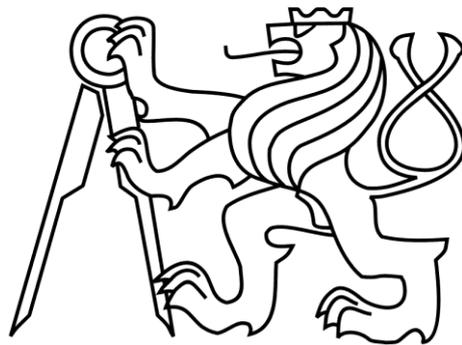


CZECH TECHNICAL UNIVERSITY IN PRAGUE

Faculty of Civil Engineering

Department of Economics and Management



RISK MANAGEMENT IN CONSTRUCTION PROJECTS

Master's Thesis

Prague 2017

Eva Honzírková



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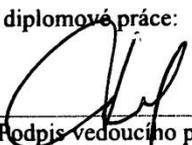
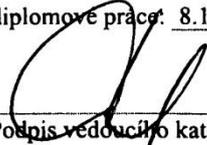
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ZADÁNÍ DIPLOMOVÉ PRÁCE

I. OSOBNÍ A STUDIJNÍ ÚDAJE

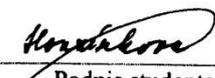
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Název diplomové práce: <u>Risk management in construction projects</u>	
Název diplomové práce anglicky: <u>Risk management in construction projects</u>	
Pokyny pro vypracování: V rámci diplomové práce bude komplexně zpracována problematika řízení rizik stavebních projektů a její význam pro jeho řízení. V praktické části práce budou analyzována data divize 3 mezinárodní společnosti Metrostav a.s. Výstupem práce bude analýza procesu řízení rizik a všech jejich aspektů v rámci řízení divize včetně vyvození konkrétních závěrů a doporučení.	
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<u>30.6.2016</u> Datum převzetí zadání	 Podpis studenta(ky)
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CZECH TECHNICAL UNIVERSITY IN PRAGUE

**Faculty of Civil Engineering
K 126 – Department of Economics and Management**

Risk management in Construction projects

Master's Thesis

Study Program: Civil Engineering
Branch of Study: Project Management and Engineering

Supervisor: Doc. Ing. Aleš Tomek, CSc.

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Prague 2017

I declare that submitted master's thesis was developed independently under the guidance of Doc. Ing. Aleš Tomek, CSc. And I properly quoted all used literature.

In Prague day:

Signature:

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Abstract

This master thesis deals with a risk management in construction project. It describes an entire process of a risk management. An issue of a risk management is very extensive and purpose of this thesis is not to describe all its areas. The thesis aims insight into risk management in the construction industry and mainly risk management in a construction project, familiar with a procedures used in risk management process, project management and project controlling. Then propose a simple model for a risk management applicable in construction company and a demonstration of its functionality on a project model example.

Generally, risk management deals with hazard identification by determining probability with which this danger can occur. This process is particularly important for further work with risk. If we do not know and are unable to identify risks, then we logically can not even work with them in any way. Main effort of every manager should be systematic work with risks, such as risk identification at every stage of a project and balance of these risks.

In the practical part there are theoretical findings on a specific construction project. For the new building project was developed model of risk management analysis, which is based on qualitative and quantative analysis. In the conclusion of the practical part is written evaluation of the analysis and design of risk measures, and the final conclusion of the work follows after this evaluation.

Keywords

Risk management, risk analysis, risk identification, risk assessment, risk measures, definition of risk, project management.

Abstrakt

Tato diplomová práce se zabývá řízením rizik ve stavebních projektech. Je zde popsán kompletní proces řízení rizik ve stavební firmě. Řízení rizik je velmi rozsáhlým tématem a cílem této práce není popsat řízení rizik se všemi aspekty, ale pouze se orientovat na řízení rizik spojené se stavebnictvím. V teoretické části je také popsán projektový management, který úzce souvisí s řízením rizik v projektech a v projektovém kontrolingu. Dále také navrhnout jednoduchý model řízení rizik, který bude jednoduše aplikovatelný ve stavební firmě, konkrétně v divizi D3, která je součástí společnosti Metrostav a.s.

Obecně, risk management pracuje s odhalováním nebezpečí, která hrozí a určováním pravděpodobnosti, se kterou tato nebezpečí mohou nastat. Tento proces je velmi důležitý při práci s těmito riziky. Pokud neznáme a nejsme schopni identifikovat rizika, pak s nimi logicky nemůžeme dále pracovat a plánovat opatření na jejich minimalizaci. Hlavní snahou každého manažera, by měla být systematická práce s riziky, jako je identifikace rizik v každé fázi projektu a vyvážení těchto rizik.

V praktické části budu praktikovat teoretické poznatky z řízení rizik na konkrétní stavební projekt. Pro nový stavební projekt byl vyvinut model analýzy řízení rizik, který je založen na kvalitativní a kvantitativní analýze. V závěru praktické části je napsáno vyhodnocení analýzy a návrhu rizikových opatření, na toto vyhodnocení navazuje výsledný závěr práce.

Keywords

Řízení rizik, analýza rizik, identifikace rizik, odhad rizika, opatření rizik, definice rizika, projektový management.

INTRODUCTION AND MOTIVATION OF WORK

Risk management is crucially important for civil engineering companies and furthermore for whole branches of business. Statistical analysis proves logical relations between companies that use a risk management and improved economic results compared with companies that use of a risk management method is not included.

Motivation processing of this work is to provide the reader with an overview in a field of risk management, their input and evaluation, as well as an overview of problematic parts of project management and design a structure of risk management for a private company. During my internship, I performed at the company Metrostav a.s., I had the opportunity to observe how the company (namely Division 3) manages the procurement and makes strategic decisions. The company has set up working procedures and controls, which are used for contract management. Division 3 has no practices and has no manuals or guidelines for risk management. Employees should mandatorily follow manuals to minimize the risks, which occurs during the process of managing.

I also had the opportunity to watch how were evaluated situations where was caused a damage. Division 3 has no comprehensive risk management system and it is possible to see how this has a negative effect on the final results of the division. Therefore I decided to handle risk management and outline the way how should a risk management system in the company look like. I believe that a properly configured system prevents threats that negatively affect the realization of contracts. I also believe that observance of risk management procedures will have a positive impact on the company's results.

Organizations from many industries have recognized the increasing importance of risk management, and many companies have established risk management departments to control the risks. Risk in construction has been the object of attention because of time and cost over-runs associated with construction projects. The construction industry and its clients are widely associated with a high degree of risk due to the nature of construction business activities, processes, environment and organization. It is generally recognized that those within the construction industry are continually faced with a variety of situations involving many unknown, unexpected, frequently undesirable and often unpredictable factors. Situations are not limited to the construction industry; it is recognized that risk is built into any commercial organization's profit structure and is a basic feature of a free enterprise system.

THEORETICAL PART

Capture 1

Risk management

Risk is something that we deal with in our daily lives. It is common to meet with many types of risk and danger everyday. We are used to face them without great emphasis.

As an example - All projects are subject to risk. As I mentioned in the abstract „If you do not know and are unable to identify the risks, then we logically can not even work with them in any way. The main effort of every manager should be systematic work with risks, such as risk identification at every stage of the project and balance of these risks. That means with which the severity will affect individual risks for the future development of the project“ After successful identifying the risks of the project follows the assessment of risks. Since each risk is certainly different weight influence. For example: When a site manager will be injured consequences of the project are significantly greater than if an ordinary worker gets hurt. Or result in losses is greater when a subcontracted steel reinforcement wouldn't be on site in time than when a subcontracted ceramic tiles are late.

„The world is in state of a constant change and survival relies on the ability to adapt to changes. Unfortunately, many project managers have not yet realised that there is a need to include project risk as a key process. It is a well known fact that managing risk has two major objectives: to avoid the downside risks and to exploit opportunities.“ [1]

Experiences so far show that the risk avoidance part of the risk management philosophy has attracted too much management attention, while the potential opportunities have been neglected. The risk avoidance strategy helps you to secure your project objectives, which for many organisations is a giant step ahead and may be the single biggest opportunity.

However, the major leaps in project cost and time reduction are results of innovative thinking with focus on exploring opportunities by challenging the risks. The difference between project success and disaster is of course more complex than managing or not managing the risk, but it appears that the number of successful projects would have been far higher if more companies had included risk management as an integral part of their project management.

In order to be described the risk management of construction projects, it is appropriate to at least briefly discuss about the definition of risk and risk management as such. When speaking about risk management, we must first define the types of risks encountered. Due to the topic of this work, here will be discussed in particular the risks of construction projects.[22]

„Risk management is a continuous, repeating a set of interrelated activities that aim to control the potential risks. It includes maximizing the results of positive events and decreasing the negative results of these risks. The purpose of risk management is to avoid problems or negative occurrence, avoid crisis management and prevent problems.” [22]

Risk management is comprised of four interrelated phases:

- Risk identification
- Risk assessment
- Risk monitoring
- Risk mastering

1.1 The definition of risk

The expression risk comes from the Italian word *risico*, who is reportedly in the 17th century, taken in connection with the ship's voyages and the danger for boats, which had to be avoided. Therefore, it reflects the risk exposure to adverse circumstances. Later, the aspect of this concept has expanded considerably. [7] At present, it is possible to define the term in several different ways in general, as a risk of harm, damage, loss or uncertainty of achieving the expected results, or as the dangers of a bad decision [22]. Therefore, the risk may arise when a deviation from the expected outcome and always has an effect on the achievement of the objectives ČSN ISO 31000 describes risk simply as “the effect of uncertainty on objectives” [5].

The risk is therefore associated with uncertainty. This means that the risk event is unexpected. We can not be sure when and if it will ever happen. The risk can be described by the situation in the interval from 0 to 1, where zero indicates an impossible plot, which is not to be considered. And number one indicates the plot that definitely occurs, and it is necessary for this situation to prepare and incorporate it into the plans. The risk therefore has two parameters that determine it: the severity of its impact (due to injury), the probability of occurrence.

The probability can be determined using statistical methods. However more often is based on the subjective estimation of experts or project team. Effect usually means negative

consequences (loss or damage). Another aspect may be its concealment, or handling. Which is a measure of how much is possible affect a risk.

1.1.1 Types of risks

The risk in the project means uncertainty, which can have a negative or positive effect on the achievement of the objectives in the project [10]. According to this definition, therefore, the risk can be seen in two ways – on the risk as an opportunity and risk as a threat. Risks can be divided according to their influence: suggestible – usually an internal risk, unsuggestible – usually external.

A suggestible risk: for example it can be a failure of workers. The risk can be reduced. While unsuggestible risks are outside a control of a project team (for example, a problem with suppliers). Sources of external risks are mainly from a micro-environment – such as political decisions. More common is this: a net risk and speculative risk. In the following text I will consider only risks with a negative impact on a project. For the record, a literature also recognizes a residual and secondary risk.

