UDC 164:005.334
DOI: 10.15587/2312-8372.2020.202054

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# DETERMINATION OF PECULIARITIES OF ANALYSIS OF INTEGRATION RISKS IN PROJECTS OF CREATION OF TRANSPORT AND LOGISTICS CENTERS

*Об'єктом дослідження є ризик розриву інтеграційних зв'язків між учасниками, що виникає в проектах створення транспортно-логістичних центрів. Визначено специфічні особливості поняття «інтеграційні проектні ризики», до складу яких належать ризики, які можуть впливати на інтеграцію в проекті та призвести до порушення проекту як системи за рахунок розриву інтеграційних зв'язків між його учасниками.*

*Одним з найбільш проблемних місць є визначення інтеграційних ризиків на передінвестиційній фазі проекту, в процесі якісного та кількісного аналізу ризиків. Проте, інтеграційні ризики майже не враховуються при проектуванні транспортно-логістичних центрів. Увага приділяється окремо логістичним та проектним ризикам. Інтеграційні ризики поєднують особливості як логістичних, так і проектних ризиків, і можуть призвести до негативних наслідків для логістичного проекту.*

*В ході дослідження використовувалися методи якісного аналізу ризиків, а саме: аналіз Парето та АВС-аналіз, що дозволило розподілити учасників проекту по групах з великою, середньою та низькою кількістю інтеграційних зв'язків. Врахування кількості здійсненних операцій між учасниками дозволило визначити потужність інтеграційних зв'язків. Поєднання отриманих результатів АВС-аналізу та визначення потужностей інтеграційних зв'язків покладено в основу створення матриці інтеграційного потенціалу учасників проекту.*

*У процесі роботи проведено якісний аналіз ризиків за пропонованою послідовністю проекту створення транспортно-логістичного центру. Застосування інструментарію менеджменту якості та розробленої авторами матриці інтеграційного потенціалу дозволило виявити множину учасників проекту, що мають найбільший вплив на інтеграцію в проекті.*

*Завдяки використанню запропонованого підходу до якісного аналізу ризиків розриву інтеграційних зв'язків між учасниками проекту на початку проекту дозволить виявити учасників з великим інтеграційним потенціалом. Інтеграційні зв'язки саме цих учасників повинні бути піддані подальшому ретельному аналізу, оскільки вихід такого учасника з проекту може призвести до вкрай негативних наслідків.*

**Ключові слова:** *проект транспортно-логістичного центру, інтеграція учасників проекту, інтеграційні ризики, якісний аналіз ризиків, матриця інтеграційного потенціалу учасників.*

*Received date: 16.01.2020*
*Accepted date: 27.02.2020*
*Published date: 30.04.2020*



## 1. Introduction

The development of the world economy is characterized by the constant expansion of economic ties and international trade, which determines the priority of integration processes, first of all, in the sphere of transport. The level of development of the transport industry of the country testifies to the general state of its economy, since the transport-logistics system performs an integrative function for other industries. It must meet the requirements of social production and national security, have an extensive infrastructure to provide the entire complex of transport and logistics services.

This can be achieved through the development of the country's transport and logistics infrastructure and the creation of a network of modern transport and logistics centers (TLCs). The solution to this practical problem requires the availability of modern methodological support, which will use modern management methods, including tools for project management, risk management and quality management.

In addition, it is necessary to consider the features of the TLC as a management object. A modern look at the process of creating a TLC is to present it as a project, one of the specific features of which is the large number of participants involved in integration ties. Analyzing these relationships will allow to respond in a timely manner in the event of a risk situation and to prevent negative consequences, almost until the project is terminated.

## 2. The object of research and its technological audit

*The subject of the study* is the risk of a break in the integration ties between the participants arising in TLC creation projects. This risk relates to the integration risks of the project and may occur in projects to create a TLC.

ISSN 2664-9969

The TLC creation projects are characterized by a large number of participants and a high degree of integration. Not all project participants have an equal impact on the project. The influence degree of the participant on the project integrity depends on the number and capacity of its integration links with other participants, that is, its integration potential.

The main distinguishing feature of the risk of rupture of integration ties between project participants is their impact on integration ties in the project, which can lead to negative consequences, as well as to destruction of the system and termination of its existence.

