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SELECTED PRACTICAL ASPECTS OF THE PROJECT RISK MANAGEMENT IN RAILWAY INDUSTRY

WYBRANE, PRAKTYCZNE ASPEKTY ZARZĄDZANIA RYZYKIEM PROJEKTOWYM W KOLEJNICTWIE

Abstract: The article constitutes theoretical and empirical study relating to selected aspects of the project risk management in railway industry. The railway projects are carried out in the environment which is much more complicated and demanding than environment of projects performed in remaining industries. This is why a category of risk is so important during the

implementation process of the project and must be analyzed carefully and multi-directionally in this regard. The paper was divided into two main parts: theoretical and empirical. The theoretical part of the article completed the theoretical goal which was the critical review of the literature on the risk management, especially the specificity of railway projects, category of risks which appear in railway projects as well as methodology of risk management in railway projects. The second part of the paper is of empirical nature. In this part, the authors performed the empirical goal which points out the major risk factors that can influence railway projects, based on Polish railway market as well as analyzed their frequency and impact. For this goal the Delphi method was used together with supportive expert interview with managers. The research allowed to determine the above mentioned factors influencing railway projects' performance and to formulate conclusions concerning further directions of research.

Keywords: project management, risk management, railway transport

Streszczenie: Artykuł stanowi teoretyczno-empiryczne studium odnoszące się do wybranych aspektów zarządzania ryzykiem w projektach na przykładzie branży kolejowej. Środowisko dla realizacji tych projektów jest bardziej skomplikowane i wymagające niż środowisko dla projektów realizowanych w innych branżach. Dlatego kategoria ryzyka jest tak ważna i musi być analizowana dokładnie i wielokierunkowo. Artykuł został podzielony na dwie części: teoretyczną i empiryczną. W pierwszej części zrealizowano cel teoretyczny, który odnosi się do krytycznej analizy literatury dotyczącej zarządzania ryzykiem, w szczególności specyfiki projektów realizowanych w branży kolejowej, kategorii ryzyka pojawiającego się w tych projektach oraz metodologii zarządzania ryzykiem w tych projektach. Druga część artykułu ma charakter empiryczny. Autorzy zrealizowali w niej cel odnoszący się do identyfikacji głównych czynników ryzyka, które mogą wpływać na projekty realizowane w branży kolejowej. W części tej oparto się na analizie polskiego rynku kolejowego, wykorzystując metodę delficką, wpartą wywiadami eksperckimi z menedżerami. Dzięki niej określono częstotliwość i wpływ tych czynników na powodzenie realizacji analizowanych projektów oraz sformułowano wskazówki dla dalszego skutecznego zarządzania tymi projektami.

Słowa kluczowe: zarządzanie projektem, zarządzanie ryzykiem, transport kolejowy

Introduction

The railway projects are usually carried out in the environment that is much larger than the usual constructional project. A number of risks appear inside the company for which the project is implemented as well as potential uncertainty that often affects projects and leads to the costs overruns or project delays may arise.

Risk management became an integral part of any project management nowadays. There is a strong connection between successful realization of the projects and well organized risk management process. In order to perform and manage project and control risks it is required to use different tools and information, however for railway it is difficult to propose one model, that will satisfy the requirements of all projects[1].

[1] M.Gorrod, *Risk management system: process, technology and trends*, Palgrave Macmillan division of St. Martin's Press, New York 2004, p. 4.

