invg}(C_k^g, F),$ $k = \overline{1, K}, g = \overline{1, G_k}$	$R_{kbij}^{g}(C_k^g, Q_{kij}^g, t_{ij}, F) =$ $= R_{kbij}^{og}(C_k^g, Q_{kij}^g) +$ $+R_{kbij}^{pg}(C_k^g, t_{ij}) + R_{kbij}^{invg}(C_k^g, F),$ $b = 1, k = \overline{1, K}, g = \overline{1, G_k},$ $i = \overline{1, n-1}, j = \overline{2, n}$	$R_{kb}^{g}(C_k^g, Q_k^g, t_{\alpha_\tau}, t_{\beta_\tau}, F) =$ $= R_{kb}^{og}(C_k^g, Q_k^g) + R_{kb}^{pg}(C_k^g, t_{\alpha_\tau}, t_{\beta_\tau}) +$ $+R_{kb}^{invg}(C_k^g, F),$ $k = \overline{1, K}, g = \overline{1, G_k}, \tau = \overline{1, \psi}$

Accepted designations: T_k^g – vehicle rental period; R_{kb}^{og} operating (maintenance) costs; $R_{kb}^{rg}, b = 2$ payment of rent; $f_k^{rg}(C_k^g, t_{ij})$, $f_k^{rg}(C_k^g, t_{\alpha_\tau}, t_{\beta_\tau})$, $f_k^{rg}(C_k^g, T_k^g)$ respectively, rental rates of vehicles for work duration t_{ij}, time period and the project as a whole; $F = (F_1, .., F_\lambda)$ – conditions of financing when purchasing a vehicle; $R_{kb}^{invg}, b = 1$ – investment costs; $R_{kb}^{pg}, b = 1$ – fixed costs of vehicles; $\gamma = \overline{1, \Gamma_k^g}$ – transport service provider index (for $b = 3$).

The main project risks associated with transport support are overspending (i.e. exceeding budget limits) and failure to meet the deadlines for project work and the project as a whole. At the same time, the loss of time can also be estimated as additional costs (including fines for delays in obtaining the project product, etc.). The risk is determined not only by the characteristics of vehicles (for example, an old ship implies a high risk of breakdowns and the need for unscheduled repairs), but, first of all, by the conditions of their use in the project. For example, when renting or purchasing vehicles, the project management system gets full control over transportation, but at the same time increases the degree of responsibility for the vehicle (for example, the need to pay for repairs). Let's look at this issue in more detail for each variant of transport support of the project from the point of view of the terms of use of vehicles.

For the use case of transport services from suppliers, that is, for $b = 3$, the main risk is the risk associated with the choice of the supplier. As a rule, the level of costs, in this situation, is relatively constant, and the main risk lays in the failure to meet the deadlines for the delivery of vehicles, etc., that is, delays in the provision of transport services. Thus, the main risk in this situation can be expressed in the form $\Delta t_{ijb}, b = 3, i = \overline{1, n-1}, j = \overline{2, n}$ for those works that use transport support, and the volume of transport services Q_{kij}^g is compared to them, this generally involves the use of several types and types of vehicles. Therefore, within the framework of the transport service of a specific work, several types and types of vehicles can take part, and the possible increase in the time for performing the work is, in principle, a function of their characteristics, that is $\Delta t_{ijb} = \Delta t_{ijb}(C_k^g, k = \overline{1, K}, g = \overline{1, G_k}), b = 3$.

When choosing the option of transport provision for $b = 3$ the alternative arises, first of all, from the point of view of the company supplying transport services, so let's supplement the characteristics of the vehicle with the index of belonging to a certain supplier – $C_k^{g\gamma}$. Taking this into account, a possible increase in the time of project work under the influence of the transport factor has the form:

$$\Delta t_{ijb} = \Delta t_{ijb}(C_k^{g\gamma}, k = \overline{1, K}, g = \overline{1, G_k}, \gamma = \overline{1, \Gamma_k^g}), b = 3. \quad (5)$$

It should be noted that this value can be estimated at the stage of project preparation and the beginning of its implementation only by an expert way, where the experience of an expert on the results of transport services for similar projects serves as the initial information.

