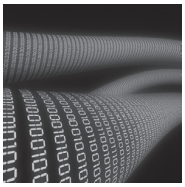

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Model of technical risk management in rail transport and technology transfer

A. JABŁOŃSKI[a], M. JABŁOŃSKI[a]

[a] STOWARZYSZENIE POŁUDNIOWY KLASTER KOLEJOWY (SOUTHERN RAIL CLUSTER ASSOCIATION), Ligocka 103, bud. Nr 7, 40-568 Katowice

EMAIL: adam.jablonski@ottima-plus.com.pl

ABSTRACT

Authors of the article present the basic assumptions of a model construction of technical risk management in rail transport. The model includes key elements affecting safety of traffic in rail transport. This refers to the system and process links between various participants in railway traffic, with reference to the technological criteria ensuring continuity of railway traffic. The author defines a place and role of technology transfer in building effective and efficient models of technical risk management in rail transport.

KEYWORDS: risk management, technology transfer, model, innovation

1. Introduction

Contemporary functioning of companies in the rail transport sector requires a new and creative look at its mechanisms. A passive model based on responding to events and disruptions occurring in rail traffic is no longer sufficient. The rail safety issue becomes particularly important, examined in the cause-and-effect relationship with risk management processes. The strategic and tactical-operational dimension of risk management then creates new space in improving organization processes. To maintain continuity of a railway business it is essential to master many factors that generate risk, to estimate probability of their occurrence, and parameterize basic management measures in a dynamic process of making decisions occurring in real time. This system developed in the form of a model, that is reproducing configuration of all the key elements, resources and relationships, can guarantee an acceptable level of railway safety, make it fully compatible with other systems and ensure technological development of the sector based on effective and efficient transfer of railway technologies that create new dimension of innovation and knowledge in rail transport. The author of the article presents the basic assumptions of a model construction of technical risk management in rail transport. This model includes key elements affecting safety of traffic in rail transport. This refers to the system and process links between various participants in railway traffic, with reference to the technological criteria ensuring continuity of railway traffic. The author defines a place and role of technology transfer in building effective and efficient models of technical risk management in rail transport.

2. New requirements and boundary conditions in the rail transport sector - the interpretive perspective

Contemporary functioning of rail transport sector companies is conditioned by numerous new boundary assumptions and criteria, which in recent years have been established by the supervisory bodies of rail transport, rail market customers and other stakeholders in the sector. The changes have resulted from numerous railway events, including several major rail disaster and the current situation related to the economic crisis, and, especially in Poland, too little financial investment in rail transport

infrastructure, rolling stock and other factors supporting the sector. Also, the European Union requirements for standardizing the mechanisms of conduct in the various sectors of economy, based on ISO 9000 standards, have reached the railway sector. Standardization and unification of solutions from organizational, managerial and technological perspective, implemented in the form of EU directives and based on entrepreneur's responsibility for performance set new criteria for doing business in the rail sector. The past years are a period of increased efforts of Polish entrepreneurs, which involve adjusting their business models to the legal, organizational and managerial standards of conduct accepted by the European Railway Agency.

3. A place and role of technology transfer in building a system of technical risk management in rail transport

An important area to improve safety in rail transport is skillful transfer of rail technologies, which can be conducted through innovation management systems. According to a classic definition of J.A. Schumpeter, innovation is understood as a combination of [1]:

- Developing new products and placing them on the market,
- Implementing new ways of production,
- Capturing and creating new markets,
- Acquiring new sources in obtaining resources,
- New organization.

Innovativeness of solutions in rail transport is affected by the use of best available technology (techniques). It also refers to procedures of managing, supervising and monitoring processes. In rail transport principles of building incremental and groundbreaking innovation can be applied.

Incremental innovations in rail transport result from gradual improvement of a product, mainly due to exhaustion of the technical or organizational potential of the railway technology process being applied. They can be implemented for example by:

- A modern approach to systems of safety management in rail transport,
- A modern approach to systems of maintenance management in rail transport,
- Benchmarking of supply chains.

Benchmarking of supply chains is essential for efficient and effective risk management, since technology transfer can occur on its basis. Benchmarking of supply chains means a process of continuous search, measuring and adapting solutions used to improve efficiency and effectiveness of the chains according to customers' expectations, based on best standards in their best links and competitive partner relationships [2].