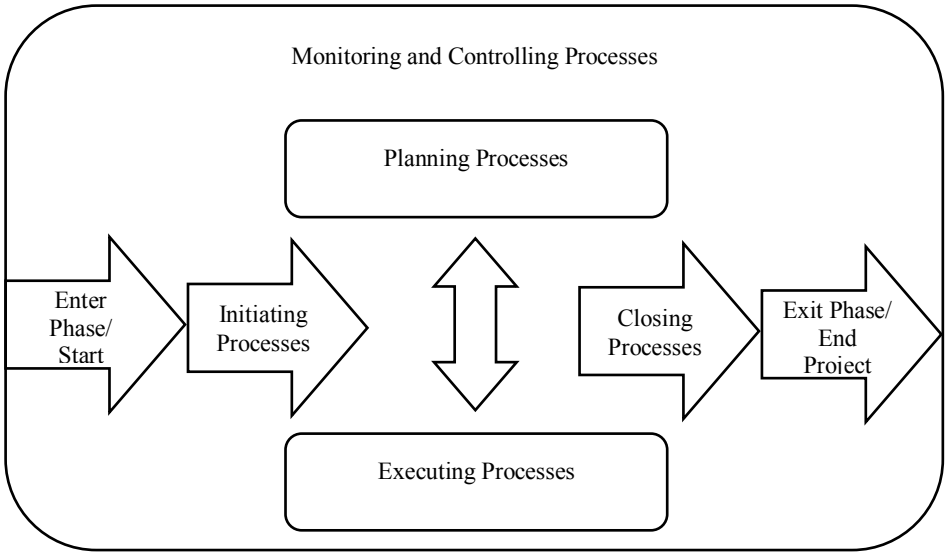
The purpose of this paper was to investigate how to manage risks in railway project, considering the project's restrictions, such as long duration, high costs of realization, ecological factors, technological limitations, law regulations, difficulties in coordination between contractors.

The following paper constitutes the part of the broader research carried out by the authors and partly presented earlier in Polish scientific journals.

1. The concept of railway projects

The main principle of the traditional railway project management model is on-time delivery within planned budget and with required quality. The project has a start date, completion date, planned materials, resources and methods for realization[2]. This model is often referred to as "waterfall project management"[3] because it handles one thing after another in a linear order. It suits for the simple projects where tasks should be completed one by one, for example, project in which it should be created design before starting of building of the actual project. According to the PMBOOK® Guide (Fifth edition) there are five basic project process groups. Those are initiating, planning, the process of execution, controlling process and the process of closing, presented in Figure 1.

Figure 1. Project management process groups
Rysunek 1. Grupy procesów zarządzania projektami



Source: A Guide to the Project Management Body of Knowledge 2013.

[2] J. Kelly, S. Male, D. Graham, *Value management of construction projects*, John Wiley&Sons Inc., New York 2014, pp. 23-26.
[3] W. Fox, G. Van Der Waldt, *A guide to project management,* Juta and Company Ltd., Cape Town 2008, p. 25.

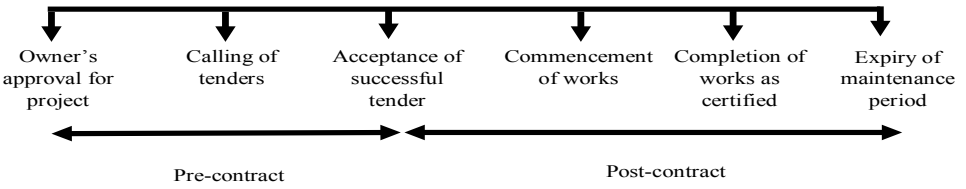
Any projects could be characterized by these processes, however these processes could be used for the each phase of the project as well. By breaking any railway project into steps that must be completed one after another, the specific stages could be specified: project planning and design, manufacturing and construction, testing, monitoring and maintenance and completion. The project team initiates each phase, formulates plans for work performing, executes and controls the performance, closing the phase and going to another[4].

The degree of complexity of railway projects in terms of the materials, technical documentation, standards, safety requirements, used equipment and invited specialists is extremely high. Not only the basic tasks are complex and require precise coordination, but also existing products and services become more complex from a technological point of view.

The main difficulty of the railway project is that there is no generic life cycle structure that covers and reflects all the projects. Each area within the project is found to have its own traditions and procedures[5].