The residual risk is according to ISO 31000. It is remaining risk after risk treatment. There is no need to perform additional countermeasures to reduce. Its negative impact is negligible. It is therefore the risk is on minimum because it lies below the reference level. [5]

Secondary risk is referred to as a direct result of the implementation of prevention measures to reduce primary risks. We can share the risks and according to different criteria, to different number of groups, there is no universal classification. Non-controlled technological process, decline in production capacity. In practice depends on the characteristics of the sector (public or private) sectors of the economy as well as on the concrete specifics of the project. According to the kind of risk we can divide them [12]:

- technical-technological – risks associated with the failed development of new technologies and products
- production – mainly a risk of supplying
- operational – such as resource scarcity, unreliability of a production facilities
- economic – mainly risks associated with growth of a cost (resources price increase)
- financial - risks associated with a method of financing of a project, ability to pay liabilities (risk tied to a liquidity)

- risk of market – mostly risks of demand and price - dependent on the demand for the product, project, sales volumes, pricing
- legislative – a risk lies in an amendment of laws (for example, tax), inadequate protection of intellectual property
- political – depends on a political system, a political decision (for example, a change might appear when you subsidize a project)
- environmental – risks associated with damage to an environment
- human – experience and competence of employees, risk management
- information – risks associated with inadequate data protection

We can also mention safety, social risks, the risk of force majeure (this includes in particular an accident and natural disaster) and other categories. Setting effected areas depends always on a project type.

1.1.2 Other related concepts

Hazardous situation we can perceive it as a time and space dependent set of circumstances in which there are sources of danger and a recipient of risks [11].

Danger means a real threat of damage to object or process. This means a real possibility of a negative event. The danger is indeterminate, it cannot be confidently predicted, when it happens. The risk, therefore, represents the risk of injury and damage to property or may be not only financial, but also psychological. The damage is termed as a material injury which results from the realisation of the danger. Risk factor or risk expresses the probability with which a given threat occurs

Triggers can be defined as circumstances that initiate danger. Signal is then an initial warning. It is essential to deal with a risk before they turn into an unexpected problem. A problem can be understood as an event that has already occurred, has a negative effect on a project and is needed to deal with it and thus prevent its adverse effects. At risk, as I have already mentioned, there is uncertainty, and it cannot therefore determine whether and to what extent [12].

1.1.3 Ways of dealing with risks [20]

Each is sensitive to risk and views it differently. Risk assessment is always subjective. There are a few basic attitudes to risk: aversion to risk, risk searching and neutral position. This concept can be applied in general, not only for the projects. Aversion is the risk refusing. There is

an evident effort to prevent risks and opportunities. This approach applies to projects, which must meet its objectives as preciously as possible and any situation giving rise to risk for a change is unwanted. The second group looks for risk and tolerates it until risk event does not occur. Negative effects of risk events are underestimated and usually there is no action planned in advance. This approach brings the biggest gains. However is possible a case of the failure and large losses. One, who occupies a neutral relationship to a risk, tries to achieve a balance between these two extremes. This approach is the most appropriate for a project management because it tries to maximize benefits, register risks and try to prevent them in most cases. A risk is related to a money return. It also depends on the predictability of risk. For investments or projects with a high degree of certainty, risk level is lower. On a contrary, a risk is growing with every new solution.

1.2 Project risk management

Although project management is used in practice for decades, with risks in projects are started systematically working predominantly from the 1980s.years of the 20.century. At first has started only with the form of a quantitative risk analysis. Management of risks is now one of the disciplines of project management. A purpose of which is recognition of possible losses and their minimization [17].

The more effectively we will work with risks, the more successfully we can achieve objectives without adverse deviations from expected outcomes and minimize potential losses from failure. A main objective of risk management in the project is to increase a likelihood of successful completion of a project by three essential dimensions – cost, time and quality. A central task is to get to know in advance potential sources of threats and respond to them, ideally with a help of previously planned risk response, and minimize any damages. From a survey of project management internal projects from the year 2013 by ERNST & YOUNG [8] shows that only every second project will end up as part of a planned deadline and budget. The most common reasons for failure were presented in an initial identification of a project are incorrect, inadequate staffing and coordination of a project team, a lack of support from top management, a different expectations of a project outputs and a consequences of external changes. While lessons and informatoins learned from past projects are used only in 39% of them. A risk management system would help in many cases to their successful completion.

1.2.1 Influence of effective risk management

Risk management can avoid unforeseen disasters. And avoid from spend more, not only financial, resources as well. However, it must be able to manage risks effectively. What does it mean? Often it would be eliminating all risks disproportionately expensive, which is not desirable. Cost of risk management should not exceed losses caused by an omission of any risk. And a cost of risk management has to be included in a budget of a project. Additionally, when you work with risks it is always necessary to take into account the type of project, hence an amount of expended funds, and consider another context, because each project is unique, and risk management is needed to adapt to him. In a project we should try to proactive risk management, which consists of ready-made strategies with a character of preventive measures. The opposite of reactive management is that only responds to no longer risks [22].

1.2.2 The process of risk management

Decisions taken under uncertainty analyses should be supported so that they can focus on the most serious risks and problems arising therefrom. However, for decision-making must be available enough information. The more quality information available, the less will be the risks and uncertainty. Risk management has the task of mapping the risks, to describe their causes and impacts according to model: cause – risk - impact. Part of the risk management process is specifying a priority and making decisions to minimise the risks. For a prevention of the risks are laid down preventive measures (such as insurance and the reserves creation), scheduled reactive action are to mitigate the effects of risk events. [21] The decision, which one to choose is based on the conclusions of a risk analysis. The process includes four major phasis:

1. Risk identification
2. Risk quantification
3. Risk response development
4. Risk response control.

These steps include initial risk detection, analysis and evaluation, creating a monitoring and response plans, operational risk management throughout the project. This process is extended furthermore to the context of the determination of risk communications.

In any case, it is needed to communicate about the risks in the project with management stakeholders and consult decisions with them. The degree of involvement of interested groups depends on the nature of the project. The risk identification should be preceded by an assessment of the environment, internal and external links of the project and the determination of the context. Documents and information are gathering for the project. As an example: the objectives and their priorities, plans, milestones, source limitations, the list of participants (including the project team, customers and other important stakeholders who can contribute to the detection of risks).

Determine the time and financial demands on risk management, assesses the overall level of risk of the project and the boundaries of acceptability of the risk, which depends on the level of tolerance of the business. For high-risk projects, it is appropriate to allocate special funds for experts. The formal outcome of this initial phase is the risk management plan, which includes the procedure, determining the methods for identifying and assessing risks, specifies the responsibilities in the process and a cost estimating.

1.2.3 Identification of risks

Identification of risks represents the most important and the most time-consuming phase. The aim of identification is to find substantive (relevant) risk with the help of selected methods and record it in the register of risks. Next, you need to specify is the owner of the risk [22].

The first risks and opportunities are considered already in the pre-project studies and in the logical framework (analysis of the assumptions and constraints). A full analysis is done in the context of project planning. However, the project team must work with the risks during the entire development of the project, not only in its initial stages, risk monitoring thus becomes part of the operational management. Imminent danger may increase with time.

Risk and severity differ according to the stage at which the project is located. At the beginning of the project there are many new risks, a threat is no longer at the end of the project. The risk is lower. [23] There are typical risks for every phase of the project. When we are planning we should observe particular risks associated with poorly formulated objectives of the project (specified source of risk is unclear), on a contractual basis, an incomplete plan, or a set of communication rules in project team and stakeholders.

In the implementation of the subject problems occur more in personal security, with suppliers or to cash-flow problems. In the last phase of the project may appear the risks associated with accepting the project outputs, or their lack of quality. In General, the most frequently occurring risks in the project due to changes in the project (mainly due to changes of the range), due to poor communication and due to changes in external conditions (external risks and limitations of the project) [22]

Risk identification methods

It is appropriate to combine a variety of methods and not rely only on one of them. The major part of the risks (60-80%) should be found with the help of three basic methods. Essential step to find a risk assessment should always be the project documentation and the completeness of all documents. It is appropriate to draw from the experience of the past and similar projects. Another effective method is to brainstorm, which is spontaneously generated numerous ideas verbally. A third of the most important methods are the so-called check sheets, check lists, therefore, potential risk factors of previous similar projects. They are suitable for quick identification of risks.

Another of the best and simpler ways of detection of risks is a group discussion, or a structured interview with the experts. You can also use questionnaires, which seek primarily a gathering of key information, which are relevant for the successful completion of the project. The helper method is a SWOT analysis, which identifies the main threats and weaknesses of the project [15].

These methods can deepen the knowledge gained by previous methods. On the contrary, one of timely most difficult method is the Delphi method. Which purpose is to build interview that is suited for the special area of risk and whose task is to gain a consensus of opinion of experts on the risks of the project. From graphics methods can be used an Ishikak diagram of fish-bone, which analyzes the causes and consequences of the risk, or the affinity diagram (diagram), which organizes related risks into logical groups, and thus reveal the missed risk category.

Risk register

Identified risks are documented, as well as in the later stage of their reviews. The formal output of the risk management process is a risk register, which takes the form of a structured list, sort of the underlying database. Its content should be at least the following information [1]:

- the name of a risk event
- identification date
- risk category
- starter
- cause of a risk
- expected impact of the risk
- risk development probability
- risk status
- risk owner
- risk treatment strategy

Thanks to the registry is unable to determine whether it has several risks one common cause or whether one risk does not apply to more of the activities in the project. You can reveal the most problematic activities of the project, which is the need to pay more attention.

1.2.4 Risk analysis

After identifying the risks, the next stage in the process of risk management approaches to their analysis and evaluation. The aim of this phase is to evaluate and determine the impact and probability of risk situations and prioritize risks according to their severity. The choice of method depends on availability of resources (money and time), and information for analysis, size and the complexity of the project and the purpose of analysis.

Standard ISO 10006 distinguishes two groups of methods [6]:

- Methods for risk analysis of product of project
- Methods for risk analysis of project management

In the first case the use of a particular method depends on the project's subject and type of product. The second group focused on management attention is focused on risks inherent to the project management. For example: problems with coordination or project problems with meeting the deadline.

In a slightly different concept there are two approaches to risk analysis:

- Quantitative methods
- Qualitative methods

Quantitative methods are based on a mathematical calculation of the probability of occurrence and the impact to risk events. For qualitative methods the severity of the impact and probability of risk events is determined on the set verbal scale. Or we can use a point scale. These methods are simpler. They are used primarily to compare the severity individual risks. But these methods do not work with financial impact of risks comparing with the quantitative methods. Quantitative methods are more accurate. However they are time consuming and needs more information as well.

1.2.5 Risk analysis methods

To qualify a risk we can use division, in which we use probability and expected value of risk. It is just simpler method for rapid classification. Other options are statistical simulation methods that can evaluate the overall project risk. These include Monte Carlo method, which respects difficult links between a large numbers of often interrelated risks. It generates forecasts through repeated simulations [4].

A similar principle is founded in sensitivity analysis, which is used to determine the impacts if the percentage any of the assumptions is changed. Generally we may use a scoring method, a map of risks (a view of risks in the chart) or matrix diagram (tabular view). All these qualitative methods are based on expert evaluation.