One of the most problematic places is the lack of methodological support for the analysis of this risk category in TLC projects. Scientists pay particular attention to project or logistical risks, without considering their integrative nature.

## 3. The aim and objectives of research

*The aim of research* is to determine the features and consistency of qualitative analysis of the risk of integration ties between the participants of the TLC project.

To achieve this aim the following objectives are required:

1. Identify the specific features of the risk of rupture of integration ties between the participants of the TLC project.

2. Develop a sequence of qualitative risk analysis of the gap in integration ties between the participants of the TLC project.

3. Carry out experimental calculations to determine the integration potential of the participants in the TLC creation project.

## 4. Research of existing solutions to the problem

The study of integration risk management issues in TLC creation projects is based on the analysis of previous research by scientists. Thus, the research of authors [1] is devoted to the management of risks of functioning of transport and logistics systems, which belong to the category of logistical risks, but they do not consider the risks specific to the objects of transport and logistics infrastructure. The impact of logistical risks on improving the efficiency of enterprises, but without taking into account industry affiliation, is investigated in [2]. The conceptual principles of logistics risk management at the enterprise are explored in [3]. The authors highlight the risks of the enterprise logistics system, but do not take into account the integration of its elements. Therefore, the above studies of logistics risks do not take into account their integrative nature, do not study the design risks of creating logistics systems.

Design risks are considered and their classification is made in [4]. Among the large number of project risks, the authors do not distinguish integration risks into a separate group, which reduces the completeness of identification of possible risks in the project. Features of risk management in projects were highlighted in [5], but without taking into account the specifics of the management object. In [6, 7], the issues of risk management are studied with emphasis on the field of project activity. The authors of [8, 9] pay attention to the specific features of risk management in the transport sector, but do not cover the issues of integration risks in transport. The issue of project risk analysis is highlighted in [10], which identifies the advantages and disadvantages of existing methods of risk analysis and assessment. Emphasis is placed on quantitative risk analysis, the issues of qualitative analysis of project risks are not considered. Therefore, it can be concluded that the issue of studying integration risks in projects, taking into account the features of transport and logistics infrastructure objects, is almost ignored.

Successful implementation of such large-scale and complex projects as the TLC creation project requires the availability of appropriate methodological support, which will allow to take into account the features of the created objects. The large number of TLC project participants causes integration project risks, which can lead to very negative consequences, even if the project is completely closed. In [11] the authors distinguished the project integration risks into a separate category, in [12] proposed a methodological approach to integrating risk analysis in the TLC creation project, and in [13] emphasized on a qualitative risk analysis. Therefore, this issue needs further study, taking into account aspects of current management methodologies and the specific features of the research object – TLC project.

## 5. Methods of research

In the course of the research, the tools of modern management methodologies, such as project management, risk management and quality management, were used.

From the perspective of project management, the process of creating a TLC is considered as a project. As a result, a complex object is created, consisting of a large number of participants connected by integration ties.

For the study of integration project risks, the methods of risk management are applied, in particular the sequence of qualitative risk analysis of the project is proposed, as a result of which the matrix of integration potential of project participants is created.

In the process of qualitative analysis it is proposed to use methods of quality management, namely: Pareto diagram, ABC analysis. Application of these methods allows to determine the number of integration ties between participants and to rank the participants according to the degree of their influence on the project integrity.

## 6. Research results

**6.1. Determining the risk of tear-offs in TLC creation projects.** Integration risks fall into the category of risks that can be catastrophic for the project – a break in integration links can lead to the destruction of the entire system. The focus on them is justified as they affect the viability of the project.

When considering integration risks through the lens of integration in a TLC project, one of the most important integration risks of the project is the risk of a break in integration ties between project participants. The classification features of this type of risk according to the existing categories of classification of objects from the biological approach (class, type, type) are presented in Fig. 1.

This type of risk is inherent in all project participants, but its implications for the project depend on which group the participants belong to major or minor. Catastrophic consequences can occur if the integration links between

the main participant (investor, customer, general contractor, etc.) and other project participants till the termination of the project [2]. When it comes to minor participants, the consequences of integration risks may not be as significant for the project. In this case, a preliminary risk analysis helps to influence the situation and preserve the integrity of the project as a system.

