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RIPRAN – one of the best project risk analysis methodologies

1. Introduction

Project risk management remains a relatively undeveloped discipline, distinct from the risk management used by operational, financial, and underwriters' risk management. This gulf is due to several factors: risk aversion (especially the public understanding and risk in social activities), confusion in the application of risk management to projects, and the additional sophistication of probability mechanics above those of accounting, finance, and engineering. With the above disciplines of operational, financial, and underwriting risk management, the concepts of risk, risk management, and individual risks are nearly interchangeable (being either personnel or monetary impacts, respectively).

Impacts in project risk management are more diverse, overlapping the monetary, schedule, capability, quality, and engineering disciplines. For this reason, it is necessary to specify the differences in project risk management as they are cited in the *Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs* (2017).

- **Risk management:** The organizational policy for optimizing investments and (individual) risks to minimize the possibility of failure.
- **Risk:** The likelihood that a project will fail to meet its objectives.
- **A risk:** A single action, event, or hardware component that contributes to an effort's overall "risk".

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According to ČSN ISO 31 000:2009 (2009, p. 10), term **risk** is defined as the "effect of uncertainty on objectives. An effect is a deviation from the expected – positive and/or negative. Objectives can have different aspects (such as financial, health and safety, and environmental goals), and can apply at different levels (such as strategic, organization-wide, project, product, or process)." By definition of risk by ISO 31000:2009, it is possible to divide risks into the categories of positive risks (opportunities) and negative risks (threats).

Risk management is then defined by PMBoK (2013, p. 126) as "the systematic process of identifying, analyzing, and responding to project risk. It includes maximizing the probability and consequences of positive events and minimalizing the probability and consequences of adverse events to project objectives." An improvement on the PMBOK definition of risk management is to add a future date to the definition of a risk. Mathematically, this is expressed as a probability multiplied by an impact, with the inclusion of a future impact date and critical dates. This addition of future dates allows for predictive approaches.

Good project risk management depends on supporting organizational factors, having clear roles and responsibilities, and a technical analysis.

Chronologically, project risk management may begin with recognizing a threat or by examining an opportunity. For example, these may be competitor developments or novel products. Due to the lack of a definition, this is frequently performed qualitatively or semi-quantitatively using product or averaging models. This approach is used to prioritize possible solutions where necessary. In some instances, it is possible to begin an analysis of the alternatives, generating cost evaluations and developing estimates for potential solutions.

Once an approach is selected, more-familiar risk management tools and a general project risk management process may be used for the new projects.

– Planning risk management.
– Risk identification and monetary identification.
– Performing a qualitative risk analysis.
– Communicating the risk to stakeholders and the funders of the project.
– Refining or iterating the risk based on research and new information.
– Monitoring and controlling risks.

Finally, risks must be integrated to provide a complete picture, so projects should be integrated into an enterprise-wide risk management framework to seize the opportunities related to the achievement of their objectives.

According to ISO 31 000:2009 (2009, p. 11), it is possible to define a **Risk management framework** as a "set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing, and continually improving risk management through the organization."

The five main steps that usually create risk management framework are as follows:

- **Risk identification.** A process of recognizing, finding, and describing risks.
- **Risk analysis**. A very important process. A team must assess the probability and impact of any risks that will be identified in the process of risk identification.
- **Risk evaluation**. In this phase, a manager must compare the results of a risk analysis with the risk criteria that will be established. The manager must determine each risk and find out if its magnitude is acceptable or unacceptable.
- **Risk treatment**. This process is possible to define as the process of modifying risk.
- **Monitoring, review, communication, and control**. Monitoring is continually checking, determining, and observing the status of a risk.
- **Risk management components** allow planners to explicitly address uncertainty by identifying and generating metrics, parameterizing, prioritizing, and developing responses, and tracking risk. These activities may be difficult to track without techniques, documentation, information systems, and various tools.

There are two distinct types of risk tools that are identified by their approach: the capital asset pricing model (CAP-M) and probabilistic risk assessment (PRA). These are the mainstays of project risk management and are classified by the quality and fidelity of the information required for their calculations. Market-level tools use market forces to make risk decisions between securities. System-level tools use project constraints to make risk decisions between projects. Component-level tools use the functions of probability and impact of individual risks to make decisions between resource allocations (Projektová rizika, 2017).