A map of risks shows risks in the dot pot. Using indifference curves, it is possible to divide them according to their degree of criticality on a regular, serious and critical.

Risk matrix is similar projection in the diagram, where the most serious risks are in the right top corner. We may select either verbal or numerical rating scale.

Scoring method utilizes expert estimates. Each participant of the assessment provides an estimate. The estimate is settled with the aid of a ten point scale. Each participant set the points independently of others. The score is calculated as arithmetic average of all estimates. Risks can then be visualized using a risk map.

Another method is RIPRAN. [14] It is written to the table that contains the threat, scenario, probability and impact (can be evaluated both numerically and verbally), risk value,

proposed measures including cost and owner of risk. Measures are recalculated after implementation. The probability and size and impact determined new risk value.

The analysis is followed by a risk assessment, which means comparing the analysis results with predetermined criteria. Then we adopt the decisions to accept risks based on an assessment of their acceptability and the decision how to treat them as well. Special attention will be paid to significant risks, those which have a greater probability of the worst impacts on project objectives.

1.2.6 Reaction on risks [22]

After analyzing and evaluating the materiality of risks comes the response risk planning whose purpose is to reduce risks. If possible, it is preferable to prevent risk with a prevention measures before the risk occurs. And before arises a need to eliminate its negative consequences.

Generally, there are two approaches to reduce the risk:

- offensive - which was aimed at weakening the causes of riskpursue
- defensive - which focuses on the reduction of adverse consequences

When we choose the right strategy, there plays a variety of factors the role – the most decisive are: size project, time and financial demands solutions. It is also useful to base on the map of risks and location according to their impact on the project and the probability of occurrence.

There are many possible strategies how to reduce risks [9]:

- Risk monitoring - monitoring is used for a risks with low probability and moderate impact. Risk factors are monitored and if become to increase the significance of any of them, it is necessary to plan the response to potential risk.
- Risk avoiding - this reaction is used for significant risks. It is based on the elimination of the causes of the risks so that the risk should not occur. We can avoid the risk of finding other solutions or redefining goals, changing technology or find new supplier, or a detailed definition of the scope to avoid later adjustments and subsequent cost increases.

- Risk mitigation - this strategy can be aimed at either the reduction of the impact of risk on project, or the likelihood of its occurrence (but not eliminate the risk entirely). An example may be to increase product quality, involvement experienced workers to process, ongoing periodic checks or a backup making.
- Risk Acceptance - adoption strategy is used for non-serious risks and the risks that we are unable to influence or their treatment would be too expensive. Risk accepting can take two forms - passive and active. Active acceptance requires the preparation of plans. But they may be used only if the risk occurs. Passive means only passive acceptance of the consequences of risk. For these cases we can create reserves.
- Risk transfer - Risk transfer means transferring the responsibility for the consequences threats to a third party. This defensive character solution is applied mainly to solve financial risks with high-impact and low probability to occur. The risk is not eliminated, but its solution is transferred to another entity. However, we have to expect other costs (third party does not take the risk on themselves without payment). This solution often appears in the form of insurance, where the risks and consequences are covered by insurance or in the form of leases. The leasing company is responsible for the risks associated with the ownership of property. It is possible to transfer the risk to the supplier (in the form of agreed fixed prices).

1.2.7 Risk controlling

The likelihood and severity of risks may change in time of the project. Therefore we need to pursue the monitoring of risks and operative management. Risks must be continuously reassessed. This happens regularly or periodically as needed. If there is a new or secondary risk in time, we repeat the process of identification, quantification and planning. If there is remission of threats, not current risk can be overlooked [23].

This phase also includes evaluation of the effectiveness of risk management. For example, whether there is a selection of appropriate strategies in response to the risk. Whether the strategy was effective and what the problem is so managed to avoid. It is also necessary to evaluate the effectiveness of prevention. For future projects should be retained documentation of obtained knowledge and knowledge from previous projects, so it is possible to trace the risks that have been identified and how they was managed and with what result. This approach can greatly facilitate the work with the risks to the future.

1.2.8 Shortcomings of a risk management

Here I present the greatest shortcomings in risk management process for projects, identified by Rita Mulcahy in her study focused on risk management in enterprises [23]:

- a lack of data for a risk identification - undefined scope of the project, WBS, timetable, budget
- insufficient concretization of risk - a vague verbal description (eg. the phrase "poor communication"), unspecified risks
- current list of risks - risk management is therefore only a one-off affair on beginning of the project
- skipping across important areas of risk in the identification
- subjectivity of a risk assessment
- use only one method for the quantification of risk – risks should be identified as many as possible with the use of several methods combination
- incorrectly proposed measures - those are selected, without discretion, without comparison with other possibilities

Capture 2

Project management

Already from the name can be inferred that the subject of project management is a project. For now, there is not one generally accepted definition of this term, however most of them match in the key characteristics of the project, which are primarily, the uniqueness of the outputs, the temporary duration and limited resources. Institute PMI defines project as "a temporary effort expended to create a unique product, service or result"[22].

The project is unique product where are always another circumstances – with the use of different sources and different budget, in another time and place. The product can be a tangible output or service. Apt description is the definition according to the standard ČSN ISO 10 006 [6] for the quality management of projects, in compliance to which the project is "a unique process consisting of a series of coordinated and controlled activities with start and end dates, undertaken to achieve the objective, that meets the specific requirements, including the limits of time, cost and resources ". It follows from this definition that the project can be understood as a process by which individual activities are implemented in successive steps.

Each project is unique, and because of its uniqueness and unrepeatability it causes management difficult. In order to achieve the desired result, it is necessary to comply with a specific process control. Therefore, in the context of the past few decades had been developed many methods of project management, to make project management easier. They are built on the principles of general management, as also include basic tasks such as planning, organizing, leading and controlling.

2.1 A project

Unique process consisting of a series of coordinated and controlled activities with start and end dates, undertaken to achieve the objective. It meets the specific requirements, including the limits of time, cost and resources [10]. It follows from this definition that the project can be understood as a process by which individual activities are implemented in successive steps.

2.2 Participants of a project

For the purposes of the project is assembled the project team. As we know, each project is temporary. If achieved its goals, which the customer accepts, the project ends and the project team (after the handover of project results) is falling apart, its members tend to be transferred to other projects. Team work coordinated by the project manager, who must have certain qualifications and skills for a project management. [16]

The main activities project manager is responsible for, are mainly resource management, planning, control of project progress and managing a communication. Project team members are selected on the basis of their professional competences. The responsibility assignment of members of the project team individual work activities are specified in the responsibility matrix. This matrix help determines who will be responsible for the execution of a particular task or who will only be informed about this task. This also creates the basic rules for project communication.

Stakeholders

Some of the other authors define project management as the use of knowledge, skills, tools and techniques for project activities so as to meet the requirements and expectations that the investor and the customer puts on a project. The Investor and the customer belong to the so-called stakeholder group. In this group is primarily a contracting authority (user) of the project, the contractor (project team) and the public (for example, the local community and media). [2]These groups affect the project, whether positively or negatively, or are affected by the project. In the implementation of the project is the need to identify their expectations and interests related to the project and to be able to communicate with these groups. A conflict of interest may pose a potential threat to the project. We need to count with these risks in the analysis of project risks.

2.3 Method of project management

In project management it is important to use systemic approach because the project is basically a system. This approach is based on the thinking in context and a comprehensive perspective on the entire system with respect to all of the mutual connections between elements in the project and bonds to its surroundings. This is related to systemic thinking. It contains in itself as thinking analytical (assumes the ability to decompose the system into individual elements and on them to look for causes of problems) and synthetic as well (the ability to apply the results of

the sub-parts of the system as a whole). Project product and project processes are subjects to systemic analysis, which is decomposed into individual elements and identifies a connection between them [7].

2.4 Life cycle of a project

The cycle of the project is formed by a succession of individual project phases, which logically follow each other and should not overlap in time. In other words, phases of the project represent “a group of logically related activities in terms of project management” [22]. Each phase has its objectives (outputs) and the intended time range. For marking the achievement of sub-goal or another phase are used the milestones. Milestones do not have duration value. At this moment occurs to check whether in a given phase were reached the outputs of or not.

The life cycle of the project

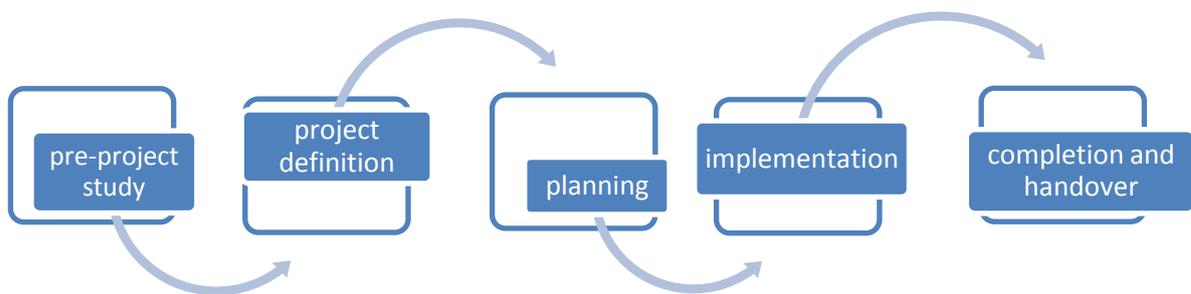


Figure 1 The life cycle of the project

1. pre-project study– this phase precedes the decision on the implementation of the project
2. project definition – this phase involves the process of making outputs of pre-project studies more accurate
3. planning
4. implementation
5. completion and handover of the project

2.4 Pre-project study

A study of opportunities is made to provide recommendations to implement or not to implement a vision of the project plan. The recommendation is made on the basis of the stimuli of the market, analysis of opportunities and threats, initial risk estimation, the basic assumptions of success and potential losses. It is advisable here to use a simple SWOT method. Feasibility study assess the technical and economic feasibility of such a project, specifies the content of the project and specifies the project objectives, the planned date of commencement and completion, the necessary resources and the estimated total cost (return on investments) [19].

It has to be assessed the profitability and payback of the project before the start of the project. Their assessment differs depending on the type of project. The internal project will measure success not by profit, but to achieve return on invested funds (income at least should offset the costs). While an external project is considered as a source of a profit.

2.5 The definition of project

Definition from ISO 10006, *“This project is a unique process consisting of a series of coordinated and controlled activities with start and end dates, undertaken to achieve an objective that meets specific requirements, including the constraints of time, cost and resources.”*[6]

Definition from the Guide to the Project Management Body of Knowledge (PMBOK Guide): *“A project is a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project’s objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists.”*[22]

2.6 Project planning

The aim of the plan is to create a sort of guideline that will guide the implementation of the project and would be based on this guide. At the end of this guide should be achieved set targets. The outcome of the project planning is the plan, which includes in particular[20]:

- project scope plan
- time plan (schedule)
- plan of resources
- cost plan (budget)

Usually the project planning is supplemented by a communication plan, risk management plan and quality plan. It is important that all the plans should be interconnected and change in one of them should be reflected in other plans.