Generally the railway project could be divided into two main parts – Pre-contract phase and Post-contract phase, as illustrated in the Figure 2.

Figure 2. Time-line in railway project
Rysunek 2. Oś czasu w projekcie kolejowym



Source: P. Lim, *Contract administration and procurement in the Singapore construction industry*, World Scientific Publishing Company Singapore, 2006

2. Categories of risks in railway projects

"Projects are widely used for getting things done, organizing changes or performing innovative tasks. Thus projects are inherently risky and project manager needs to mitigate those risks in order to achieve the desired outcome"[6]. The most important aspect in project management is allocation of risks[7].

[4] C. Snyder, F. Parth, *Introduction to IT project management,* Berrett-Koehler Publishers, Oakland 2006, p. 37.
[5] A. Hamilton, *Handbook of project management procedures*, Thomas Telford, London 2004, p. 3.
[6] C.N. Bodea, *Managing project risks for competitive advantage in changing business environments,* IGI Global, Hershey 2016, p. 16.
[7] R. Miller, D.R. Lessard, *The strategic management of large engineering projects: shaping institutions, risk*

Generally risk can be classified as a project execution topic or event that has not happened yet, whereas an issue is something that has already happened and requires management attention. Issues should be recorded by the project team in the issues register almost every day, while risks recorded in the risk register should be reviewed periodically.

In management theory project risks are often associated with macroeconomic, legislative, political factors that are known as "force majeure". Conditionally, these risks can be called "external" in relation to the project. It is almost impossible to influence the probability of occurrence of these risks, but it is, of course, possible to work with their influence on the project.

R. Chapman points seven sections, namely environment, external stakeholders (including the supply chain), organization, leadership, internal stakeholders, resources and systems, and rules of project which support the implementation of effective risk management[8]. Their description is as follows[9]:

1. The term environment characterizes economic, financial, technological, social, cultural, political, legal, regulatory aspects.
2. An external project stakeholder is a party that may influence or be influenced by a project, for example government and local authorities, private companies, design and survey consultancies, contractors, sub-contractors and suppliers.
3. The term organization is closely connected with the environment, that influences for example on organization mission, structure, human resources, profitability and so on.
4. Leadership as a part of risk management represents driving for continuous improvements during project implementation.
5. The internal stakeholders within the project may include the company board, client or end users, project manager and project team and other company functions such as controlling, legal, human resources.
6. Risk management resources include financial, physical, human and intangible resources.
7. Systems include risk management documents, software and practices, such as frameworks, policies, plans, procedures and templates.

The most common risks that could happen during the construction of a project are as follows[10]:

and governance, MIT Press, Cambridge 2000, p. 165; K. Kaczorek, M. Krzemiński, N. Ibadov, *The problem of choosing risk management methodology at the example of railway construction*, MATEC Web Conf., Vol. 117, 2017, RSP 2017 – XXVI R-S-P Seminar 2017 Theoretical Foundation of Civil Engineering.

[8] R.J. Chapman, *The rules of project risk management: implementation guidelines for major projects,* Routledge, New York 2016, p. 6.

[9] Ibidem.

[10] A. Twort, G. Rees, *Civil engineering project management, Fourth edition*, Elsevier, New York 2003, p. 20.

1. Design errors, quantification errors.
2. Design changes required by the client or other technical requirements.
3. Unforeseen physical conditions of the site.
4. Unforeseen price change in labour or materials.
5. Damage of the performed works, materials or equipment on site.
6. Weather conditions, including floods, rains or very hot weather.
7. Delays or inability to obtain required materials and equipment.
8. Inability to get the required amount of labour, labour strikes.
9. Errors in pricing by contractors.