The presented paper presents one of the best risk management analyses in the theoretical and practical viewpoints (RIPRAN – of Czech origin) that can be used not only in the Czech business environment but worldwide.

2. Methodology

The aim of the presented paper is to demonstrate how to use RIPRAN (Czech project for risk analysis) as the main part of a feasibility study of a new product project in a manufacturing company. To fulfill this primary goal, we formulated the following secondary aims:

- To provide a critical analysis of the available information sources dealing with risk management in new product projects in manufacturing companies.
- To study and profoundly understand the RIPRAN project, risk analysis, its history, application, principles, rules, and exceptions.

– To discuss with the author of RIPRAN about the RIPRAN application in new product projects in manufacturing companies of non-Czech origin.
– To compile a feasibility study of the new product project.

All of these highly cited secondary aims were fulfilled. A short overview of the risk management topic as well as RIPRAN's characteristics and definition are part of the presented paper. To process this theoretical part of the paper, we used mostly analysis, synthesis, comparison, and deduction. We studied monographs, journals, and internet links with the impact of each source's topicality. The used sources are cited in the list of references.

During the process of a feasibility study of a new product project provided through the analysis of our own experience, we discussed the application of the RIPRAN method to a new product project with the author of this method. We realized e-mail correspondence, phone discussions, and finally a personal meeting to control the whole RIPRAN analysis document and discuss the method's application in the non-Czech origin business environment.

To fulfill the primary aim of presented paper, we decided to use the case study method.

3. Risk management

As cited in Lacko (2017), the issue of risk management is very current today. This is not only due to the fact that the market economy is risk-based; there are other reasons why there is often a risk today. The current global marketplace presents many threats for each company that must be identified by the company's personnel whichever area they come from (technical, economic, financial, or personnel), and they must prepare the appropriate measures to reduce these risks. The current turbulent environment full of changes resulting mainly from the rapid scientific and technological development (as well as those that are the consequence of solving many of our society's problems and changes in nature) presents a source of many potential threats to the economy of all companies.

Recently, a number of legislative measures have been issued requiring risk analysis at a professional level (e.g., the new labor code – occupational safety risks, a new safety machine approval regulation, the risk of data leakage that is subject to the privacy act, etc.) or in other contexts (e.g., IS risks – theft of a new product's data, etc.). For many Czech companies (especially recently established ones), this issue is new. In addition, the necessary Czech publications on risk engineering and the application of risk engineering in selected areas are lacking that would reflect current progress and demands in this area. A contribution in this direction is Professor Tichy's publications (Tichý, 2006 or Tichý and Valjentová, 2011), which present a very good overview of the issue of risk management for those who need to get acquainted with this issue in detail.

Project management must necessarily consider the potential threats to a project, so risk analysis is a necessary part of it (as is presented in Mozga and Vítek 2001). Of course, this also applies to the design and management of information technology projects (as highlighted in the university textbook by Krajčík [Krajčík, 2006, p. 82]), because risk management is a part of the project manager's work (see the specification of the project manager's professional knowledge developed by Trávník [Trávník, 2004]).

Other available publications that are relevant to the Czech environment regarding this topic are Korecký and Trkovský (2011), Mareš et al. (2013), or Doležal et al. (2013).

The requirements for quality risk analysis are increasing in such projects as complex engineering and of other complexes (e.g., mechatronic systems, automation systems, robotic systems). Given the high financial budgets of such projects, there is a need to look into ensuring a high probability of the successful completion of such projects (Lacko, 2017).

The underestimation of project risks in some of our firms and projects often comes from the ignorance of risk engineering issues or from overlooking the issue of risk management (as is reported in Weinberger (2005, p. 28–31). Professional risk management requires not only the necessary knowledge of the risks (Tichý, 2006; PMBoK, 2013) but also knowledge of the methods that allow for a qualified risk analysis. A good project risk analysis is part of the quality management of the project (PMBoK, 2013; ISO 31 000:2009; Doležal et al., 2012 or Kreslíková and Kubát, 2003). Therefore, this knowledge should be a part of the required knowledge of a project manager (Marsina, 2009). Only a formal statement of the type ("The project could endanger the lack of awareness of possible educational events, so it is necessary to devote the sufficient publication of courses in the regional press" or "The project could significantly endanger the delayed delivery of program modules by external firms") is necessary to consider as an insufficient output from the project risk analysis (note the generality and absence of any quantified facts!).