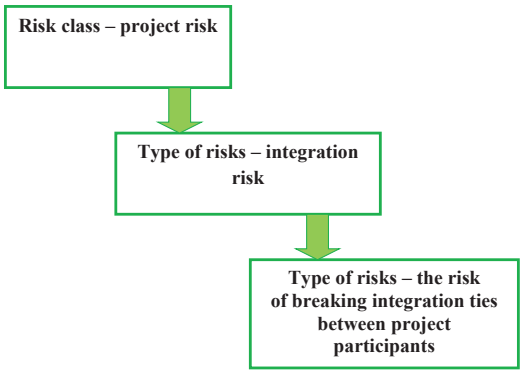


**Fig. 1.** Classification signs of risk of rupture of integration ties between project participants

Integration in creation of TLC projects also has an appropriate classification (system, design, transport and logistics), which is described in detail in [4]. Combining the peculiarities of the project integration of project participants, the selection of secondary project participants gives rise to the concept of risk of rupture of integration links between project participants (Fig. 2).

**6.2. Analysis of integration risks of the TLC creation project.** Integration risk management involves such processes as: risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, risk response implementation, risk monitoring.

Particular attention should be paid to risk analysis. At the stage of qualitative analysis, it is necessary to identify the sources of possible integration risks of the project, that is, to identify those project participants, whose actions may lead to disruption of integration ties in the project. For this purpose it is proposed to use quality management methods, namely: Pareto analysis, ABC analysis, as well as the matrix of integration potential. A qualitative analysis of integration risks, which is to determine the integration potential of project participants, is proposed in three steps:

*Step 1.* Separation of minor project participants into groups according to the number of their integration ties with other partners.

*Step 2.* Determination of the integration capabilities of the project participants.

*Step 3.* Determination of the integration potential of the project participants.

The proposed sequence of analysis of the integration risks of the TLTC project allows, in the absence of reliable information about the project implementation conditions:

– identify the elements of the project participants most prone to integration risks;

– determine the integration potential of project participants – the degree of impact on the sustainability of the project system.