Railway projects very often take place in an environment that is wider than the usual constructional projects. A lot of risks arise inside the company for which the project being implemented as well as potential uncertainty that often affects projects and leads to the costs overruns or project delays could occur. All railway projects could be characterized by the following criteria[11]:

1. Long duration of realization.
2. Scale and dimension of the project are depended on the location country.
3. Design, constructional, technological and procedural complexity.
4. Complex financial schemes of sponsoring and financing, that involve governmental organizations, public and private sectors, world financial authorities.
5. The various methods of project delivery and procurement lead to necessity to allocate connected risks during early stages of projects.
6. Long and complex end phase of the project sometimes is more significant and critical than the management of the procurement, design or construction phases.
7. High public profile and public scrutiny of the railway.
8. Unique organizational structure of railway projects that involve a lot of companies and authorities and requires good vertical as well as horizontal management.
9. High degree of regulation in terms of safety.
10. Multiple stakeholders create management challenges that do not usually exist in small projects.
11. Ethical dilemmas and challenges appear because of weak governance structure, conflicts between project participants, lack of transparency, failure in communication with stakeholders, etc.

[11] V.A. Greiman, *Megaproject management: lessons on risk and project management from the big dig, Project management Institute,* New Jersey 2013, p. 10-24; R. Miller, J.B. Hobbs, *Governance regimes for large complex projects: worst practices in project management within the television production industry,* "Project Management Journal", 36 (3), PMI, Brussel, 2005, p. 45; E. Chinyio, P. Olomolaiye, *Construction stakeholder management*, John Wiley & Sons Ltd, Cichester, West Sussex, UK, 2010, p. 45; B. Flyvbjerg, M.K.S. Holm, S.L. Buhl, *Cost underestimation in public works projects: error or lie?,* "Journal of the American Planning Association" 2002, 68(3), p. 279-295.

12. Consistent underestimation of costs a due to different factors, such as political risks, mistakes in original cost estimation, design changes, low contingencies, risk connected with geological conditions, , technological risk and underestimation of the length and cost of delays.

13. Strong environment impact on the project realization.

Understanding such a wide context of railway projects helps to ensure that works are carried out in alignment with the organizations' goals and possible risks of the project are minimized.

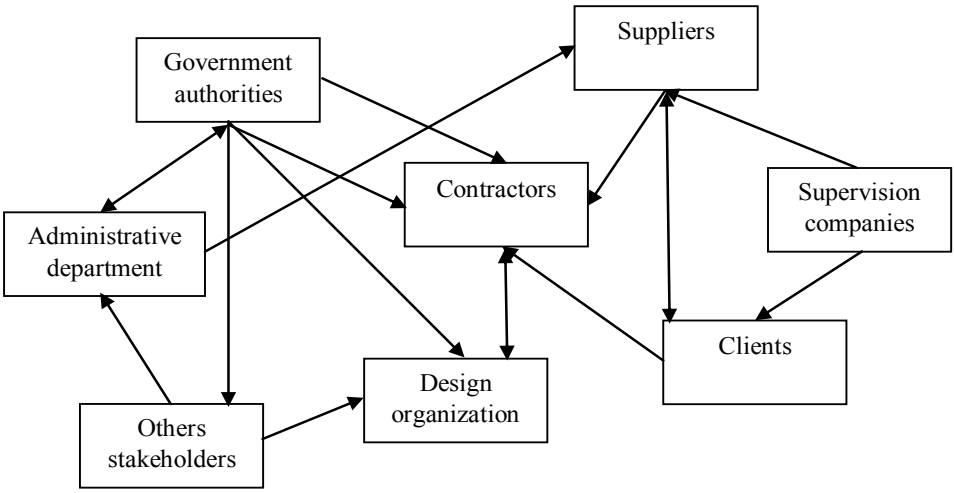
In the railway projects following basic categories of risks could be defined:

1. Technical and technological risks connected with design, integration of new technologies, using of new materials/technologies.
2. Constructional and operational risks connected with safety, quality control or labor safety, geographical location or geological conditions.
3. Commercial, financial and procurement risks connected with size of projects, contract conditions, sources of financing, budget constraints, dispute resolutions, penalties, exchange rates changes, inflation and so on.
4. Legal and political risks connected with taxation, government policy, uncertain regulatory environment.