The RIPRAN method (which is the subject of the presented paper) complements a set of methods such as the UMRA or risk matrix scoring method, which can be used for high-quality project risk analysis (Tichý, 2006; Podmolík, 2006).

Many Czech projects fail, as confirmed by a number of studies and surveys (e.g., Knapp et al., 2015 or Doležal, 2016). Despite the warnings of many authors (Weinberger, 2005, p. 25–38; Kubiš, 2002, p. 109–116 or Szabo, 2005, p. 1–8), the attention on risk issues or risk analysis is performed poorly, unprofessional, and is still very low.

RIPRAN enables project teams to carry out risk analyses at a quality and professional level.

4. RIPRAN

The RIPRAN™ method (RIsk PRoject ANalysis) represents an empiric method for project risk analysis. The author of the method is Branislav Lacko.

It issues from the process notion of risk analysis, understanding risk analysis as a process (inputs in a process – outputs from the process – activities transforming inputs to outputs with certain goals).

The method accepts quality philosophy (TQM) and, therefore, covers activities that provide for the quality of the risk analysis as required by the ISO 10 006 standard. The method is designed in order to respect the principles of risk project management (as described in the PMI and IPMA materials).

It especially focuses on the processing of analysis or the project risks that must be done prior to its implementation.

However, this does not mean that we should not be working with threats in other phases. In each phase of a project's life cycle, we should carry out activities (this relates mainly to pre-project phases – opportunity studies and feasibility studies) that lead to the gathering of data for the project risk analysis for the project implementation phase and evaluate the potential risks of success of the particular phases on which we are actually working. The captured risks are then used for the overall analysis of the project risks. The RIPRAN method may be used in all phases of the project.

The whole process of risk analysis following the RIPRAN method consists of the following phases:

- Preparation of the risk analysis.
- Identification of the risk.
- Quantification of the risk.
- Response to the risk.
- General assessment of the risk.

Activities in the individual phases are designed as a consequent series of processes.

The method does not deal with the process of monitoring risks in a project. Whenever some new danger is identified or the situation changes and requires a re-evaluation of a certain risk, it is possible to use the RIPRAN method again (also during the monitoring of the project risks).

5. Case study of project risk management

5.1. Timeline of risk analysis

This documentation of a risk analysis is provided as a main part of a feasibility study of the PRJ 001325 PFC project, which covers the patent of a new product in a manufacturing company. The timeline of this risk analysis is from 08 March 2017 – 16 March 2018. This time frame is sufficient to assess the main risks that can affect the project.

5.2. Creating a team for risk analysis

For this risk analysis, professionals were chosen who already have a lot of skills with similar projects:

– Project manager.
– Electrical design engineer.
– Manager of electrical design department.
– Global project manager.

5.3. Risk management context

The core team that was established for risk assessment chose the following scales of likelihood, impact, and risk level (see Tabs. 1–4).

Table 1

Table of probability scale

Item description	Scale
Very high probability – VVP	more than 0.8
High probability – VP	from 0.6 to 0.8 (included)
Middle probability – SP	from 0.4 to 0.6 (included)
Low probability – NP	from 0.2 to 0.4 (included)
Very low probability – VNP	below 0.02 (included)

Source: RIPRAN 2017, own solution

Table 2

Table of impact scale

Item description	Scale
Very high impact – VVD	more than €3800
High impact – VD	from €2500 to €3800 (included)
Middle impact – SD	from €1500 to €2500 (included)
Low impact – MD	from €750 to €1500 (included)
Very low impact – VMD	below €750 (included)

Source: RIPRAN 2017, own solution

Table 3

Table of risk level

Item description
Very high risk – VVHR
High risk – VHR
Middle risk – SHR
Low risk – NHR
Very low risk – VNHR

Source: RIPRAN 2017, own solution

Table 4

Table of acceptable/unacceptable risk level

	VVD	VD	SD	MD	VMD
VVP	VVHR	VVHR	VHR	VHR	SHR
VP	VVHR	VVHR	VHR	SHR	NHR
SP	VHR	VHR	SHR	NHR	NHR
NP	VHR	SHR	NHR	VNHR	VNHR
VNP	SHR	NHR	NHR	VNHR	VNHR

Source: RIPRAN 2017, own solution

5.4. Risk identification

According to the RIPRAN methodology, the team identifies the greatest threats that may affect the project. The team has to create a scenario for each risk. For the risk identification, the team used the brainstorming method (see Tab. 5).