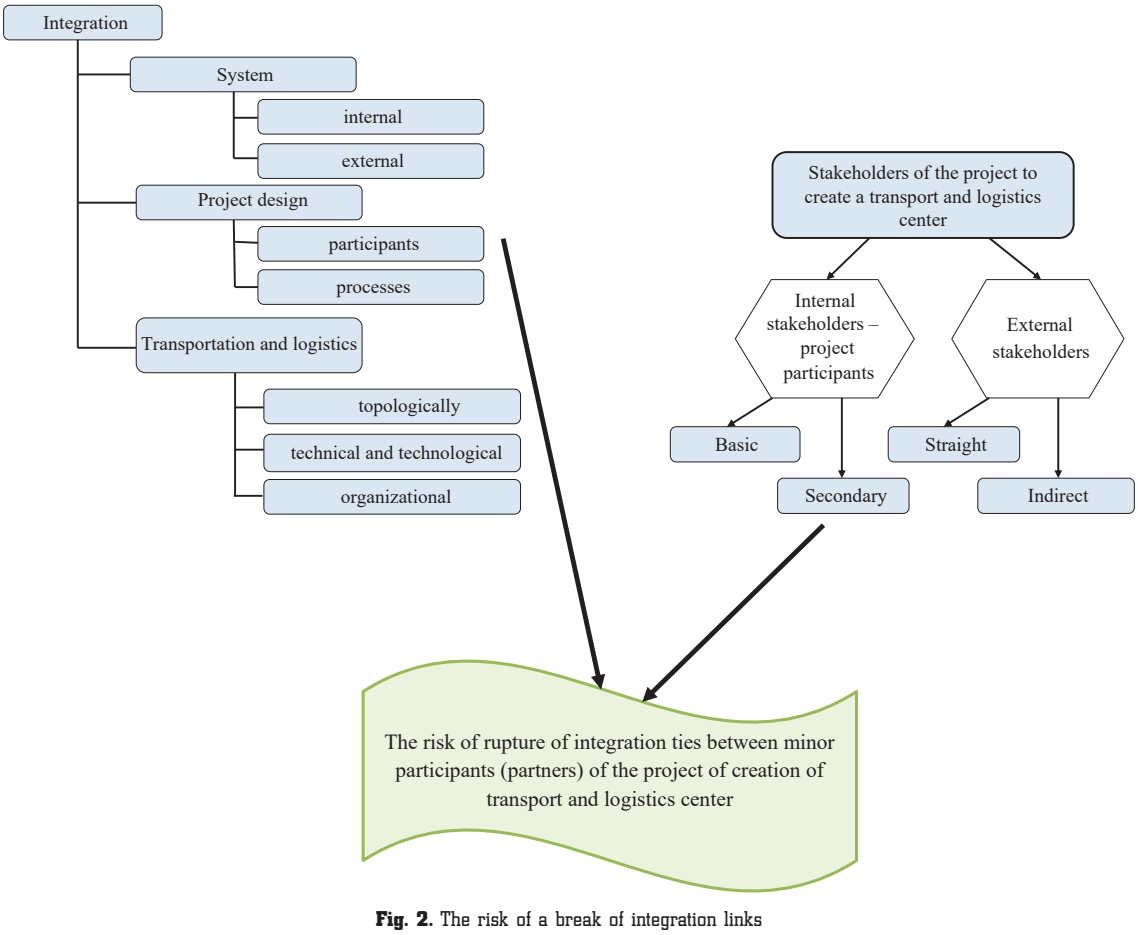


**Fig. 2.** The risk of a break of integration links

ISSN 2664-9969

The study of the proposed sequence of qualitative analysis will be carried out on the example of a project for the creation of a TLC, which includes 30 minor participants (partners) in the operational phase.

*Step 1. Separation of minor project participants into groups according to the number of their integration ties with other partners.*

Pareto analysis is proposed to identify participants' propensity to integrate risks. The input for the analysis is the set of integration links between the project participants, and the output is a Pareto diagram.

A qualitative analysis of project integration risks using a Pareto diagram consists of the following steps:

– creating a contiguity matrix that reflects the presence (1) or the absence (0) of integration relations between the elements (Table 1);

– analysis of the significance of the obtained results, which is reflected in the table of aggregated data (Table 2);

– construction of the Pareto diagram (Fig. 3);

– carrying out the ABC analysis of project participants (Fig. 4).

Participants have integration links that can be described using a contiguity matrix.

Analysis of integration links between project participants based on the results presented in Table 1, it is possible to carry out the following indicators:

– the number of connections of this element with other elements of the system;

– % of the connections of this element with other elements in the total number of integration links between system elements, which is presented in Table 2.

**Table 1**

Matrix of contiguity of elements (partners, project participants)

| No. | Participant (element) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Warehouse ABCD | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 2 | Custom warehouse | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | Warehouse oftemporary storage (WTS) | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 4 | Warehouseof freight forwarding organization | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 5 | Motor transport company (TIR) | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 6 | Railway transportation management center | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Linear company | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 8 | Stevedoring companies | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 9 | TEO | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 10 | 3PL-operator | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 11 | 4PL-operator | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 12 | Distribution companies | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 13 | Distribution complex | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 14 | Cargo terminal | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 15 | Branch of authorized banks | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 16 | Insurance company | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 17 | International express carriers DHL, TNT | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 18 | Law company | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 19 | Customs authorities | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 20 | Representatives of official controls | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 21 | Customs broker | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 22 | Customer service | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| 23 | Service station (TIR) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 24 | Parking | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 25 | Security and safety service | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 26 | Gas station | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 27 | Catering | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 28 | Hotel/hostel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 |
| 29 | Store | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 30 | Business center | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |

**Table 2**

Aggregated data for element integration links (partners, project participants)