2.6.1 A time plan

When creating a schedule we start from the hierarchical structure of the project, milestones (such as the important control points of the project) and resource estimates. The individual activities shall be organised in time while respecting the logical links between them. For each of the activities is then needed to estimate its duration, estimation based on experience or use statistical methods. Mainly is used of the method of PERT (Program Evaluation and Review Technique), which calculates a pessimistic and optimistic estimate, with the expected common duration of the duration of the project is located between these two extremes. [10] Network diagram is used for a graphical representation of activities. After is determined the so-called critical path, which is the only longest path in the graph from the initial to the end node, which indicates the shortest possible time of realization of the project.

2.6.2 Resource planning

Resources (both human and material or information) are limited. Accordingly there is a reason for their capacity planning. First we need to identify the necessary resources, and then following the set up of a timetable to build their plan with respect to the availability and productivity of resources. Resource planning is done with the reason to avoid overloading. In that case it would be necessary to temporarily alternate another source.

2.6.3 Budget

After creating a resource plan follows the cost plan, based on previous plans, mentioned above. The budget consists of revenues and expenses, usually expressed in monetary units. We distinguish between the direct costs associated with the implementation of the project, as well as indirect, that can not be clearly assigned to the project relating to the whole organization, and

other costs such reserves. For the determination of costs is possible to use an analogous method (derivation based on past projects), expert estimates, parametric modeling (to determine values using regression analysis) or bottom-up estimate (assessment of each individual item WBS) The budget should include financial reserve to cover unforeseen expenses, usually determined as a percentage of total expenditure [7].

It is not sufficient to manage just the costs of the project. An important role is played by the cash-flow monitor expenditure (payments for resources) and revenue (eg. payments from the investor) that the project generates throughout its life cycle. This cash flow is used to assess the financial stability of the project. And whether the revenues generated by the project would pay expenses and whether the project would generate surplus or shortage from the cash resources.

2.7 The project implementation

After approval of the project plan and resource allocation we can start the implementation of the project and project completion. An essential part of the implementation phase is monitoring and control of the actual progress of the project, which can differ from the previous plan. It is necessary to set milestones such as checkpoints and measurable indicators on the status of the project and its completion and receive regular news about realization. In the case of deviations from the plan, it is necessary to proceed with corrective measures or changes in schedule or the subject of the project, if approved by the customer. Any approved changes in the project, is need to manage, assess their impact on project plans and schedules to update. [10]

2.8 Completion of project

In the post-project phase (when the product of project was completed and passed into use) should be assessed the objectives of the project and re-evaluation, including lessons learned from the mistakes. Part of the formal handover of the final product and approval of project outputs by customer is signing the acceptance certificate. We also need to settle financial obligations and archive documents. Resources are discarded after completion of the work and can be transformed to another project.

For evaluating the effectiveness of the projects are frequently uses the net present value (Net Present Value), allowing for the discounted cash flows resulting from the project. [2]

Capture 3

Strategic and situation analysis

Strategic analysis is performed to assess the current state of the organization and for making a decision about appropriate business strategy for the future. It is performed before a fundamental change such as a new project. Strategic Analysis examines the company's strategic position and potential threats to the company's operations. Influences can be found in the macro and micro environment, always depending on the sector. As part of the strategic analysis we examine:

- Internal environment of the organization
- Industry environment
- External environment

3.1 SWOT analysis

SWOT analysis is universal analytical technique focused on assessment of the internal and external factors that affect the success of the organization or any particular intention, for example a new project. Most often it is the SWOT analysis used as a situational analysis in the strategic management of the enterprise.

SWOT is an acronym from the initial letters of the English names of the individual factors. Factors are internal or external. Internal (influenced environment by the company) - therefore **strengths** and **weaknesses**. External - **threats** and **opportunities**. [15]

Its essence is to identify inside key strengths and weaknesses. Therefore, what in an organisation or part of it is good and what is bad. It is equally important to know the key opportunities and threats, which are located in external environment. An aim of SWOT analysis is to identify and subsequently reduce weaknesses, promote strengths, seek new opportunities and know threats. Organization should make use of opportunities and avoid threats.

3.2 SLEPT analysis

SLEPT analysis monitors macro business and it focuses on the opportunities and threats from the external environment. Monitored factors are as follows [10]:

- **social** – follow an example of demographic characteristics as (population structure, age, education), income distribution, labor market situation, living standards
- **legislative** – legislative restrictions, tax laws, labor legislation, prepared legislation
- **economical** – estimate of prices of products and services, macroeconomic indicators as (inflation, gross domestic output, interest rate, exchange rate), tax rate, purchasing power, access to financial resources
- **political** – political stability, regional politics, business restrictions, influential groups
- **technological** – government spending on research and development, technological level, infrastructure development, moral obsolescence, intellectual property protection

3.3 Porter's analysis of competitors

Porter's model examines the industry environment of enterprise. This model assesses the development of the competitive environment in the surveyed industries and in a given market through the following factors: [17]

- bargaining power of customers
- bargaining power of suppliers
- existing competition - examines market share, size or financial strength of competitors
- threat of new competitors in an industry - examined barriers to entry, product differentiation, capital requirements, cost and complexity savings, access to distribution channels, customer loyalty and brand awareness
- availability of substitutes - products from another industry, that can replace those products. Products using different technology. We evaluate an availability, price and quality of substitutes, as well as the innovative potential of a product / service

PRACTICAL PART

Capture 4

Analysis of a current state of company

4.1 Introducing of a company and its activities [18]

Metrostav a.s.

The company:	Metrostav a.s
Legal form:	joint-stock company
Identification number:	00014915
Registration:	23 rd of May 1991
Company main office:	Koželužská 2450/4, Libeň, 180 00 Praha 8
Statutory authority:	board of directors
Subject of business:	civil construction, development projects, industrial constructions, road constructions, subway, underground constructions, water works and other civil engineering works

Metrostav based in Prague is a universal building society, whose activities can be monitored throughout the territory of the Czech Republic, the Slovak Republic and abroad. Among the largest construction companies operating in the Czech Republic. The company is divided into eight divisions, each division is specifically aimed at a particular segment of the construction market. [18]

Metrostav a.s. was founded in 1991 as the legal successor of the national, then state-owned company Metrostav, which was founded in 1971 as a specialized enterprise for the underground construction. The company's activity is focused on civil construction, industrial and residential construction, underground, transportation and water facilities, construction of underground lines and other civil engineering works. [18] Metrostav a.s. It has been long a financially strong and stable universal construction company capable to acquire and manage large and complex projects both domestically and abroad. Simultaneously, the company aims to achieve a significant market position in the segment of smaller contracts on a regional level in

various regions. Among the key opportunities include road construction, bridges, tunnels, projects for large industrial companies and public investors. For further assert their supporting technologies accentuates Metrostav a.s. development of foreign businesses to establish themselves on their own or in cooperation with local partners in target markets.

Metrostav a.s. is a high-tech company that systematically develops its own internal capacity of supporting technologies and strives for continuous improvement capabilities in the area of construction. The company puts emphasis on the professional development of personnel, development of corporate culture, the goodwill and promotes zero tolerance for violations of ethical principles. Metrostav a.s. as a leading company of Metrostav Group supports the development of all its subsidiaries, and also seeks to achieve synergies within the Group. [18]

4.2 Introducing of the Division 3 and its activities

Division 3 is a production division, which is focused on engineering in the segments of civil, industrial and residential. It is divided into two parts cooperating since the original division D3 was assigned to go for the more part with the steel structures. Part of the steel structures was originally a separate Division 7. That, however, was canceled due to poor economic performance in the long term. Division 3, after merging with the rest of the steel division, now also engaged in the manufacture and supply of steel structures particularly for bridge technology, mass-tank systems, roof structures of large complex, steel structure of various technological, industrial and warehouse buildings.

4.2.1 Completed projects

Division 3 has dealt with many construction projects over the years. These projects include significant buildings such as: Comprehensive renovation of powerplant Prunéřov, which worth around 3mld. CZK, Ophthalmic Centre Vinohrady or residential house Janáčkovo nábřeží, and the project of roofing reconstruction of platforms in the Praue Main Station, which will later be discussed in the section dealing with risks in the project and which is still in the process of reconstruction and completion time is determined at the beginning of 2018. [18]

Not all projects have been successfully completed. Influenced and division results. Especially in recent years, 2014-2016, the planned economic results differed widely from real results.

4.3 Analysis 7S

The following subsections are focused on detailed analysis of the current state of Division 3 of company Metrostav. This is an external analysis of professional and internal factors that affect this company. First, we focus on the internal environment of analyzed company and division.

4.3.1 The division strategy

Division 3 - mission reflects the strategic objectives of the parent company Metrostav a.s., Division 3 has the ability to acquire and manage large and complex projects both domestically and abroad, for example in the neighboring Slovak Republic and the Republic of Belarus. Among the key opportunities for the division include the construction of industrial buildings, residential and commercial constructions.

Metrostav a.s. is a high-tech company that systematically develops its own internal capacity of supporting technologies and strives for continuous improvement capabilities in the area of construction. The company puts emphasis on the professional development of personnel, development of corporate culture and the goodwill.

Fulfillment, set results from the parent company, dramatically changed especially in the last two years. Because there were trying to meet the planned production volume, risks have been neglected from inadequate examination of project documentation and valuation budgets. A major role occupied the pressure to conclude the largest possible number of contracts for projects. Often with the adverse conditions in those contracts.

4.3.2 Breakdown structure of the Division

Organizational structure of analyzed division is not very complicated. Despite the higher number of employees, the organizational structure is effective and fully satisfactory. Decision-making power has the division director, who must respect the regulations of the parent company. Further powers are distributed among the deputies who manage their departments and have oversight of all decisions relating to completed projects.

Division Director shall not participate in any negotiations, but it is informed of any developments. If the award of a so-called big contract, then the contract is a decision of the

Division Director, together with the deputies, also monitored by the parent company as a result of these orders can significantly affect the existence of the entire division and its future.



Figure 2 Breakdown structure of the Division 3

4.3.3 Systems [18]

The Company, due to its size, use several information systems. To a date 1st of January 2000 was implemented a new information system - One World prepared by the American company JD Edwards World Solutions Company. System functions cover the area of economy, society, the purchase of materials and services, inventory management and monitoring of construction contracts. The new system focuses mainly on construction contracts (ie. Job Cost) and allows optimal management and control of construction activities across the company.

EFA (An electronic invoicing) introducing tools for effective monitoring and evaluating of outstanding invoices. After scanning the invoice, it is submitted for indexation, where with the help of data from system the shirt of invoice is filled. Approvers can attach the invoice with an additional documents and comments. Finally, the invoice is posted, and a link to the electronic invoice is stored in the system. The solution allows XML import of invoices and approving invoices via e-mail.

To communicate with clients and the workers are used commercially available communication channels, particularly e-mail and mobile phone network.

4.3.4 Style of management

The management style of the company is more authoritarian than democratic. The division is subject to the legal form of the company Metrostav a.s.. Company management Metrostav consists of the general meeting of shareholders, the supervisory board, the board of directors and CEO.