An increase in the time of work execution by an amount Δt_{ijb} allows in accordance with the network schedule of design work, taking into account time reserves, critical path, etc. to determine the impact Δt_{ijb} on the duration of the life cycle of the project T and, in particular, the time of receipt of the project product T_b^{prod}, that is, to set the values $T_b^{prod}, \Delta T_b$:

$$\Delta T_b^{prod} = \Delta T_b^{prod} (\Delta t_{ijb}, i = \overline{1, n-1}, j = \overline{2, n}),$$
$$\Delta T_b = \Delta T_b (\Delta t_{ijb}, i = \overline{1, n-1}, j = \overline{2, n}), b = 3. \qquad (6)$$

Any delays in the course of project work, as a rule, lead to additional financial costs for the project ΔR_b :

$$\Delta R_b = \Delta R_b (\Delta T_b, \Delta T_b^{prod}, \Delta t_{ijb},$$
$$i = \overline{1, n-1}, j = \overline{2, n}), b = 3. \qquad (7)$$

Note that in (7) additional project costs ΔR are, on the one hand, the results of an increase in the duration of the project, on the other hand, the result of not completing the project on time, that is, delays in receiving the project product T_b^{prod} and completing the project ΔT_b (for example, penalties, loss of favorable time to market with the project product). Thus, not only direct costs, but also indirect ones, in the form of loss of commercial opportunities with the project product, form ΔR_b, that is, (7) can be clarified:

$$\Delta R_b = \Delta R_1 (\Delta T_b) + \Delta R_2 (\Delta T_b^{prod}) +$$
$$+ \Delta R_3 (\Delta t_{ijb} (C_k^{g\gamma}), k = \overline{1, K}, g = \overline{1, G_k}, \qquad (8)$$
$$\gamma = \overline{1, \Gamma_k^g}, i = \overline{1, n-1}, j = \overline{2, n}), b = 3.$$

For the option of leasing vehicles, that is for $b = 2$ the main risk is associated with the excess of the planned costs for work, time period and project, respectively, by the values: $\Delta R_{kbij}^{og} (C_k^g, Q_{kij}^g)$, $\Delta R_{kb}^{og} (C_k^g, Q_k^g)$, $\Delta R *_{kb}^{og} (C_k^g, Q *_k^g)$. Moreover, the level of these values is specific for a particular type and type of vehicle, in addition, the characteristics of a vehicle C_k^g determine not only a possible increase in operating costs (for example, an "old" vehicle requires additional costs for fuel, lubricants, minor repairs, etc.), but also possible loss of time due to a malfunction of the vehicle, which, as in the above situation, leads to an increase in the duration of the project. In contrast to (5), for the situation with the rental of a vehicle, the increase in the duration of the work is not associated with suppliers, but exclusively with the characteristics of vehicles:

$$\Delta t_{ijb} = \Delta t_{ijb} (C_k^g, k = \overline{1, K}, g = \overline{1, G_k}), b = 2. \qquad (9)$$

Taking into account the more complex cost structure for this option of transport provision, the risk of increased costs ΔR_b is associated with two components – one is formed under the influence of a possible increase in the time for work ΔR^t (similar to the option $b = 3$ considered above), the second - under the influence of risk factors associated with operating a vehicle temporary ownership) ΔR^r.

Thus, additional project costs in case of using rented vehicles:

$$\Delta R_b = \Delta R^t + \Delta R^r, b = 2,$$
$$\Delta R^t = \Delta R_1 (\Delta T_b) + \Delta R_2 (\Delta T_b^{prod}) +$$
$$+ \Delta R_3 (\Delta t_{ijb} (C_k^g), k = \overline{1, K}, g = \overline{1, G_k}, i = \overline{1, n-1}, j = \overline{2, n}); \qquad (10)$$
$$\Delta R^r = \sum_{k=1}^{K} \sum_{g=1}^{G_k} \xi_k^g \cdot \Delta R *_{kb}^{og} (C_k^g, Q *_k^g),$$