| Project participant | Number of integration links | The cumulative sum of the number of integration links | % of integration links in total | Cumulative % |
|---|---|---|---|---|
| 10 | 25 | 25 | 5.18 % | 5.18 % |
| 9 | 24 | 49 | 4.97 % | 10.14 % |
| 15 | 24 | 73 | 4.97 % | 15.11 % |
| 14 | 23 | 96 | 4.76 % | 19.88 % |
| 11 | 21 | 117 | 4.35 % | 24.22 % |
| 12 | 21 | 138 | 4.35 % | 28.57 % |
| 13 | 21 | 159 | 4.35 % | 32.92 % |
| 17 | 21 | 180 | 4.35 % | 37.27 % |
| 5 | 20 | 200 | 4.14 % | 41.41 % |
| 19 | 19 | 219 | 3.93 % | 45.34 % |
| 3 | 18 | 237 | 3.73 % | 49.07 % |
| 1 | 18 | 255 | 3.73 % | 52.80 % |
| 18 | 18 | 273 | 3.73 % | 56.52 % |
| 2 | 17 | 290 | 3.52 % | 60.04 % |
| 16 | 17 | 307 | 3.52 % | 63.56 % |
| 4 | 16 | 323 | 3.31 % | 66.87 % |
| 21 | 16 | 339 | 3.31 % | 70.19 % |
| 22 | 16 | 355 | 3.31 % | 73.50 % |
| 30 | 15 | 370 | 3.11 % | 76.60 % |
| 8 | 14 | 384 | 2.90 % | 79.50 % |
| 25 | 13 | 397 | 2.69 % | 82.19 % |
| 29 | 13 | 410 | 2.69 % | 84.89 % |
| 7 | 11 | 421 | 2.28 % | 87.16 % |
| 20 | 11 | 432 | 2.28 % | 89.44 % |
| 26 | 10 | 442 | 2.07 % | 91.51 % |
| 6 | 9 | 451 | 1.86 % | 93.37 % |
| 27 | 9 | 460 | 1.86 % | 95.24 % |
| 23 | 8 | 468 | 1.66 % | 96.89 % |
| 24 | 8 | 476 | 1.66 % | 98.55 % |
| 28 | 7 | 483 | 1.45 % | 100.00 % |

Let's build a Pareto diagram of partner integration relationships using the data presented in Table 2. On the abscissa axis, let's place the elements according to the degree of integration, and along the ordinate axis – the percentage of integration relations of the elements in the total and the cumulative percentage of integration relations (Fig. 3).

The use of ABC analysis allows to identify the project participants who have the highest number of integration ties (Fig. 4).

It is determined that the group «A» with the largest number of integration links includes elements: «10», «9», «15», «14», «11», «12», «13», «17», «5», «19», «3», «1», «18», «2», «16», «4», «21», «22». The largest number of integration links (25) is observed in the element «10» – 3PL operator. But this kind of estimation is not enough because the system element can have a large number of integration links, and the power of these connections may be negligible.

*Step 2. Determination of the integration capabilities of the project participants.*

Let's propose to determine the power of the integration link taking into account the number of realized relationships (transactions) using this connection and the cash flow (cost) of the respective operations. An example of calculating the value of the number of operations for 6 months for the element «10» is presented in Table 3.

In terms of number of transactions, the most popular is the connection «10–7» (3PL operator – Linear carrier company). But for the sake of completeness of the importance of this or that integration connection let's suggest to consider not only the number but also the cost of the performed operations. Their output will determine the cash flows between the elements of the system that create the integration link. This will allow to determine the amount of work done on a system that matches a particular integration link:

$$CF_{ij} = q_{ij} \cdot c_{ij}, \quad (1)$$

where $CF_{ij}$ – cash flows moving from the $i$-th to the $j$-th element between which the integration link is established; $q_{ij}$ – number of operations between $i$-th and $j$-th elements; $c_{ij}$ – the average cost of one operation between the $i$-th and $j$-th elements.