Division D3 has its own director, who manages the division. Decision-making power is divided hierarchically, as already indicates the organizational structure of the division.

Division director and deputy managers, manages the whole division. The main persons who manage individual projects division, is a project manager. Those are in the decision-making structure under deputy managers. Project managers are familiar with every detail of the project and their decisions are consulted each month during the so-called reprehension procedure.

4.3.5 Fellow workers

Employees are a key factor for the success of the company. The selection of specific employees takes place through the personnel department of the division. Employees are not very well motivated. When working on projects they get to new remits. Employees have space for a career growth through the company. Emphasis is placed on teamwork, especially when working on projects. Metrostav also pays great attention to education, knowledge and skills development mainly for management employee groups.

Individual training programs are prepared by the education center of metrostav group in cooperation with the divisions management and experts. In the preparation and implementation of educational events is increased emphasis on quality and safety of their work, a high standard of professionalism of employees and on knowledge to management principles, methods and practices by organizational and management documentation. The system of education is improving the quality with a long-term close cooperation with experts from the technical sector.

4.3.6 Abilities

Employees are involved in the projects implementation according to qualifications and experience. The vast majority of employees are university graduates, usually in technical and economical fields. With each project, the employees receive a new experience, because each project is unique. Furthermore, they are systematically trained, as already mentioned in the previous paragraph.

4.3.7 Shared values [18]

Shared values are expressed in the Code of Ethics. This document is given to each incoming employee.

The main points of the Code of Ethics contains the following. Metrostav enforces the laws of the Czech Republic and countries in which operates entrepreneurially. Credibility, professionalism and stability are fundamental shared values. Customer satisfaction is the main goal, but never with the violations of ethical and legal standards. Respecting the rights and duties of all employees. There should be no discriminatory behavior. Furthermore Metrostav does not admit the possibility of a conflict of personal interests with the interests of Metrostav Group. Failure to comply with the moral principles of Metrostav Group is not tolerated.

4.4 Slept analysis

4.4.1 Social factors [3]

Metrostav - D3 employs mostly people from capital city Prague and central Bohemia. Metrostavit is headquartered in Palmovka. Many projects are implemented in these regions. In the Prague region was 30. 9. 2016 recorded 1,276,741 residents, while the population from year to year continuously increases. In the long term the size of the workforce increases. The unemployment rate, the percentage of unemployed persons in the population aged 15-64 years in this region is 3.4% to a date 30. 11. 2016, which means only a slight reduction in unemployment over the previous period. The lowest unemployment rate is among university educated population. In the services sector, employment increases. Significant increase is mainly in the administrative activities. Most staff analyzed divisions have higher education, does not apply to employees in blue-collar positions.

In 2015 was the university education of the population of Prague 40.7% of the total employed, while the share is constantly increasing for several years, as can be seen in the following table. Likewise, the education level of the population in the Prague region has long been improving. The unemployment rate among people with university education is only 1.8%, which is the lowest in the Czech Republic.

Metrostav has a yearly high percentage of job seekers that many times exceeds the offer announced by positions. The following figure depicts the status of unemployment during 2016 in Central Bohemia and Prague.

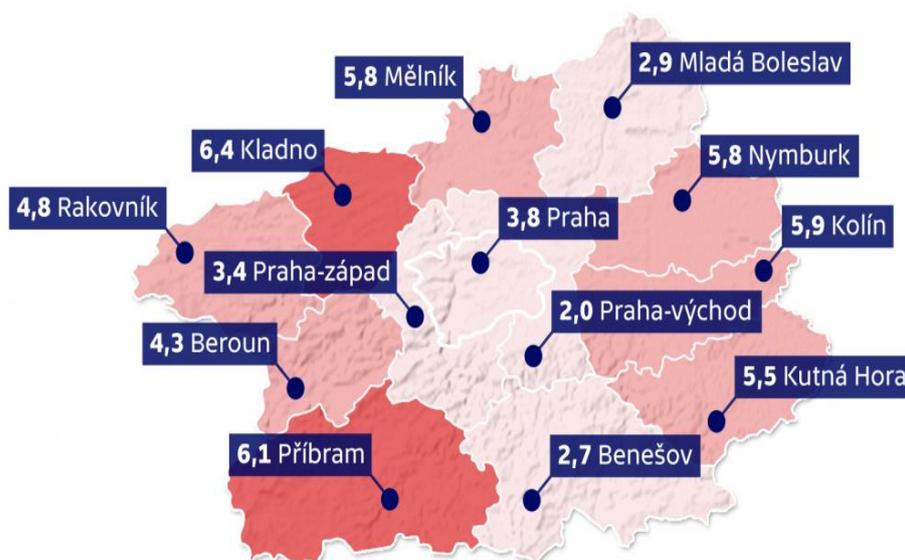


Figure 1 Unemployment during 2016 in Central Bohemia

Evolution of unemployment across the Czech Republic shows the following table:

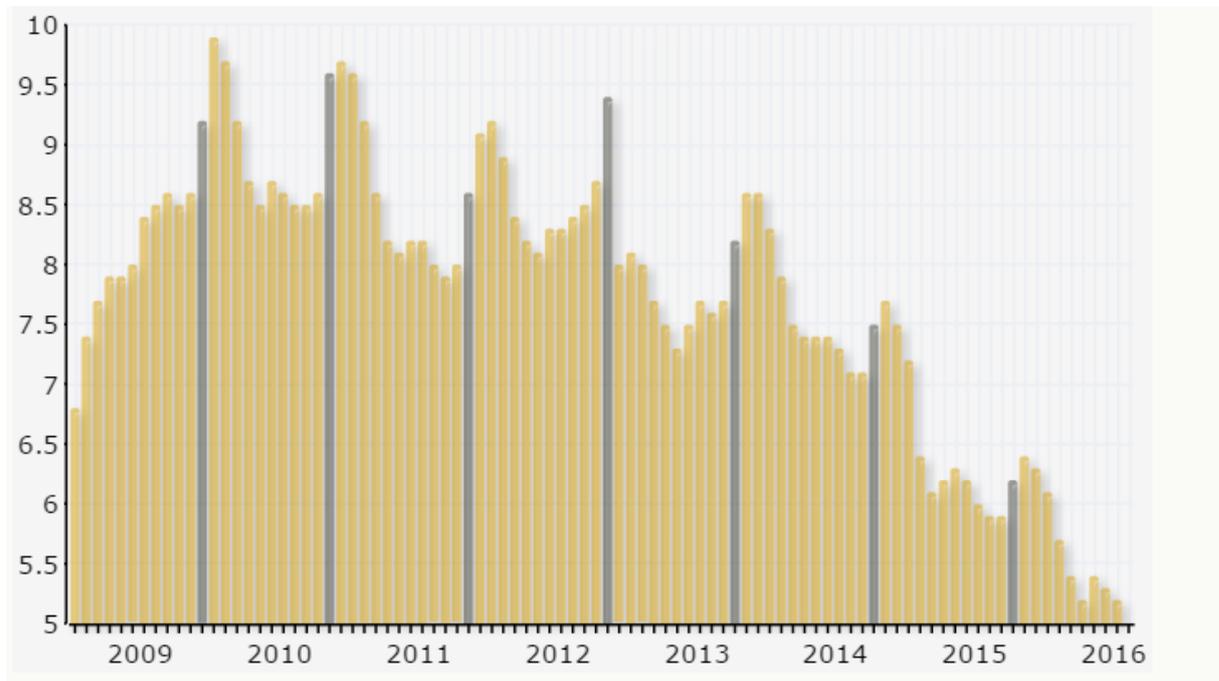


Figure 2 Unemployment rates

4.4.2 Legislative factors

Among the basic standards, which must be followed each business entity include, in particular [3]:

- Business Law, which came into effect from 1st of January 2014 replaced Law no. 90/2012, on business corporations, governing the operation of commercial companies,
- Civil Code, which is also the first since the first in 2014 replaced by the new Civil Code, according to the Law no. 89/2012, governed by contract law and relationships with customers,
- Labour Code, the Act no. 262/2006 Coll.,
- Tax regulations.

An important factor is the amount of VAT which is regulated by Act no. 235/2004 Coll., On Value Added Tax. VAT rates in recent years have changed many times, in 2012 there was an increase in the reduced VAT rate to 14%. A year later, there was an increase in the basic rate to 21% and the reduced rate to 15%. Development tax rate on corporate income is relatively

favorable business entities For many years there has been a reduction in the rate. Since 2010, the rate has remained at 19%. Income tax rate, which is regulated by Act no. 586/1992 Coll., Income taxes.

4.4.3 Economic factors [3]

Like most of the macroeconomic indicators is considered an indicator of inflation, and also the development of regional GDP. According to the Czech Statistical Office, we can very quickly analyze the development of average wages and the number of economic entities. Inflation is an increase in the price level over time. Since 2009, when inflation reached its minimum, average annual inflation rate grew, but in 2015 fell below 1%. The highest value reached in the sixth month and to 0.8%. In 2016 inflation did not exceed 0.6%.

The average wage of the average wage, according to information CSO annually rising slightly. The national average for the third quarter of 2016 amounted to 27 220 CZK, which is 4.5% more than in the same period in 2015, the median wage for the reporting period on the level of 23 527 CZK. The volume of wages increased by 6.1%, while the number of employees only 0,6%. In the business sphere, the average wage increased by slightly more than in the non-business sphere. If we focus on employees wages in the Prague region, the average gross monthly wage here in the third quarter of 2016 amounted to 34 512 CZK. In comparison with the national average gross salary and in Prague during this period increased by 26.8%.

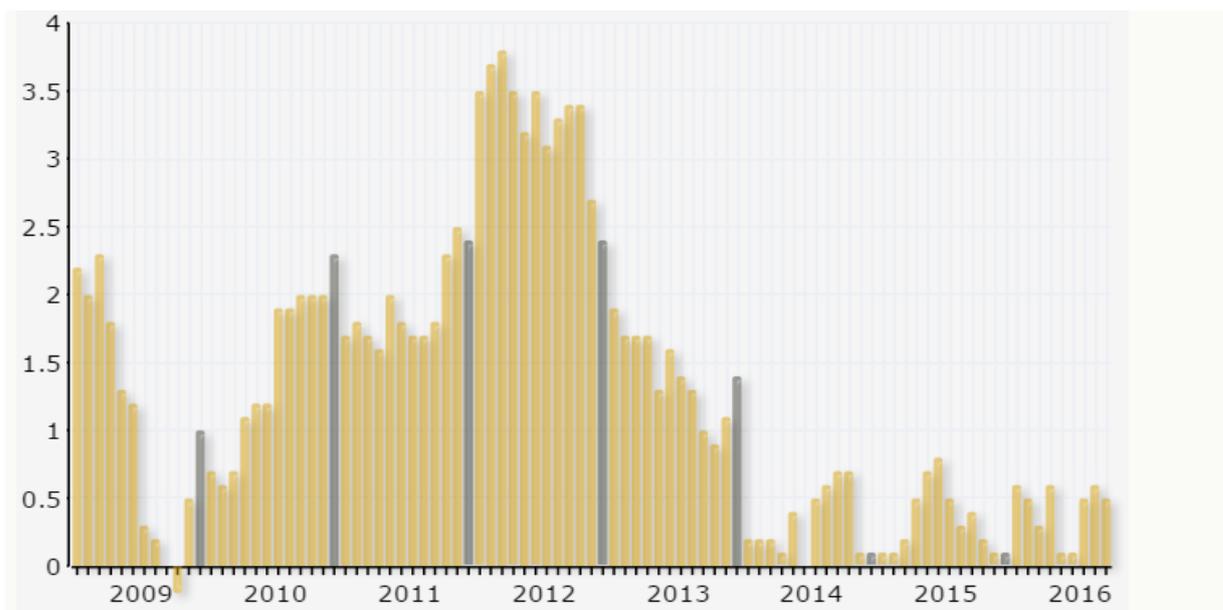


Figure 3 Average gross salary rates

The number of businesses subjects in the region Prague to the day 30. 9. 2016 is in total 585 144, It includes both legal and natural persons. Compared to the previous period makes these statistics increase of 2.7%., A gradual steady decline in the share of fyzical entrepreneurs (namely around 80%) and increasing the proportion of bussines objects.