Most of the railway projects involve in the project not only investor, rail company, engineers and contractors, but much wider range of stakeholders, that could influence the projects. That lead to the "relationship risk"[12], for example the judgement about the project, role and influence of the specific stakeholder in the project as well as "network risk"[13], for example the judgement about the project reliability and effectiveness of the entire network of the project stakeholders. The relationship between the stakeholders is illustrated in the Figure number 3.

[12] R. Ding, *Key project management based on effective project thinking,* Springer, Berlin 2015, p. 267.
[13] Ibidem.

Figure 3. Nets between the stakeholders in the project (exemplary connections)
Rysunek 3. Sieci pomiędzy interesariuszami w projekcie (przykładowe połączenia)



Source: R. Ding, *Key project management based on effective project thinking*, Springer, Berlin 2015.

The following basic judgements of risk analysis based on stakeholders network for the project could be done[14]:

1. The higher density of the network the higher levels of the constrains of the project.
2. The higher centrality of one specific stakeholder, the higher capability to counteract to the pressure of other stakeholders.
3. If other conditions remain unchanged, stakeholders with higher density and higher centrality are more likely to start negotiations and to find compromises.
4. If other conditions remain unchanged, stakeholders with lower density and higher centrality are more likely to control other stakeholders.
5. If other conditions remain unchanged, stakeholders with higher density and lower centrality are more likely to adopt compromising strategies in order to work with other stakeholders.

3. Methodology of risk management in railway projects

Traditionally risk arises from uncertainty and is considered as something bad, harmful, negative and unwelcome. However, some uncertainties if they occur, could be beneficial and positive and are called opportunities[15].

[14] Ibidem.
[15] D. Hillson, *Practical project risk management: the ATOM methodology*, Berrett-Koehler Publishers, Oakland 2012, p. 22.

Nowadays, the key feature of the risk management is understanding and considering of both positive and negative risks. Positive risks are associated with opportunities for the project, negative risks are associated with obstacles in the way of the project development. Both types of risks are interrelated, so non-use of opportunities for positive risk leads to a negative risk.

Despite of the fact that projects vary so considerably in their technical requirements, execution, context, timeframe, complexity and scale, risk management in railway projects deals with identifying and assessing risks before they occur as well as managing project risks by taking proactive measures to avoid them or taking proactive measures to reduce their impact on the project[16]. Effective risk management process will guaranty, that project is under control, all unforeseen risks are managed and all opportunities are captured. This is an ongoing process that should be performed continuously[17].

The formula of 3C – Condition, Cause and Consequence is one of the most effective instruments used during risk analysis:

1. Condition, describes the event or series of events that could lead to the risk.
2. Cause, identifies the generic cause area and describes the specific source of the event.
3. Consequence, describes the direct impact of the event in terms of the effect on the work areas in which the event occurs (cost, schedule, performance and quality).

4. Selected results of conducted research

Implementation of the paper's research objective was based on the analyses of Polish railway market. The main risk factors that may influence a project implementation in this market were analyzed. The data for the analyses were collected with use of Delphi method. The analyses was divided into two parts. In the first part of the examination, the questionnaire was sent to following interviewees: 8 project managers, 7 project engineers and 5 construction engineers and 1 lawyer, who are working in railway projects in Poland. The experts were asked to specify main risk factors that could appear during performance of the railway projects. After the first part of the research proper studies were done. The list of classified factors was sent to the experts as the second part of the examination. The experts were asked to estimate both frequency and impact of factors on railway projects realization. The