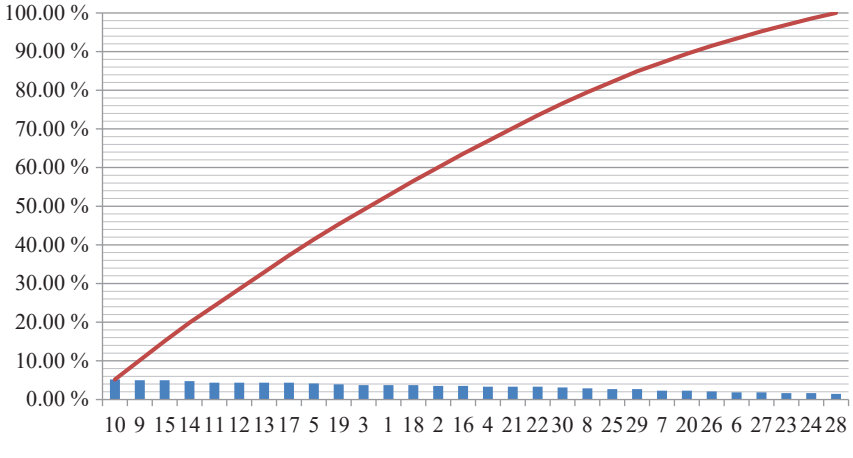


**Fig. 3.** Pareto diagram of the integration links of the project participants

ISSN 2664-9969

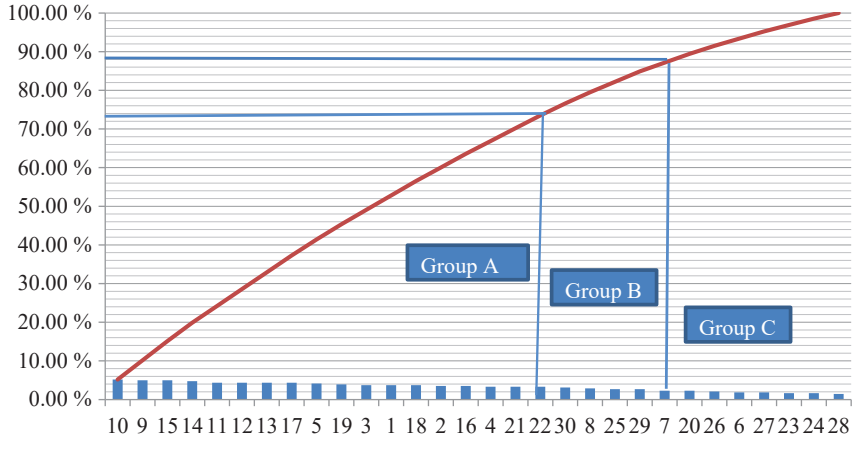


**Fig. 4.** ABC analysis of project participants

**Table 3**

Number of integration operations of element «10» – 3PL operator

| Connection | Time period, month | | | | | | Total units |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 10–1 | 3 | 5 | 7 | 9 | 10 | 14 | 48 |
| 10–2 | 2 | 4 | 3 | 6 | 5 | 8 | 28 |
| 10–3 | 3 | 5 | 6 | 8 | 9 | 11 | 42 |
| 10–4 | 4 | 6 | 8 | 10 | 9 | 6 | 43 |
| 10–5 | 8 | 9 | 12 | 10 | 11 | 12 | 62 |
| 10–6 | 10 | 9 | 12 | 15 | 14 | 14 | 74 |
| 10–7 | 11 | 14 | 15 | 14 | 15 | 15 | 84 |
| 10–8 | 11 | 14 | 15 | 10 | 12 | 14 | 76 |
| 10–9 | 12 | 10 | 13 | 15 | 14 | 13 | 77 |
| 10–11 | 3 | 2 | 2 | 4 | 6 | 5 | 22 |
| 10–12 | 2 | 3 | 1 | 4 | 2 | 2 | 14 |
| 10–13 | 4 | 6 | 8 | 7 | 5 | 7 | 37 |
| 10–14 | 5 | 8 | 10 | 12 | 10 | 13 | 58 |
| 10–15 | 7 | 9 | 9 | 10 | 12 | 14 | 61 |
| 10–16 | 4 | 3 | 6 | 5 | 4 | 4 | 26 |
| 10–17 | 3 | 5 | 4 | 2 | 3 | 4 | 21 |
| 10–18 | 2 | 1 | 3 | 2 | 4 | 3 | 15 |
| 10–19 | 9 | 10 | 11 | 10 | 9 | 12 | 61 |
| 10–20 | 2 | 1 | 4 | 3 | 5 | 4 | 19 |
| 10–21 | 8 | 10 | 12 | 11 | 10 | 13 | 64 |
| 10–22 | 3 | 2 | 5 | 4 | 3 | 3 | 20 |
| 10–24 | 2 | 1 | 3 | 4 | 3 | 4 | 17 |
| 10–26 | 4 | 3 | 5 | 4 | 3 | 6 | 25 |
| 10–29 | 3 | 2 | 1 | 2 | 3 | 4 | 15 |
| 10–30 | 1 | 2 | 1 | 3 | 4 | 3 | 14 |

To determine the power of the integration link between system elements – TCP project participants – let's apply the formula:

$$N_{ij} = \frac{CF_{ij}}{t_{ij}}, \quad (2)$$

where $t_{ij}$ – time spent performing operations between $i$-th and $j$-th elements.