4.4.4 Political factors [3]

The political situation in the Czech Republic is not as stable, the ruling political parties are rotated (regularly alternates leftist government of right-wing). The concerns of Prague, so the council consists of 65 members who are elected by the citizens of the City. City Hall in municipal elections in four years. For the election period 2014 - 2018 are represented by these parties, movements and coalitions: TOP09, ODS, ČSSD, KSČM, ANO 2011, the Czech Pirate Party, SZ three-party coalition, the Christian Democrats, STAN. [3] The Assembly decides on important and major issues related to the capital city of Prague, eg.: submits bills of Deputies, upon negotiations with the boroughs of the City budget. Prague, program development of the entire city and regional districts, issues generally binding regulations.

4.4.5 Technological factors

Due to the nature of the activities of the analyzed company we would be particularly interested in external competitive factors, technological construction companies. But given the size of the company Metrostav (part of which is being investigated Division 3), which has the most modern technological that are available in Central Europe. It is because of this fact the company is very successful in the competitive environment and easier way to acquire new contracts, which depend on the technology used. Other important areas include the construction of bridges and steel structures of Division 3

Significant clearance ability of the production components were in the year 2015, supply and installation of high-performance steel supporting structure, which spans twice across a tube of the Strahov tunnel in Prague 5, to create a solid base for multistorey of newly built luxury residential building Sacre Couer 2. [18]

Moreover, after obtaining authorization to supply products to energy sector in the operation of steel structures in division 3 repeatedly managed to exercise their capacity for major suppliers in the energy sector and the implementation of contracts.

4.5 Porter's five forces

4.5.1 Bargaining power of customers

Customer Metrostav - Division 3 are both development companies and private investors as well as companies and public purchasers. But the bulk procurement division implements for private investors who use the experience of this division with the construction of industrial buildings and development projects. Services prices depends on agreement with customers and also on the selection process, if the choice involved a competition with more competitive construction companies. It also depends on the extent of the required services required and their uniqueness. Bargaining power of customers is very strong, because the division has a need to get as many orders to fulfill plans determined by the parent company.

4.5.2 Bargaining power of suppliers

Metrostav - Division 3 is very dependent on suppliers, mainly uses the services of specialized contractors and material suppliers. These suppliers include providers of specialized services such as handicraft production and installations and constructions (despite the fact that the company Metrostav has their own building supply store).

Prices are mainly determined through several rounds of selection procedure. The course of this tender is adjusted according to the principles of division and may be solved operatively with project managers. In all these areas there are many alternative suppliers, and there are only minimal switching costs, bargaining power of suppliers is lower.

4.5.3 Existing competition

In the same field as the analyzed company operates many construction companies in Prague and central Bohemia, but not all can be considered as competition. The biggest competitors for the company Metrostav a.s. are shown in the following table:



Figure 4 Competing companies for Metrostav and Division 3

These competitive construction companies are not competitors for the company Metrostav as such, but also for the actual Division 3.

Another distinguishing feature of the construction sector is the fact that businesses (although competitive) together often cooperate. Although public contract only gets one company often uses subcontracting of works by others.

Regarding the domestic construction market and foreign construction companies. Czech building market has no barriers as any type of mandatory deposit on taxes and mandatory payments, which increase the cost impact of all construction companies, for example in Germany. Metrostav is fully comparable with the quality of the work of foreign companies. In addition, Metrostav can build a little faster and affordable. Technologies used by Metrostav have certifications and fulfills all the requirements for international clients. Metrostav has no so

dominant competitor in the market. A major competition from existing scope of activities is Skanska a.s. and HOCHTIEF CZ a.s.

4.5.4 Threat of new competitors in the industry

For new competitors, market entry is relatively complicated. When talking about projects that Division 3 handles, such large development projects, industrial buildings, bridges, steel structures etc. There is a large capital-intensity and other barriers, such as knowledge and experienced staff, who worked on many previous projects. New entrants company would have to offer a similar experience, technological capabilities and network of contacts, otherwise it would be difficult to passed. And very important are references from satisfied customers.

4.5.5 Availability of the substitutes

An investor who decides to use services of Metrostav - Division 3, is looking for services in the construction sector with a company which has a large scale of experiences, both in terms of quality workmanship, many years of experience assisting in project work or stability and part of the largest construction companies which Metrostav is.

Substitutes do exist on the market (both in the preparation and implementation of projects), pressure from their side is great. Most often it is the pressure to win a contract, which is evaluated by the lowest bid price. The question is whether companies with a lower price offeres a good quality and whether is possible to achieve the same results.

The advantage for customers is especially remarkable that Metrostav - Division 3 is able to provide these services to comprehensively networked and tailored to the individual needs of investors. Background of the largest Czech construction company is very hard to replace. The company has many positive references and is very well known in the Czech Republic. Existing customers have a relatively high fidelity and some companies collaborate again.

4.6 SWOT analysis [15]

In the previous chapters was performed an analysis of internal and external environment. The SWOT table analysis is based on these information and summarizes the strengths, weaknesses, opportunities and threats. The SWOT analysis of company Metrostav provides a

strategic SWOT analysis of the company's businesses and operations. It provides comprehensive strategic analysis with the table SWOT analysis, which shows a preview of the main components of the strengths and weaknesses of the company and the potential opportunities and threats.

After identifying all four factors we need to choose a strategy that will promote the strengths of the company, while minimizing the weaknesses and prepare the company for potential threats and opportunities. It is appropriate to pay attention to cases where is the border between opportunities and threats. Opportunity may change at risk and vice versa threat of the company may under certain circumstances be transformed in their favor. It is important therefore to evaluate the situation in the context of the industry and with the knowledge of all bonds. Generally we can say, the SWOT analysis is a relatively transparent tool for determining the strategic position of the company. However, it is not appropriate to overestimate its explicitness in the strategy development.



Figure 5 SWOT analysis

Capture 5

Project

This project, reconstruction of existing buildings and roofing of railway main station in Prague, which is being completed by Metrostav a.s. – Division 3 in cooperation with PROMINECON a.s., it is also currently a public contract. Although it was previously stated that the Division 3 does not handle large amounts of public procurement. This public contract is very important for the division. Given project was worth more than 570 mil CZK(although the original value should be 469 mil CZK).

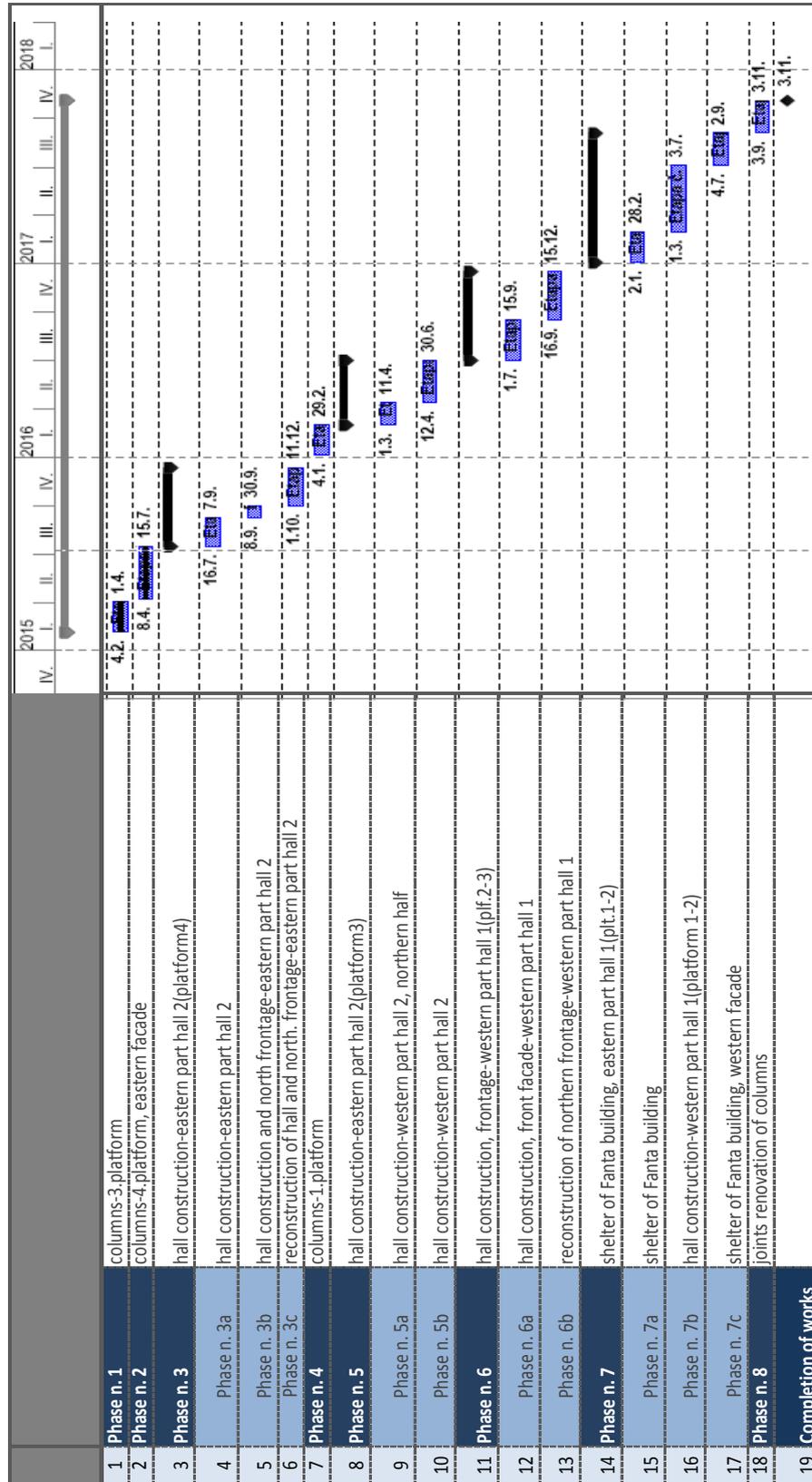
The subject of the public contract is the reconstruction of the existing building and roofing of railway main station in Prague The building is a tangible asset and aims to retain its original function and increase its aesthetic and utility value.