Groundbreaking innovation in rail transport means using new railway technologies, which require newer devices, new professional specialities and new materials.

Both incremental and groundbreaking innovations can be implemented through skillful transfer of technologies that have already been used in railway systems of other countries, where there is a higher technical culture of railway transport operation.

The advantage of using technology transfer, based on a contract authorizing the company to use technology that has already been tested by its legal owner or user, is reduced risk due to the fact that the applied solution has already been implemented elsewhere. Consequently, time of entering the market is shorter and there is impetus conducive to developing internal capabilities in the area which the technology concerns [3]. In current Polish conditions this may relate in particular to:

- ETCS systems – the European Train Control System, which ensures operation of the cabin signalling system and continuous control of engine driver's work;
- Diagnostic testing of railway vehicle wheel sets without disassembling its parts, and diagnostic testing of other key parameters that affect technical and operational conditions and safety of railway traffic;
- New technologies supporting basic operational functions which affect safety and monitoring of operating parameters;
- Test – measuring equipment, essential to apply in rail transport;
- Modern descriptions of construction, maintenance, adjustment and repair of assemblies and wagon components, drawings, diagrams, measuring cards, and sample measurement tools.

An important advantage of technology transfer, also in rail transport, is the transfer of research findings, for example introduced into economy by means of a patent. However, timing of the transfer and efficiency of implementation procedures are important. Systemically, it is worth seeing it from the angle of the implemented technological strategy, which Dogson understands as an understanding inside the company, first by senior management and then by the whole organization, of technology importance and potential because of its competitive impact on how the potential can be used in future and how it complements other elements of the strategy, such as finance, marketing and HR [4].

An important factor strongly creating and accelerating the transfer of railway technologies in Polish conditions may be establishing cluster initiatives. According to one definition, a cluster is a geographical centre of specialized companies (mostly SMEs) operating in related sectors, linked with the network of public and private institutions supporting their activity. There are market and non-market links between companies resulting from the exchange of goods and information. Behaviour of individual companies is determined by a sense of relationship and community with other companies from related sectors, operating in this location [5].

Therefore, an objective of railway clusters may be building successful cluster initiatives to create favourable conditions for development of companies operating in the railway industry. This enables consolidation of the railway sector, technology transfer, technological benchmarking and creating innovative solutions for railway traffic. This objective can be achieved thanks to the effect of synergy between participants of cluster initiatives. Linking comprehensive actions to develop the railway sector by building mechanisms of effective rail technology transfer to Poland may significantly reduce the risk of adverse events in the sector.

4. Basic assumptions of implementing a system of risk management in the railway company

An important element in the concept of implementing a system of risk management in rail transport is conducting a multidimensional, comprehensive and thorough analysis of the status quo to identify solutions used in a company, related to technical risk management. Technical risk is a part of operational risk, which can be defined as risk arising from inadequate or defective internal processes inside the organization, inadequate or defective work of people or systems, as well as external events. The definition also includes legal risk but strategic risk and the risk of damaging reputation are excluded [6]. Operational risk consists of two different sets of events. On the one hand we deal with relatively minor and repeatable events. They are themselves predictable, and probability of their occurrence and the total loss owing to them are easy to calculate. On the other hand, there are rare events, fraught with consequences, often bearing the hallmarks of a disaster (major events) [7].

The sample programme of implementing the Integrated Risk Management System is presented below.

Stage I

1.1 Identifying solutions used in risk management.
1.2 Defining principles of decision making in a railway company.
1.3 Evaluating effectiveness of applied and designed solutions, especially in the context of their actual impact on probability and consequences of the risk materialization.
1.4 Conducting an analysis of benefits from implementing a technical risk management system, together with showing the stakeholders of the solution.
1.5 Preparing a report summarizing the situation in the area of risk management, indicating the major categories of risk.

Stage II

2.1 Developing the Technical Risk Management Policy.
2.2 Standardizing concepts and definitions of a risk management system.
2.3 Developing procedures and tools used to identify risk within the framework of the established categories.
2.4 Developing methodology of risk assessment, i.e. determining the level of significance.
2.5 Developing a map and risk register.
2.6 Establishing risk hedging instruments.
2.7 Establishing risk control measures.
2.8 Developing a risk management structure, i.e. distribution of duties and responsibilities of people involved in the risk management process.
2.9 Developing a process of modification and changes in the risk management system.
2.10 Establishing rules of monitoring adequacy of the Risk Management Policy and risk management procedures
2.11 Taking other important actions to enhance effectiveness of the solutions.