Table 5

Identification of the risks

Risk no.	Threat	Scenario
R1	Patent is impossible to sell	If the research and development of the product takes a lot of time and the project will be delayed, the product may lose its features and characteristics that are possible to patent.
R2	Timeline, schedule, and budget are not in balance	If the project obtains a timeline, schedule, budget, and manpower characteristics that do not respect each other, it may cause a delay in the project or it can influence other project objectives.
R3	Poorly defined project objectives	Unclearly defined project objectives of a product can cause a project delay or a project stoppage.
R4	Impact of trend and market objectives on the project	The market is very dynamic and market forces influence the market. One of the market forces is the customer's expectation, which is very important and can affect the project's approval.
R5	Government and market restrictions	Government and market restrictions may affect the project if they are changed on the go. For example, a change in an ISO standard, a new law or change in legislation, etc.
R6	Patent infringement	The competitors may be faster in the research and development of a similar product. If they develop their new product earlier, they can patent it sooner; later on, our patent can cause an infringement of patent rights.
R7	Prioritization of human resources	The company regularly researches and develops new products and often uses a similar combination of human resources within various teams. Since each project has a different priority for the company, this can cause issues in the timely delivery of the project.
R8	High buyer power	This type of product has a very characteristic and narrow group of customers. In the sector for which this product is targeted, the differences between the competitors and substitute products are very small. There are also a lot of barriers in the market areas. Specifically, there are very high technology protection parameters for this product.

Table 5 cont.

Risk no.	Threat	Scenario
R9	Threats of substitutive and new entrants	The costs and time for the entry in this sector are very low. Each entrant has to have very good knowledge about the product specifications, product options, and customer expectations.
R10	Insufficient communication	Insufficient communication might have a negative impact on the project, project communication objectives, and communication between the core team and the stakeholders.
R11	Refusal of the project	A project may be refused or stopped because of its overtime or over cost.
R12	Insufficient team knowledge and skills	The product is very new for the organization. Employees have insufficient knowledge and skills for the research and development, manufacture, and sale of the product.
R13	In the past, the team worked together on many other projects.	The group of people that will establish the core team worked efficiently together on other similar projects in the past. This is a positive fact and it is an advantage of this project.
R14	The product does not follow the objectives that must be met to obtain CE certification.	If a company wants to sell a product on the EU market, it needs to have CE certification. The objectives that must be met to obtain this certification are very strict. A product without CE certification is impossible to sell on the EU market.

Source: RIPRAN 2017, own solution

5.5. Risk quantification

In this phase, the team has to assess the risk probability and impact, calculate the risk value, and choose the proper risk level. Risks were quantified by the brainstorming method (see Tab. 6 and Fig. 1).

Table 6

Quantification of risks

Risk no.	Threat	Probability	Impact	Risk value (Level)
R1	Patent is impossible to sell	0.5 – SP	€37000– VVD	VHR – N
R2	Timeline, schedule, and budget are not in balance	0.25 – NP	€1200 – MD	VNHR – A
R3	Poorly defined project objectives	0.2 – NP	€500 – VMD	VNHR – A

Table 6 cont.

R4	Impact of trend and market objectives on the project	0.6 – SP	€20000 –VVD	VHR – N
R5	Government and market restrictions	0.25 – NP	€1300 – MD	VNHR – A
R6	Patent infringement	0.1 – VNP	€3000 – VD	NHR – A
R7	Prioritization of human resources	0.35 – NP	€700 – VMD	VNHR – A
R8	High buyer power	0.3 – NP	€1200 – MD	VNHR – A
R9	Threats of substitutive and new entrants	0.4 – SP	€0850 – MD	NHR – A
R10	Insufficient communication	0.2 – NP	€1200 – MD	VNHR – A
R11	Refusal of the project	0.4 – SP	€1000 – MD	VNHR – A
R12	Insufficient team knowledge and skills	0.3 – NP	€2500 – SD	NHR – A
R13	In the past, the team worked together on many other projects.	0.5 – SP	€500 – VMD	NHR – A
R14	The product doesn't follow objectives that must be met to obtain CE certification.	0.35 – NP	€4000 – VVD	VHR – N
R15	Insufficient support	0.3 – NP	€2000 – SD	NHR – A