The architectural design of the building includes the construction of a steel architectural buildings above rail and platforms 1, 2, 3, 4. Due to lack of finances is carried out only maintenance which requires to ensure passenger safety. This is due to the significant decrease in the proportion of natural lighting due to blinded glass skylights and windows on the side walls of steel structures. The biggest problems currently represents local damage to historical steel construction, and from the resulting leakage and subsequent corrosion of steel parts, especially in the aboveground parts of columns over the knuckles.

5.1 Objectives of the project

The aim of the project is the successful completion of the renovation of the hall and the roof of the main station in Prague. As successful is meant in the time range, according to the schedule, that was agreed in the contract, as well as a price that was signed with the investor. It also retains the original function of the station and increasing its aesthetic value and their utility.

5.2 The project time schedule



5.3 The project team

The project team is changed during the time, the change depends on phase of the project. The project has a pre-preparation, followed by the preparation and production. After the project is carried out, subsequent financial controlling and after the warranty period of the project is necessary to respond to any complaints.

At the beginning, the planning team prepare project documentation, which must be extremely careful examined and then the team create a bill of quantities. Report and assessment is the basis for the team of calculants who create quotation calculation and budget. After that is determined a project manager and implementation team may start to care about the project.

During the project implementation is project manager the most important person. He is currently leading the project because he has the most comprehensive information and must know all the conditions of the implementation. He manages communication with subcontractors along with technical supervision of investor, and also communicates with the division management and is responsible for the implementation process. He controls site managers and foremen. He is also responsible for compliance with the construction schedule and budget. Project manager during performance of the contract - Reconstruction of the existing building and roofing railway main station in Prague, is Ing. Jan Krajdl.

Ing. Jan Krajdl is a very experienced project manager. He has had many successful projects, which include, for example, Pavilion D of Kolín Hospital (worth more than 220mil.CZK.) Or reconstruction of the sports hall Letná. Outside the reconstruction of the main station he leads in the same while four more projects. It's a very challenging position that requires great flexibility, stress resistance, excellent communication skills and, most importantly, experience in the field.

The main planning worker for the reconstruction of the existing hall is Ing. Petr Giovagnoni. Main planning worker preparer passes through a contract from the very beginning, when processing project documentation and materials for the bill of quantities. He is the right hand of the project manager and is responsible for the smooth running of the project. He leads the team of planning workers. He handles invoices and communicates with the department for the project control.

Furthermore, all projects go through a review that takes place every month directly at the division. These checks are called reproach procedures. At this reproach procedure participate management of division, project manager, main planner and head of the project controlling.

The following diagram are plotted relationships and communication links between project participants.

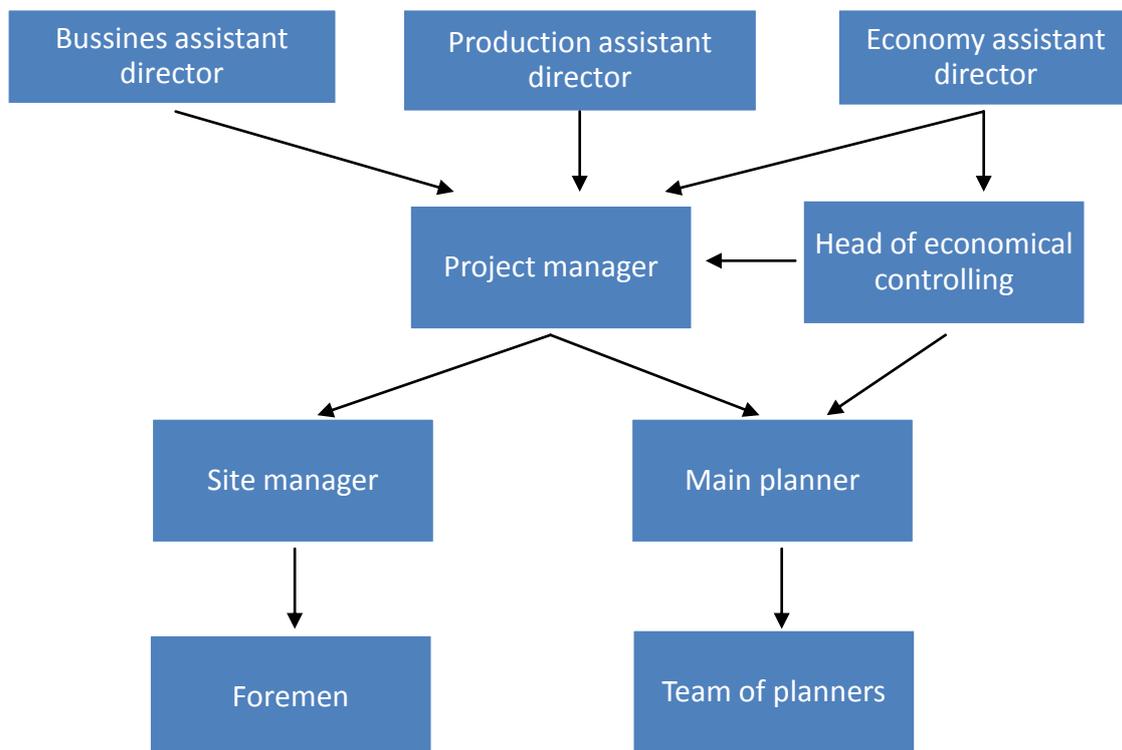


Figure 6 Project participants relationship

5.4 Budget of the project¹

Notes to the Control Agreement on Terms for a construction works 0300XXXX Roofing reconstruction of platforms-M.ST. in PRG

Project manager: **KRAJDL JAN, ING.**

10000000 Building objects	UM	Amount	Total
10135000 Steel Constructions	ths/FU	123 919	123 719 325 Czk
10135200 Temporarysuppor of SChall	ths/FU	31 504	31 304 391 Czk
10135310 Wall and roofsheating	ths/FU	9 739	9 735 581 Czk
10150000 Exchange of connection crossing	ths/FU	9 493	8 992 942 Czk
10155200 Redevelopment of the track top	ths/FU	16 568	15 967 820 Czk
10174000 Electronics, tractions, rail earthing	ths/FU	22 151	23 150 691 Czk
10176200 Construction and protection	ths/FU	3 889	3 988 837 Czk
10176400 Plumbing work withdownpipes	ths/FU	23 697	23 596 919 Czk
10176700 Columns supporting the structure	ths/FU	17 928	17 927 789 Czk
10176701 Metalwork, glazing	ths/FU	65 339	65 439 341 Czk
10176702 Walkways-gratings	ths/FU	2 793	2 692 669 Czk
10176703 Protection shelters	ths/FU	0	0 Czk
10178300 Painting and blasting	ths/FU	42 900	42 900 000 Czk
10179000 Security and Communication Tech.	ths/FU	3 935	3 934 951 Czk
10190000 Rail transport	ths/FU	8 400	8 600 000 Czk
10190001 Project documentation	ths/FU	4 155	4 054 825 Czk
10190002 Other work-orders	ths/FU	5	4 840 Czk
10190003 Other works	ths/FU	3 770	3 770 203 Czk
10192000 Scaffolding	ths/FU	44 780	44 780 388 Czk
10195000 Panelizing tracks	ths/FU	1 500	1 500 000 Czk
10195001 Tarpaulin	ths/FU	0	0 Czk
10199850 Ancillary works	ths/FU	3 000	3 000 000 Czk
10000000 Building objects			439 464 511 Czk
92000000 Budget reserve			
92199990 Budget provision for construction	ths/FU	0	0 Czk
92000000 Budget reserve 0 Czk			
97000000 Site facilities			
97300010 Site facilities	ths/FU	4 297	4 293 519 Czk
97300020 Site facilities-removing	ths/FU	44	44 000 Czk
97000000 Site facilities			4 337 519 Czk
98000000 Common construction costs			
98499000 Other expenses/evaluation	ths/FU	0	0 Czk
98000000 Common construction costs			56 249 167 Czk
99000000 Revenues			
99910000 Revenues from construction activity			453 085 703 Czk
99910001 Revenue from extra work			96 831 927 Czk
99920000 Other incm. Rltd. to const. Acts			4 242 849 Czk
99990000 Other Revenues			140 620 Czk
99000000 Revenues			469 793 672 Czk

¹ This is a real contract, numbers were modified

Capture 6

Risk analysis of the project

For the project of reconstruction of existing buildings and roofing railway station Prague Main Station is not developed a detailed risk management plan. For now, the risks are addressed more intuitively without the existence of a risk register.

My task will be based on the analysis of the plans for the project to proceed to search for potential risks that could affect the successful achievement of project objectives within a specified time range, and observing the budget. Throughout the analysis, the risks they will be considered only in terms of potential losses, rather than opportunities. After their identification comes the ranking in terms of likelihood and magnitude of potential losses as a result can be identified risks divided into common, serious and critical for the project. After will be recommend possible actions to protect the risks.

For the analysis itself I will use the **RIPRAN** method (*R*isk *P*roject *A*nalysis) [12]

6.1 Risk identification

The initial step is to identify the risk assessment project documentation and partial plans, which should reveal the vast majority of threats.

Project management in Division 3 does not include some risk management plan. The only thing that can be considered as a risk management process is the planning of the project at the beginning. Where it has been in the preparation of the project determines the risks of communicating and organizing the project between the project manager and division management.

These risks are the same at almost every project.

- **staff turnover**
- **breach schedule**
- **imprecision in the cost estimates**

Despite knowledge of these risks are some of those still neglected and there is no established procedure for how deal with these risks thru the working process.

An important part of risk management is to identify risks, and although at the strategy meeting were told only a small amount of risk, I believe that the project is threatened with more of them, and therefore I will focus on identifying those risks. :

- staff turnover
- breach schedule
- imprecision in the cost estimates
- lax cost control
- changes in project
- incomplete plans
- unexpected project expenses
- unexpected expences of materials
- failure of project equipment
- lax quality control
- fails of subcontractors
- coordination plans differ from cost plan
- a sudden shortage of construction materials
- members of the project teams involved in multiple project tasks at once

The most often, there are risks in human resources, project management and financial risks.

6.2 Risk analysis

For the risk assessment will be used grading scale with values ranging from 1 to 5, where 1 in verbal expression represents the lowest and 5 the contrary, the highest probability of occurrence or impact on project . Quantitative evaluation does not seem appropriate mainly due to lack of information about the probabilities and impacts monetary terms.