Stage III

3. Conducting varied staff trainings, depending on their role in the designed risk management system.

Stage IV

4. Giving presentations of the designed Risk Management System to the company top management.
5. Identifying, analyzing and assessing risks and establishing instruments of conduct aimed at reducing probability and impact of their occurrence and determining control measures.
6. Establishing schedules of the Risk Management System implementation.
7.1. Conducting a general analysis of the main processes carried out in the company, together with identifying key people responsible for their course.
7.2 Acquiring information about risks, using the developed tools and methodologies.
7.3 Identifying market risk in the context of technical risk.
7.4 Identifying operational risk in the context of technical risk.
7.5 Identifying financial risk in the context of technical risk.
7.6 Conducting a risk analysis of probability and impact of its occurrence, specifying a level of its significance.
7.7 Creating a risk map.
7.8 Determining the appetite for risk in the context of identified business objectives of the company.
7.9 Establishing a way of dealing with risks, identified and evaluated, for example by using financial hedging instruments.
7.10 Establishing control measures for the identified risk.
7.11 Developing a list of key risk types.
7.12 Developing plans of responding to key risks.
7.13 Establishing risk owners, together with handing over appropriate tools used to manage risks.

Stage V

8.1 Developing accounting principles and rules of recognising hedging instruments, authorised for use in the company, in the financial statements.
8.2 Developing principles, procedures and methodologies of security accounting, including measuring security effectiveness.
8.3 Preparing a staff training on implemented solutions.
8.4 Preparing a staff training on implemented solutions.
9. Designing and supporting implementation of separate risk management infrastructure elements, i.e. inter alia: a course of risk management processes, designing and preparing requirements for IT tools supporting risk management.

Stage VI

10.Developing a communication system for risk management.
11. Establishing a specimen of documents reporting the situation regarding risk and determining frequency of drawing them up and the rules for monitoring risk.
12. Developing a methodology of assessing effectiveness of the Risk Management System.
13. Preparing a final report including a summary of implementation and recommendations on effective use of the Risk Management System in future.

5. Practical implementation of the Risk Management System according to the adopted model

The fundamental activities that are necessary to implement the risk management system properly are presented and explained in the following paragraphs.

5.1. Conducting a general analysis of main processes in the company together with identifying key people responsible for their course

In this area you should identify processes related to company activities that are of particular importance for the occurrence of the related risks.

A proposal to integrate a process approach with identification of risk in the processes is shown in Table 2

Table 2. Integration of a process approach with identification of risk in the processes

No.	Process type:	Process owner	Risk arising in the processes	Risk owner
	Main processes: 1. 2. n			
	Fundamental processes: 1. 2. n			
	Supporting processes: 1. 2. n.			
	Management processes: 1. 2. n.			

Source: own study

5.2. Acquiring information about risks, using the developed tools and methodologies.

A list of risk types together with their categorization should be developed, as a result of both the audit of solutions applied in a company and related to protection against risk and a process and historical event analysis, as part of the retrospective method and analyses of secondary data (historical events that have had, or will have an impact on safety). Techniques of event identification are used to do it.

5.3. Conducting a risk analysis of probability and impact of its occurrence, specifying a level of significance.

Numerous methods of analyzing technical systems, which can be used to identify hazards and assess risks, include inter alia:

- Hazard and Operability Study (HAZOP),
- Failure Mode and Effect Analysis (FMEA),
- Fault Tree Analysis (FTA),
- Event Tree Analysis (ETA),
- Preliminary Hazard Analysis (PHA),
- Human Reliability Assessment (HRA).