where $\xi_k^g \geq 0$ is a coefficient that reflects the share of possible increase in operating costs for each type and type of vehicle. Establishing this ratio goes beyond project management, but is determined by transport specialists, taking into account the specifics of each type and type. In general, this coefficient depends not only on the specifics of the type and type of vehicle, but also on its characteristics C_k^g (for example, the use of an old truck naturally has a great chance of causing an increase in operating costs, including for minor repairs, than a new one), that is $\xi_k^g (C_k^g)$. As $\Delta R *_{kb}^{og} (C_k^g, Q *_k^g)$ is associated with each vehicle, then when forming the final value of additional costs in (9) this is taken into account as a sum for all vehicles.

For the option of purchasing vehicles for the project, that is at $b = 1$, the risks of a possible increase in the time parameters of the project are similar for the option $b = 2$. At the same time, the risks of an increase in project costs are maximum, since in addition to the risks of an increase in operating costs as for $b = 2$, there is a risk of an increase in investment costs (for example, if a loan was used in foreign currency, and the exchange rate changed significantly during the implementation of the project; or due to the inability to complete the next payment on the loan, penalties are charged).

Thus, additional project costs in case of using the purchase of vehicles:

$$\Delta R_b = \Delta R^t + \Delta R^r + \Delta R^{inv}, b = 1,$$
$$\Delta R^t = \Delta R_1 (\Delta T_b) + \Delta R_2 (\Delta T_b^{prod}) +$$
$$+ \Delta R_3 (\Delta t_{ijb} (C_k^g), k = \overline{1, K}, g = \overline{1, G_k}, i = \overline{1, n-1}, j = \overline{2, n}); \qquad (11)$$
$$\Delta R^r = \sum_{k=1}^{K} \sum_{g=1}^{G_k} \xi_k^g \cdot R *_{kb}^{og} (C_k^g, Q *_k^g),$$
$$\Delta R^{inv} = \sum_{k=1}^{K} \sum_{g=1}^{G_k} \varsigma_k^g \cdot R *_{kb}^{inv\, g} (C_k^g, F),$$

where the coefficient $\varsigma_k^g \geq 0$ determines the possible increase in investment costs, and in the general case it depends on the financing conditions, that is, it can be represented as $\varsigma_k^g (F)$.