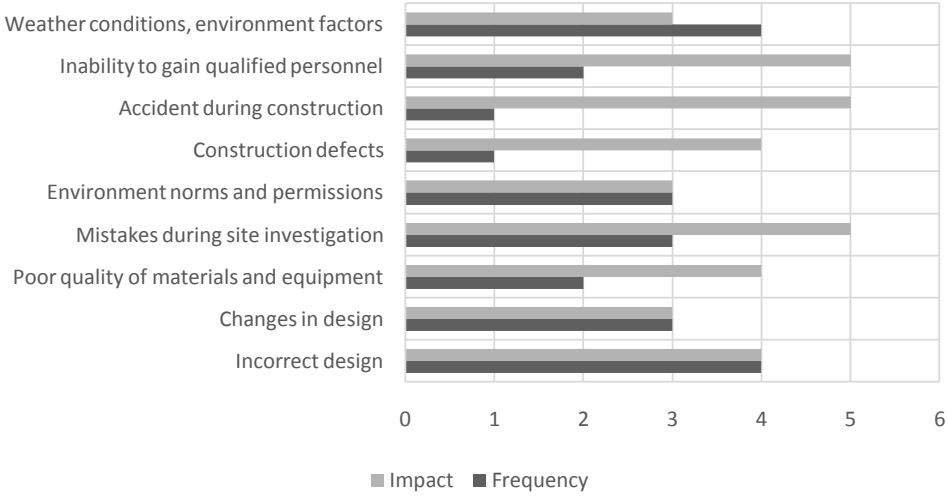
[16] R.J. Chapman, *The rules of project risk management: implementation guidelines for major projects*, Routledge, New York 2016, p. 6.

[17] M. Gorrod, *Risk management system: process, technology and trends*, Palgrave Macmillan division of St. Martin's Press, New York 2004, pp. 3-4; L. Quing, L. Rengkui, Z. Jun, S. Quanxin, *Quality Risk Management Model for Railway Construction Projects*, "Procedia Engineering" 2014, Vol. 84.

interviewees were estimating frequency and impact of selected risk factors basing on Likert scale, giving rankings from 1 to 5 for frequency and from 1 to 5 for impact. After the second part of the research, risk factors were divided into following groups: technical and constructional risks, commercial risks and legal risks and their frequency and impact on performance of railway project were assessed. The results were presented in figures 4, 5 and 6.

In the group of technical and constructional risks following factors were specified: incorrect design, changes in design, differences between the design and the implementation, actual quantities differ from the planned in the contract, poor quality of materials and equipment, materials are not available at time, delays with deliveries, security of the delivered materials and equipment, construction defects, mistakes during site investigation, permissions for land use, environment norms, accident during construction, poor communication between workers and main office, weather condition and inability to gain qualified personnel. Selected technical and constructional risks were presented in the Figure number 4.

Figure 4. Technical and constructional risks with regard to their impact and frequency
Rysunek 4. Ryzyko techniczne i konstrukcyjne w odniesieniu do ich wpływu i częstotliwości

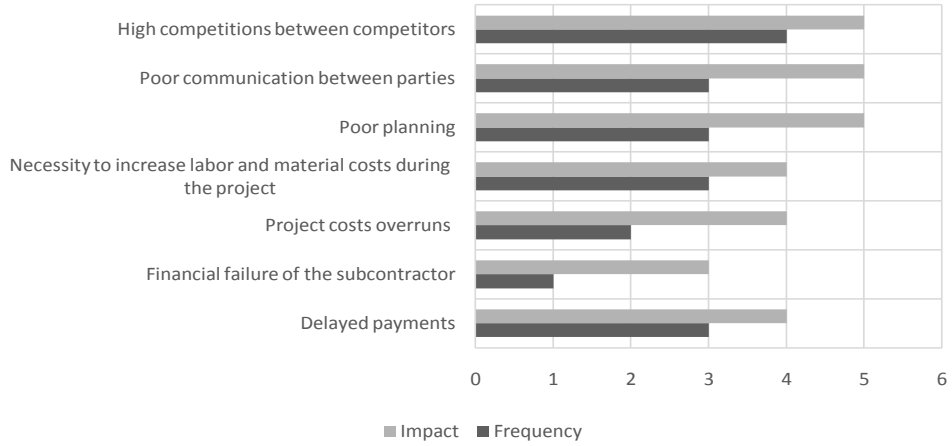


Source: own work.