Source: RIPRAN 2017, own solution

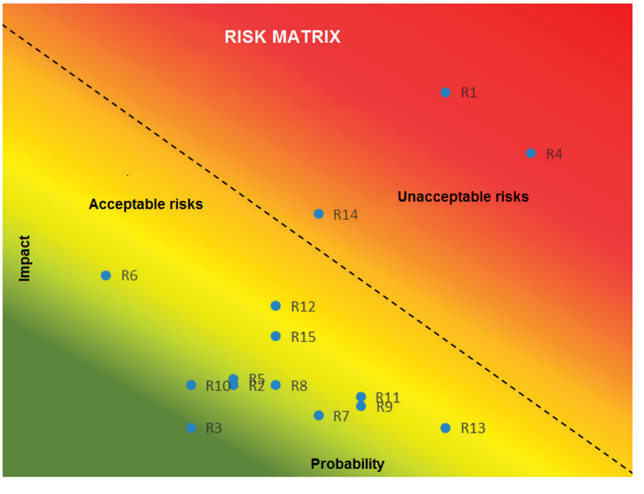

Figure 1. Risk matrix

Source: RIPRAN 2017, own solution

5.6. Response to risks

In this phase, the project team defines their ideas for reducing the risks. For a better description of each risk, we used the Monte Carlo simulation to better describe the risk characteristics.

5.7. Risk: R1 – Patent is impossible to sell

Scenario: The patent may be impossible to sell because of a delay in the phase of the project research and development. The next reason is the fact that the process to obtain a license for the patent takes a lot of time. Usually, the process to obtain a license for a patent takes about 4 years on average. If these delays occur, it may lead to increase in costs, changes in customer expectations, or a change in the conditions on the market (i.e., new entrants, substitutive products, etc.).
Simulation of risk R1 is seen in Figure 2.
Probability: 0.5 SP.
Impact: €36,000 VVD.
Risk value: 17.6 VHR – N.

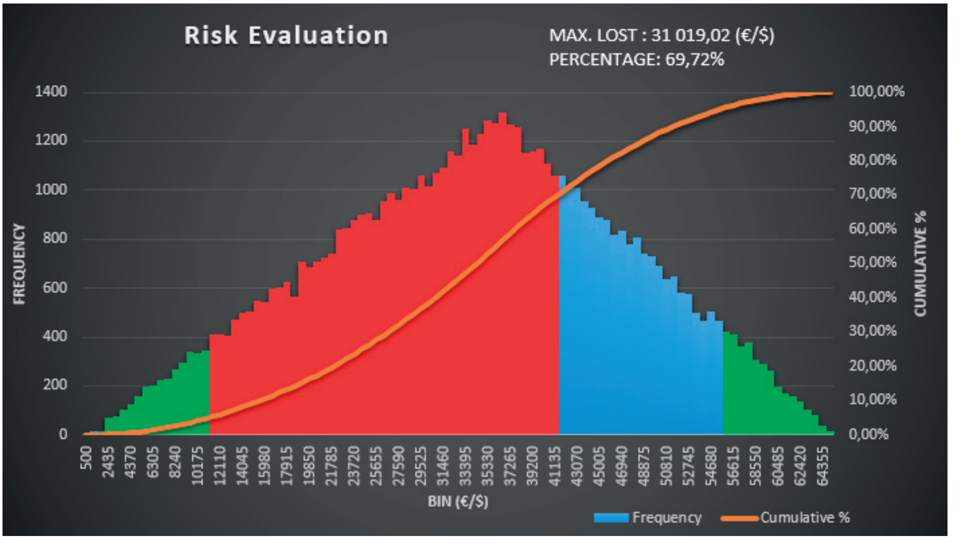

Figure 2. Simulation of risk R1

Source: RIPRAN 2017, own solution

Mitigation plan: patent insurance by Industrial Property Office of the Slovak Republic.
Risk owner: project manager.

Apply mitigation plan on: April 08, 2017.
Costs to realize the mitigation plan: €5500/year × 3 years = €16,500.
New probability: 0.02 VNP.
New impact: €36,000 VVD.
New risk value: 0.8 SHR – A.
Effectiveness of the action: 1.02.