Based on the obtained values of the power of integration links, it is possible to determine their rating (Table 4).

**Table 4**

Power of integration links of element «10» – 3PL operator

| Connection | Number of operations, units | The average cost of one operation, USD | Cash flow, USD | Connection power, USD/month |
|---|---|---|---|---|
| 10–1 | 48 | 1800 | 86400 | 14400 |
| 10–2 | 28 | 5280 | 147840 | 24640 |
| 10–3 | 42 | 2200 | 92400 | 15400 |
| 10–4 | 43 | 3600 | 154800 | 25800 |
| 10–5 | 62 | 10000 | 620000 | 103333 |
| 10–6 | 74 | 1500 | 111000 | 18500 |
| 10–7 | 84 | 13000 | 1092000 | 182000 |
| 10–8 | 76 | 3700 | 281200 | 46867 |
| 10–9 | 77 | 1000 | 77000 | 12833 |
| 10–11 | 22 | 1500 | 33000 | 5500 |
| 10–12 | 14 | 5000 | 70000 | 11667 |
| 10–13 | 37 | 84000 | 3108000 | 518000 |
| 10–14 | 58 | 100000 | 5800000 | 966667 |
| 10–15 | 61 | 200 | 12200 | 2033 |
| 10–16 | 26 | 2000 | 52000 | 8667 |
| 10–17 | 21 | 400 | 8400 | 1400 |
| 10–18 | 15 | 1000 | 15000 | 2500 |
| 10–19 | 61 | 4000 | 244000 | 40667 |
| 10–20 | 19 | 350 | 6650 | 1108 |
| 10–21 | 64 | 1000 | 64000 | 10667 |
| 10–22 | 20 | 600 | 12000 | 2000 |
| 10–24 | 17 | 120 | 2040 | 340 |
| 10–26 | 25 | 200 | 5000 | 833 |
| 10–29 | 15 | 1000 | 15000 | 2500 |
| 10–30 | 14 | 700 | 9800 | 1633 |

The most powerful link is the «10» and «14» elements (3PL Operator – Cargo Terminal).

It is possible to determine the total power of all element integration links by the formula:

$$N_i = \sum_{j=1}^{m} N_{ij} \left( i = \overline{1,n} \right). \quad (3)$$

Thus, the total integration power of element «10» is 2019955 USD/month. If to carry out a similar assessment for other elements of the system, it is possible to determine the rating and the total integration power for each project participant and to determine the integration capacity of the project participants (Table 5).

**Table 5**

Power of integration links of project participants

| Element (project participant) | Total power connection of element | Rating ofpower connection of element |
|---|---|---|
| 10 | 2019955 | 5 |
| 9 | 2155880 | 4 |
| 15 | 7500 | 27 |
| 14 | 809390 | 10 |
| 11 | 1781067 | 20 |
| 12 | 363641 | 16 |
| 13 | 23364348 | 1 |
| 17 | 282073 | 17 |
| 5 | 2669525 | 3 |
| 19 | 491350 | 12 |
| 3 | 1060741 | 7 |
| 1 | 412646 | 14 |
| 18 | 59480 | 24 |
| 2 | 376049 | 15 |
| 16 | 212883 | 19 |
| 4 | 1017380 | 8 |
| 21 | 12085147 | 2 |
| 22 | 9763 | 26 |
| 30 | 687000 | 11 |
| 8 | 129748 | 21 |
| 25 | 942717 | 9 |
| 29 | 1757727 | 6 |
| 7 | 453683 | 13 |
| 20 | 1808 | 30 |
| 26 | 2400 | 29 |
| 6 | 226423 | 18 |
| 27 | 86595 | 23 |
| 23 | 18175 | 25 |
| 24 | 6927.5 | 28 |
| 28 | 108230 | 22 |

Based on the obtained results, a management decision should be made to manage the integration risks in the project.