The group of commercial risks was represented by factors: delayed payments, inflation, financial failure of the subcontractor, too

high costs of a project, necessity to increase labor and material costs during the project, bad planning, wrong communication between cooperating parties, changes within stakeholders and high competition between sites. The selection of commercial risks was presented in Figure number 5.

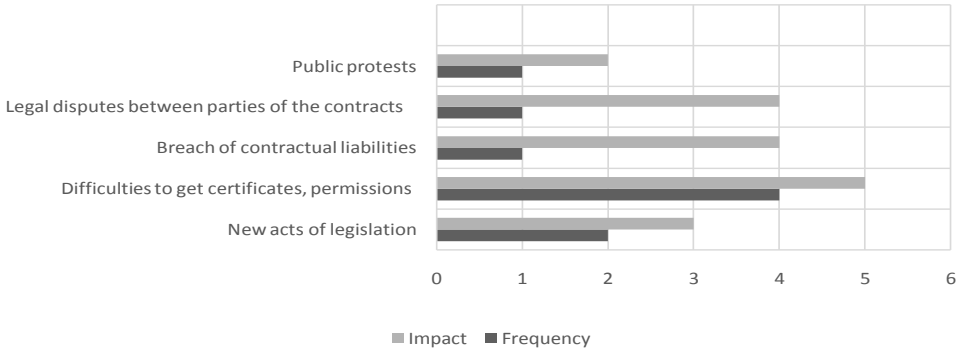
Figure 5. Commercial risks with regard to their impact and frequency
Rysunek 5. Ryzyko handlowe w odniesieniu do ich wpływu i częstotliwości



Source: own work.

The last group of factors – legal risks – concerned: new acts or legislation, new directives or procedures issued by Polish Railway Company, difficulties to get proper certificates and permissions, breach of contractual liabilities, legal disputes between parties of the contracts and public protests concerning issues of the project. Some of the above risks were presented in the Figure number 6.

Figure 6. Legal risks with regard to their impact and frequency
Rysunek 6. Ryzyko prawne w odniesieniu do ich wpływu i częstotliwości



Source: own work.

Estimation of mentioned factors conducted by the experts showed that many problems concerning the execution of the railway project occur because: during planning process mistakes relating to incorrect design happen, weather conditions determine

execution of the project, contractors and interested parties compete very strongly and companies performing projects have problems with getting proper certificates and permissions. According to the examination the biggest impact on implementation of the railway project have the following factors: incorrect design, low quality of used materials, security of the delivered materials, construction defects, mistakes during site investigation, accidents during construction, lack of qualified employees, delayed payments, poor planning and communication between parties, high competition between them and difficulties to receive proper permissions and certificates again.

Conclusion

Analysis of the literature in area of examined topic and the research which was performed allowed to formulate following final conclusions relating to project risk management in railway industry:

1. The main project risk management factors in railway industry concern wider spectrum, that it is used to consider by general risk management theory.
2. Contracts exercised in railway industry do not meet rules of general constructional projects, especially in area of their finishing. They have to be analyzed carefully to minimize possible risks, in particular concerning categories: costs, delays and safety.
3. Possible risks should be managed according to the project lifecycle. Some risks could appear during the whole project's performance.
4. Risk factors are allocated differently in different projects. It depends on parties of the project like clients or contractors. Situations that factors are common for different projects happen too.

The paper presented the importance of the proper risk analysis during projects' implementation, especially in area of railway industry. Many risk factors could influence completed projects and their identification and examination are essential for the project's success.

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