5.8. Risk: R4 – Impact of trend and market objectives on project

Scenario: The market is very dynamic, and the market variables influence the market. One of the market's variables is customer expectation, which is very important and can affect the project's approval.
Simulation of risk R2 is seen in Figure 3.
Probability: 0.6 SP.
Impact: €20,000 VVD.
Risk value: 12 VHR – N.

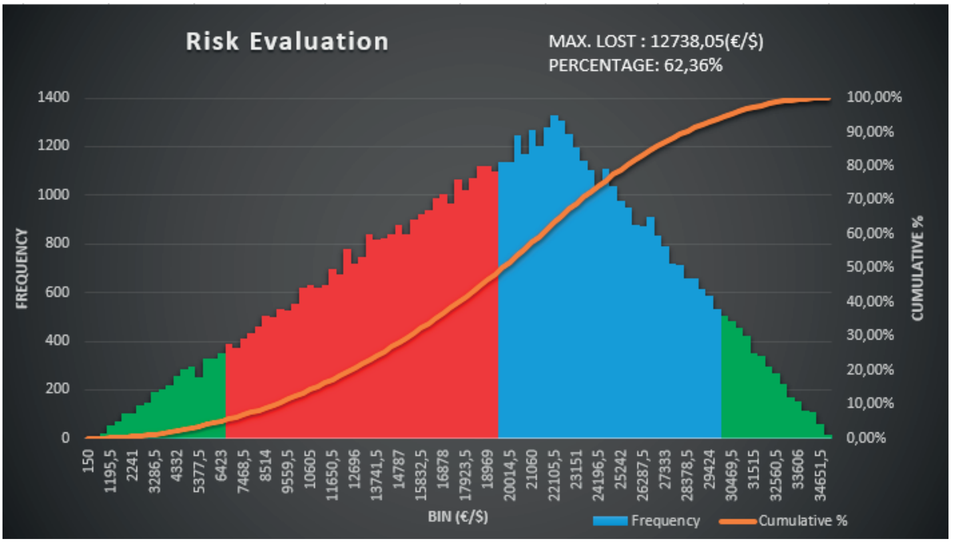

Figure 3. Simulation of Risk R4

Source: RIPRAN 2017, own solution

Mitigation plan: Regular monitoring of various aspects (one market research session per three months), which can influence the market environment and may subsequently affect the project objectives. The marketing department has to analyze new trends in the sector and new regulatory objectives every three months.

Risk owner: project manager, marketing department.
Apply mitigation plan on: May 1, 2017.
Estimated costs to realize the mitigation plan: €5,200.
New probability: 0.02 VNP.
New impact: €20,000 VVD.
New risk value: 0.4 SHR – A
Effectiveness of the action: 0.58

5.9. Risk: R14 – Product does not follow objectives that must be met to obtain CE certification

Scenario: If a company wants to sell a product on the EU market, it needs to have CE certification. The objectives that must be met to obtain the certification are very strict. A product without CE certification is impossible to sell on the EU market. Simulation of risk R3 is seen in Figure 4.
Probability: 0.35 NP.
Impact: €4000 VVD.
Risk value: 1.4 VHR – N.