*Step 3. Determination of the integration potential of the project participants.*

To determine the integration potential of project participants, it is proposed to use an integration potential matrix. The ordinates of the ordinates determine the power rating of the integration links of elements (1–10 – significant power, 11–20 – average power, 21–30 – insignificant power). The ordinate axis defines the zones of ABC analysis that reflect the number of integration links of participants (group A is large, group B is medium, group C is insignificant) (Table 6).

**Table 6**

Matrix of integration potential

| Connection power | The importance of project participants (by number of integration links) | | |
|---|---|---|---|
| | Group A | Group B | Group C |
| significant | high | high | high |
| average | high | average | low |
| insignificant | average | low | low |

For an example of a TLC project, the integration potential matrix is presented in Fig. 5.

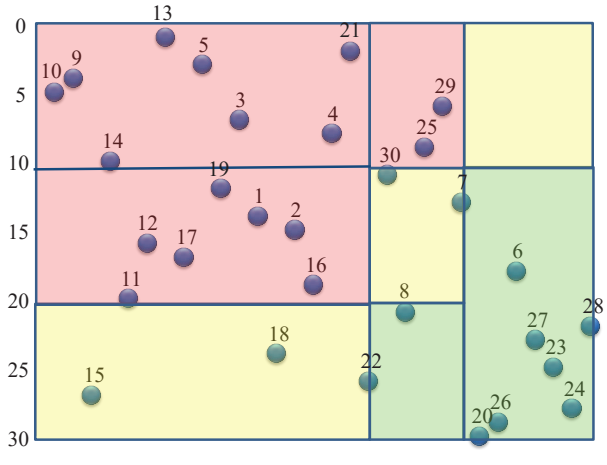


**Fig. 5.** Matrix of integration potential of participants of the project of transport and logistics center

The Integration capacity matrix allows the project participants to be divided into areas of high, medium and low integration potential of the participant. Depending on which area of the matrix a particular project participant falls in, it is possible to determine its integration potential, that is, the influence degree on the stability of integration ties between project participants.

## 7. SWOT analysis of research results

*Strengths.* The approach proposed in the paper allows for an analysis of integration risks and to prevent the integration gap between project participants, which, in turn, should have a significant impact on project performance. Positive results can be obtained by applying the tools of modern concepts of project management, risk management and quality management.

*Weaknesses.* The disadvantage of the study is the lack of analysis of individual relationships between participants and the identification of causes of risk situations, which will be the topic of the next study.

*Opportunities.* The peculiarity of the proposed approach is to identify the integration potential of the project participants, which in the uncertainty helps to identify the most vulnerable, in terms of the breakdown of integration links, elements of the «project» system. Despite the interest of researchers in the study of design, logistical

ISSN 2664-9969

risks, integration issues and the risks that may arise from its breach in the project, insufficient attention is paid.

Using the authors' «matrix of integration potential», influence degree of project participants on the resilience of the project to integration risks is determined.

*Threats.* An important limitation is the inability to apply this approach to the main project participants, such as: customer, investor, since in their exit from the project, in most cases, the whole system is broken and the project ceases to exist. This approach can be applied to minor, relatively equal participants in the project.

## 8. Conclusions

1. The specific features of the risk of the break of integration ties between TCP participants are identified, which include the risks that may affect the integration in the project and lead to disruption of the project as a system. That is, this category of risks arose at the intersection of concepts such as project integration and project participants, as shown in Fig. 2. The classification features of this type of risk are determined according to the existing categories of classification of objects from the biological approach (class, type, type), which is presented in Fig. 1.

2. A sequence of qualitative risk analysis of the TLC creation project has been developed, which includes three steps. A matrix of integration potential of project participants was created using the results obtained in the previous stages of risk analysis. Based on the data obtained from the ABC analysis and determination of the integration capacity of the project participants, the matrix is divided into three zones of integration potential: high, medium and low (Table 6).

3. Experimental calculations of a qualitative analysis of the risks of the break of integration ties between project participants were carried out using the example of a TLC, consisting of 30 participants. The results of the analysis are presented in Tables 1–6 and in Fig. 3–5. The participants of the project of creation of TLCs by zones of matrix of integration potential are distributed and their tendency to influence of integration risks is determined (Fig. 5). The area of high integration potential has been reached by 15 participants, who should be further analyzed for individual integration links and identify the causes of the risks of their break.

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