A diagram of the influence of the transport option on the project risks in terms of time and costs is shown in fig. 2.
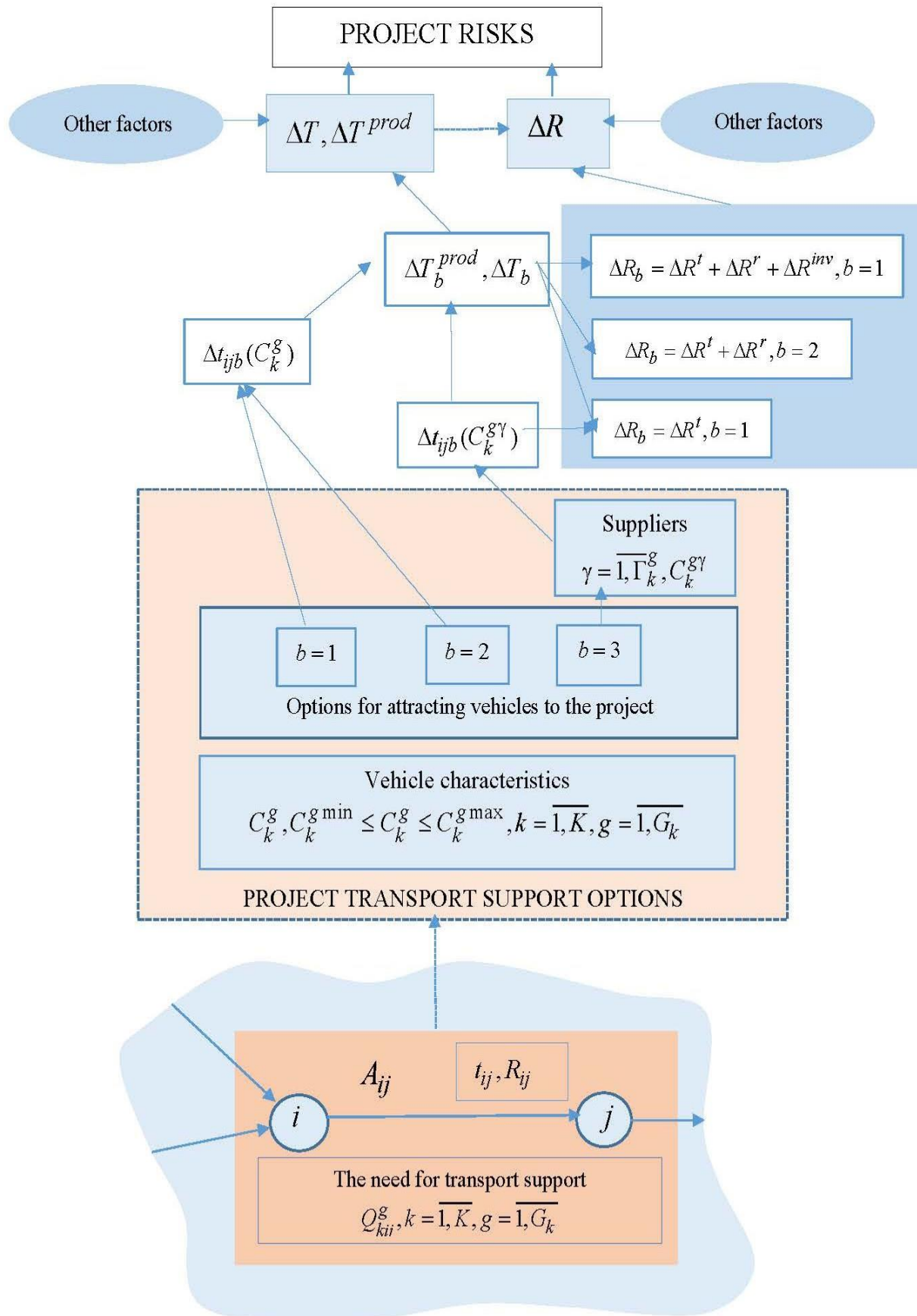
Fig. 2. Scheme of the formation of risks of excess costs and loss of time for the project associated with various options for transport support of projects

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Conclusions

Project risks are formed under the influence of many factors, and transport provision is one of the components of this set. At the same time, the alternatives and variability of transport provision form a corresponding impact on the project risks. A project transport option is a combination of specific types and types of vehicles, their characteristics (for example, carrying capacity) and the conditions for their use in the project (purchase, lease, or transport service from project suppliers). Mathematical expressions have been obtained for the magnitude of the potential risks of the project (in the form of time losses and additional costs) associated with the options for transportation.

The results obtained are the basis for the further development of a model for choosing the optimal option for transport support for the project, implying a set of specific vehicles, the terms and conditions of their use in the project.

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Відомості про авторів / Сведения об авторах / About the Authors

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МОДЕЛЮВАННЯ ВПЛИВУ ВАРІАНТУ ТРАНСПОРТНОГО ЗАБЕЗПЕЧЕННЯ НА РИЗИКИ ПРОЄКТУ

Предметом дослідження є формалізація впливу варіанту транспортного забезпечення проєкту на його ризики. **Метою** дослідження є підвищення ефективності процесів управління проєктами за рахунок ідентифікації та формалізації ризиків,