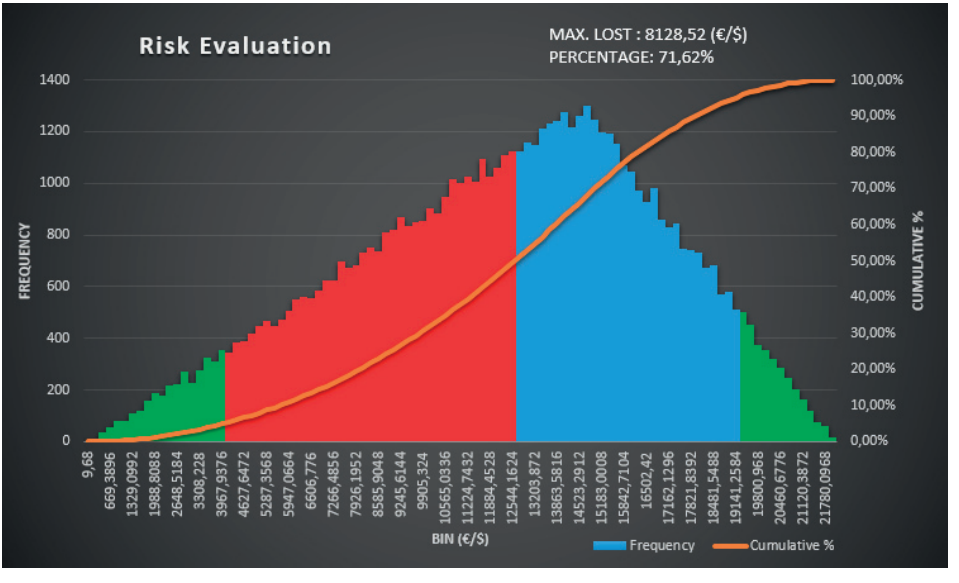

Figure 4. Simulation of Risk R14

Source: RIPRAN 2017, own solution

Mitigation plan: The research and development of the product is in accordance with the standards of CE certification. The changes in the standards are very dynamic. During the research and development phase, it is mandatory to meet the recommended values that are established in the standards of the certification.
Risk owner: project manager, electric design engineer.
Apply mitigation plan on: April 11, 2017.
Estimated costs to realize the mitigation plan: €3000.
Probability: 0.2 NP.
Impact: €2000 VVD.
New risk value: 0.4 SHR – A.
Effectiveness of the action: 0.33.

5.10. General risk assessment

Using the RIPRAN analysis, we can conclude that the project has 15 main risks that were identified and then evaluated by the project risk team. We can also conclude that, except for the three greatest unacceptable risks, all of the other evaluated risks are acceptable.

The team dealt with the three most impactful risks and developed mitigation plans to decrease their impact on the project. We want to regularly monitor and control these analyzed risks on a monthly basis. The project risk team will provide an analysis every two months.

6. Conslusion

Nowadays, project management provides a lot of various high-level project methodologies. Unfortunately, project managers do not always employ the wide range of options offered in the methodologies. In general, project risk assessment in Central Europe is usually performed in very simplified forms. The main goal of this paper was to apply the RIPRAN methodology to a specific case study and to show its advantages and disadvantages.

The used RIPRAN methodology is a very good method that is possible to apply to assess almost all projects. Utilizing the RIPRAN methodology, the core team analyzed 15 main risks that can influence a project. These risks were analyzed by a company without a risk culture. Three out of the 15 analyzed risks were identified as unacceptable risks. To lower the risks and decrease the impact on the project, the project risk team developed mitigation plans. At the end of the RIPRAN methodology process, the team created communication, review, and control objectives as well as a process.

We can state that the used methodology can be applied to almost any type of project and almost every lifecycle phase of a project. It is very easy to understand the methodology process as well as its input and output objectives, and it is also easy to use this methodology in practice. It is possible to use this methodology even if the project team has lower levels of skills and knowledge of risk management characteristics. One of the advantages of this methodology is that it can be extended by other objectives based on the project's nature.

Therefore, we recommend the following risk documentation principles during the usage of the RIPRAN method:

– Each phase should be documented by a separate document that specifies this risk analysis phase that was performed for which project. The document should clearly indicate when the material was elaborated, who approved it, and other similar formalities.
– Suggestions of identification, quantification, and analysis can be done either in the form of a spreadsheet or simply by using a list of all of the facts for each risk.
– A simple form of structured enrollment can be used for the first and last phases.
– Similarly, the final report may be worked in the form of a structured entry.
– If the tables and other materials used are not normally available in the company or do not arise from any other facts (guidelines, methodological guidelines, etc.) where they are important to understand the used process, it is necessary to attach such materials to the documentation as attachments so it is clear which auxiliary materials and sources were used.

At present, it is necessary to prefer the electronic form of all documents, so all output documents should be in electronic form and also archived in electronic form.

A current overview of the risks should be supported by a "risk register" for the appropriate project. This can be solved as a simple table created in MS WORD or, respectively, MS EXCEL, both of which represent simple options to support the work of the project team or, as a database, using a sophisticated database system using SQL principles. The use of a client/server database system is the ideal solution for project risk management within corporate risk management and project management with the application of a corporate project office.

Based on our experience, we claim that the RIPRAN method can be used to support the systematic implementation of risk analysis in a systematic way so that risk analysis is implemented at a high level of quality and is achieved as an effective outcome in project risk management over time, possibly in other business processes.

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