Table 3. A sample methodology of technical risk scoring assessment

	1	2	3	4	5
Description	Rare	Unlikely	Average	Probable	Almost certain
Probability	0-20%	21-40%	41-60%	61-80%	81-100%
Scoring	**Description**	**Criteria**			
		Financial	**Organizational**	**Health and Human safety protection**	**Reputation**
5	Catastrophic	Financial loss > 500.000	No achievement of key goals	Loss of life	Press reports in the whole country
4	Serious	Financial loss 100.000 PLN < 500.000 PLN	No achievement of a key goal	Serious injuries	Some information in the national media
3	Average	Financial loss 10.000 PLN < 100.000 PLN	Activity disruptions	Injuries	Some information in the local or regional media
2	Small	Financial loss 100 PLN < 1.000 PLN	Few activity disruptions	Small injuries	Limited information in the local or regional media
1	Insignificant	Small financial loss < 100 PLN	Short activity disruptions	Small injuries	Poor information in the local and regional media

Source: own study

Table 4. A sample methodology of technical risk scoring assessment

No.	Probability
1	0-20%
2	21-40%
3	41-60%
4	61-80%
5	81-100%

No.	Loss level
1	Financial loss up to 1% of revenue
2	Financial loss from 1% to 5% of revenue
3	Financial loss from 5% to 10% of revenue
4	Financial loss from 10% to 20% of revenue
5	Financial loss over 20% of revenue

No.	Risk security
1	Non-procedural security
2	Procedure-established security
3	Procedural security, integrated into a comprehensive risk management system
4	Validated security

Source: own study

Technical risk assessment can be used in the context of:

- **Risk significance / probability of occurrence.** (**Risk significance**: Catastrophic – loss below 100 mln PLN, main – loss from 10 to 100 mln PLN, average – loss from 2 to 10 mln PLN, small – loss from 0.5 do 2 mln PLN, insignificant – loss smaller than 0.5 mln PLN.
- **Probability of occurrence** – up to 1 quarter, within 1 year, from 1 year to 2 years, from 2 to 5 years, over 5 years.

5.4. Creating a risk map

In order to design a risk map, key areas where technical risk may occur are defined in the process of identifying risk-causing phenomena.

A sample model of risks occurring in the process of railway infrastructure management is presented in Fig.1

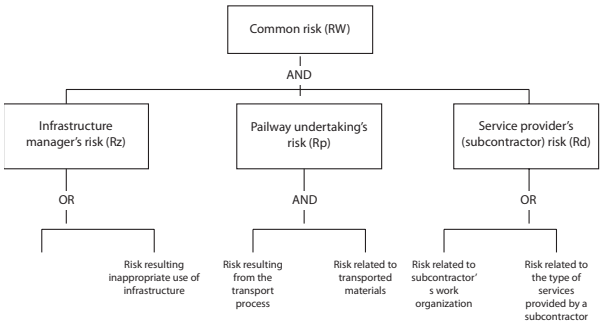

Fig.1 Risk of the railway infrastructure management process
Source: own study

Process risk assessment plays a key role, both in the activity of an infrastructure manager and a railway undertaking.

5.5. Determining the appetite for risk in the context of identified business objectives of the company

In the process of implementing the risk management system:

- a level of the appetite for technical risk is set,
- cohesion of the implemented processes with the appetite for risk is evaluated.

5.6. Establishing control measures for the identified technical risk.

Risk limits related to company processes that are carried out are set. Risk limits are accepted levels of deviations in implementing individual processes.

5.7. Developing a list of key risks.

Such risks are identified among the selected risks related to company economic activity that could potentially make the biggest losses.

5.8. Developing plans of responding to key risks

A response to risk may include avoiding, limiting, sharing and accepting technical risk. Such activities related to the risk occurred are recommended that will be most efficient, effective and risk appetite – related.

5.9. Establishing risk owners, together with handing over appropriate tools used to manage risks

A management structure facilitating a risk management process should be developed. It is recommended to appoint top management representative and risk management coordinators. In addition to these functions, there are process owners and risk owners.

5.10. Establishing a specimen of documents reporting the situation regarding risk and determining frequency of drawing them up and the rules for monitoring risk

The basic document in the risk management process is a risk card. The cards are updated on a regular basis and quarterly, after meetings of the risk management commission.

5.11. Defining principles of monitoring risk

Mainly the risk that is a deviation from the planned costs is reported in the risk management process. It is necessary to estimate the amount of loss and probability of risk occurrence.

5.12. Developing a communication system for technical risk

Implementation of the risk management system should be announced in an organization through a technical risk management policy and determining an appropriate organizational structure conducive to efficient and effective risk-related communication.

6. Conclusion

Technical risk management is now an indispensable part of managing companies operating in the railway transport sector. A company should link objectives with risks affecting them, pursuant to the adopted methodology. This should be realised in accordance aguarantees company business stability in the difficult internal and external environment, full of strategic uncertainty.

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