пов'язаних з транспортним забезпеченням проекту. **Завдання** дослідження: охарактеризувати вплив транспортного забезпечення на характеристики проекту; формалізовано описати залежність витрат за варіантами транспортного забезпечення проектів; розробити схему формування і метод оцінки ризиків перевищення витрат і втрат часу за проектом під впливом варіанти транспортного забезпечення. Використовуються такі **методи**: системний аналіз, функціональний аналіз. **Результати**: ризики проєкту формуються під впливом безлічі факторів, і транспортне забезпечення є однією зі складових цієї множини. Встановлено і охарактеризовано сукупність характеристик проєкту, на які впливає транспортне забезпечення – вартість, ризики, тривалість, якість, і результат. При цьому альтернативність і варіативність транспортного забезпечення формують відповідний вплив на ризики проєкту. В даному дослідженні під варіантом транспортного забезпечення прийнята комбінація конкретного типу і виду транспортного засобу, його характеристики (наприклад, вантажопідйомність) і умови використання в проекті (придбання, оренда або послуга від постачальників проєкту). Транспортне забезпечення проекту розглянуто для трьох рівнів: окрема робота, період часу, проєкт в цілому. Для кожного з рівнів встановлено: обсяг необхідного транспортного обслуговування; кількість необхідних транспортних засобів; витрати по кожному варіанту транспортного забезпечення. Отримано математичні вирази для величини потенційних ризиків проєкту у вигляді втрат часу і додаткових витрат, пов'язаних з варіантами транспортного забезпечення. Додаткові витрати визначаються втратами часу, характеристиками транспортного засобу, структурою витрат в залежності від умови використання транспортних засобів. **Висновки**: Отримані формалізації дозволяють кількісно оцінити вплив на проєкт на рівні ризиків варіантів транспортного забезпечення проєктів. Дані результати є базою для подальшої розробки моделі щодо вибору оптимального варіанта транспортного забезпечення проєкту, що має на увазі сукупність конкретних транспортних засобів, терміни і умови їх використання в проєкті.

Ключові слова: транспортний засіб; ризики; проєкт; оцінка; витрати.

МОДЕЛИРОВАНИЕ ВЛИЯНИЯ ВАРИАНТА ТРАНСПОРТНОГО ОБЕСПЕЧЕНИЯ НА РИСКИ ПРОЕКТА

Предметом исследования является формализация влияния варианта транспортного обеспечения проекта на его риски. **Целью** исследования является повышение эффективности процессов управления проектами за счет идентификации и формализации рисков, связанных с транспортным обеспечением проекта. **Задачи** исследования: охарактеризовать влияние транспортного обеспечения на проект; формализовано описать зависимость расходов по вариантам транспортного обеспечения проектов; разработать схему формирования и метод оценки рисков превышения расходов и потерь времени по проекту под влиянием варианта транспортного обеспечения. Используются следующие **методы**: системный анализ, функциональный анализ. **Результаты**: риски проекта формируются под влиянием множества факторов, и транспортное обеспечение является одной из составляющей этого множества. Установлена и охарактеризована совокупность характеристик проекта, на которые оказывает влияние транспортное обеспечение – стоимость, риски, продолжительность, качество, и результат. При этом альтернативность и вариативность транспортного обеспечения формируют соответствующее влияние на риски проекта. В данном исследовании под вариантом транспортного обеспечения принята комбинация конкретного типа и вида транспортного средства, его характеристики (например, грузоподъемность) и условия использования в проекте (приобретение, аренда или услуга от поставщиков проекта). Транспортное обеспечение проекта рассмотрено для трех уровней: отдельная работа, период времени, проект в целом. Для каждого из уровней установлены: объем необходимого транспортного обслуживания; количества необходимых транспортных средств; расходы по каждому варианту транспортного обеспечения. Получены математические выражения для величины потенциальных рисков проекта в виде потерь времени и дополнительных затрат, связанных с вариантами транспортного обеспечения. Дополнительные затраты определяются потерями времени, характеристиками транспортного средства, структурой затрат в зависимости от условия использования транспортных средств. **Выводы**: Полученные формализации позволяют количественно оценить влияние вариантов транспортного обеспечения на риски проектов. Данные результаты являются базой для дальнейшей разработки модели по выбору оптимального варианта транспортного обеспечения проекта, подразумевающей совокупность конкретных транспортных средств, сроки и условия их использования в проекте.

Ключевые слова: транспортное средство; риски; проект; оценка; расходы.

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