VALUE	PROBABILITY OF OCCURANCE	SIZE OF IMPACT
1	almost impossible	insignificant
2	improbable	less significant
3	possible	significant
4	probable	very significant
5	almost certain	critical

Table 1 Risk assessment grading scale

For each risk is grossed its value known as RPN (*Risk Priority Number*), which is a multiple of the probability of occurrence and the extent of the impact, reflects the seriousness of the risks. The severity and acceptability of risks is based on the resulting value of the RPN. The values are displayed in the Table 2

For assessing the seriousness of the project risks, were determined three categories in the following ranges of values RPN:

- **common** risk (1–6) is acceptable, is monitored
- **significant** risk (7–14) – is needed to pay attention, measures are planned
- **critical** risk (15–25) – threats to the project, adequate solutions are required

	Risk	Probability	Impact	RPN value
R1	staff turnover	4	3	12
R2	breach schedule	3	5	15
R3	imprecision in the cost estimates	4	5	20
R4	lax cost control	2	4	8
R5	changes in project	5	2	10
R6	incomplete plans	3	4	12
R7	unexpected project expenses	3	5	15
R8	unexpected expences of materials	2	4	8
R9	failure of project equipment	2	3	6
R10	lax quality control	2	3	6
R11	fails of subcontractors	3	2	6
R12	coordination plans differ from cost plan	4	3	12
R13	a sudden shortage of construction materials	2	4	8
R14	members of the project teams involved in multiple project tasks at once	5	4	20

Table 2 Seriousness of the project risks

6.3 Risk matrix

Graphically, the risks and the values represented by the maps or risk matrix. Critical risks are colored nejtmavěji and is located in the upper right corner.

probability of occurrence	almost certain		R5		R14	
	probable			R1; R12		R3
	possible		R11		R6	R2; R7
	improbable			R9; R10	R4; R8; R13	
	almost impossible					
		insignificant	less significant	significant	very significant	critical
	size of impact					

Table 3 Probability of occurrence vs size of impact

Capture 7

Proposed measures

For serious and critical risks is needed to establish measures to minimize them. Then make a new assessment of the probabilities and magnitude of the impacts and calculate the new risk values.

The outcome of the risk analysis is a clear risk register (Annex Work), which is a summary of previous steps to identify, assess and equally important part of the proposed measures. Each measure is determined by its owner, who monitors the risk and is responsible for implementing risk reduction measures.

The register can still be easily adjusted according to actual needs, for example in a case of probability change or value of risk impact, moreover register can be attributed with new risks. Or we can identify and delete those whose threat no longer exists.

7.1 Common risks

Improbable risks and risks with insignificant impact belong among the common risks. It is not essential to consistently prepare action to minimize them, but it is necessary to monitor them for the case of likelihood or potential impact would increase.

Risks as failure of project equipment (R9), lax quality control (R10) and fails of subcontractors (R11) have a common lower probability of occurrence. To set the research team, were chosen workers, who have extensive experience in managing similar projects and expertise to such a level that a failure in job assignments is improbable. Failure of project equipment (R9) it is very improbable risk due to the fact that Division 3 uses equipment and machines that are owned by Metrostav company. Metrostav currently has a large amount construction techniques, so the possibility of construction equipment to operationally ensure in a very short time.

Other risk – lax quality control (R10) is improbable, because Division 3 has high quality professionals in the management and quality control, but it is still necessary to monitor quality control, and all the information each month.

As far as *fails of subcontractors (R11)*, so the risk is treated in the contracts with these subcontractors and all the financial consequences, from the necessary elimination of defects, bear these subcontractors. It is important to monitor subcontractors before a contractual relationship is established, we need to know if subcontractors are liquid, so they can accept the potential financial burden.

7.2 Serious risks

The main part of the risks were assessed as severe. These risks include primarily those with moderate or higher probability of occurrence and the less significant or significant impact (R5, R1, R12), while also the risk of medium or less likely, but the impact of very significant (R6, R4, R8, R13).

It is almost certain that there will be any *change in the project (R5)*. This can be concluded from the experience with previous projects where there have always been changes, whether minor or major. It is therefore important to write these conditions in the contract with the investor, after follow the plan how to solve these changes and how to determine the price for these changes. In the contract of reconstruction of the main railway station, the investor is the city of Prague and is thus a public contract. This contract must comply with the project documentation from the investor and the changes are pricing in terms of real cost prices, where will be added the percentage margin. It is, therefore, why the risk is ranked as less serious.

Staff turnover (R1) it is very likely that there will be some employees who will leave during the project. Only during 2016 more than 15 employees left the division. This risk has a significant influence on the project, particularly if it is a qualified and professional staff. In order reconstruction of the main railway station in Prague were leaving the main project's methods. This man is very hardly replaceable plus there is even greater errors that can occur because the employee who is leaving, is not motivated to high performance work.

Coordination plans differ from cost plan (R12) In the vast majority of public contracts the project documentation differ form blind items of the budget, which is ready for a quote from potential suppliers. This risk can be avoided when preparing contracts, when the team of planners checks the documentation and it must be checked with the costing budget. If there is an error in the

blind cost plan, the team is obliged to inform the investor about the error. Very often it happens that this team has not enough time to control numerous documents. That is why therefore should be well prepared contractual relationship and prepared steps to resolve these differences.

Lax cost control (R4). Occurrence of this risk in the project is unlikely, since Division 3 has a well-developed system of financial control. In the course of the project we are constantly updated all costs and revenues. Always updating the plan and in reproach procedure team has to justify the differences from the plan. However, it is important to constantly monitor financial flows and educate employees in this because subsequent errors could have been very serious.

Unexpected expences of materials (8) is associated with risk (13) a sudden shortage of construction materials. Both leads to great consequential costs of materials. It is unlikely that the risk occurs, but it can happen, for example a specific material which does not have multiple producers and also if there is a greater demand for this material at the same time, may occurs a shortage of this material and effect construction with a delay. Or may occur a rise in prices for materials if we need given material at a certain time and we can not wait.

An essential means of minimizing most of risks is to found and secure an experienced staff with professional experiences, who will do their work as thoroughly and carefully as possible and will be able to assist managers in projects and provide professional work at a high level.

Other recommended measures to avoid risks include realistic planning, thorough monitoring of implementation plans and the project outputs, including the control of financial resources and cash flow. Failure to achieve certain specific objectives of the project could lead to serious complications.

Very important is defining the forms of communication at the beginning of the project, clear definition of responsibilities and allocation of responsibilities for each member of the project team, communicating information between investigators and participants in the project

7.3 Critical risks

Critical to the category of risk includes four of the identified risks: members of the project teams involved in multiple projects (R14), imprecisions in the cost estimates (R3), breach schedule (R2) and the unexpected project expenses (R7). It is important to plan an appropriate response, or more appropriately choose preventive measures to avoid threats to occur.

As I have previously written, so the project manager of the project: Reconstruction of the main station in Prague, has concurrently another three projects. Therefore, the risk - members of the project teams involved in multiple projects (R14) is evaluated as critical. The project manager is under a very large workload. He must control all projects simultaneously. Communicate with investors, suppliers and subordinates. Another three projects, which he leads, are not that large. Furthermore, he has to manage site managers, who manage realization of project on site and inform the project manager about every change.

Big risk lies in the fact that project manager is irreplaceable in the speed and if there is an inevitable situation that the project manager is not able to perform the job (for example, for health reasons), then the consequences would be very serious. As a measure to minimize the risk, I see an effort to lower a strain of the managers and the establishment of the operational plan which will be precisely determined for each project. And as well a deputy head of the project, who will be continuously trained for this position.

Imprecisions in the cost estimates (R3) is evaluated as probable and critical, since experience shows that almost every project there has at least partial error when creating the budget. In the financial cost planning department of Division 3 works the vast majority of employees who does not have experiences in realization of buildings. Moreover they are under pressure, because they do not have enough time for a thorough processing of these budgets. Additionally, employees are evaluated with a low pay rate and receive bonuses only after the successful implementation of the project. This happens a few months after performing their own work.

Naturally cost planning errors are not always critical, but as shows the above projects, it may even cause fatal errors of material pricing. This error can mean huge subsequent financial expenses. Therefore, as a draft measure, I see greater motivation of employees of this department. I also suggest prioritizing employment of older workers from the construction, for example, experienced site

manager, who no longer wants to continue with working on a realization site. And also ease the burden on these workers. If we can not increase the time of valuation, then we can at least increase the number of team members who are involved in pricing.

Breach schedule (R2) there is a probability of occurrence for this risk and possible consequences are particularly critical because subsequent penalties for failure to meet an implementation deadlines are very high. Recommendations to minimize the risk is to create the most accurate construction schedule, update and refine the information during the realization. Division 3 has created an organizational plans to implement a project and also employs an experienced staff, who are able to create very precise implementation plans. However, there may be situations where, for example, comes to finding of archaeological remains and it prolongs the realization time. In this case, it must be written in the contract that the contractor is not responsible for situation like this.

The last risk which may occur are unexpected project expenses (R8), which can have a great impact on the final budget of the project. Because they are unexpected expenses, so we can not planned or recommend exact instructions to minimize this risk. The only recommendation is to create a cost reserve, which will be a percentage of the total project cost. Or further set up an project insurance, which may mitigate the consequences of this risk, if it occurs.

Conclusion

Risk management should be an integral part of every project management. Each project is threatened with the considerable amount of risks. Early identification and subsequent implementation of effective management, including measures to minimize them in advance, than the risk turns out to be heavily solvable problem with great impact targets or to the project budget.

However, in practice, the importance of risk management is usually underestimated and moreover at the project is often not compiled the basic overview of risks.

The main objective was to analyze the risks in this project proposal and adequate responses to their reduction. This was preceded by work with a literature in the theoretical part, which served as the basis for the continuing practical part. Targets set at the beginning of the work were met. The corporate environment was analyzed. Analysis of project was done, identified and analyzed risks using the RIPRAN method, which was chosen due to the character of the project. Risk based on the severity was divided into three categories on a common, serious and critical. Anti-risk measures depending on the evaluation were designed. The results of the individual steps of the analysis were recorded in a transparent risk register, which is attached to this work.

As I mentioned in my work before, for serious and critical risks is needed to establish measures to minimize them. Then make a new assessment of the probabilities and magnitude of the impacts and calculate the new risk values.

The outcome of the risk analysis of every project is a clear risk register, which is a summary of steps to identify, assess, monitor and equally important part to propose measures. Each measure is determined by its owner, who monitors the risk and is responsible for implementing risk reduction measures. The register can still be easily adjusted according to actual needs, for example in the case of probability change or value of risk impact, moreover register can be attributed with new risks. Or we can identify and delete those whose threat no longer exists.

I evaluate this project as less risky because most risks can quite easily be avoided, especially by choosing experienced professionals for the research team, effective communication between investor and careful work done by project managers. As the most critical risks identified in the project are related to personnel changes in the project team and the imprecisions in the cost estimates. Most important measures for minimizing the risks the employment of skilled workers

and the creation of appropriate motivating conditions. There should also be an effort to avoid being long burdened and subjected to stress. Another big problem is the staff migration, it is important start to solve this problem. Qualified employees are not sufficiently financially motivated and migrate to competing companies.

Division 3 has no comprehensive risk management system and it is possible to see how this has a negative effect on the final results of the division. As absolutely wrong strategic decisions of Division 3, that are connected to the risk management, because this decision see the efforts to minimize internal personnel costs per employee. This decision leads to worse performance and more employees make errors in the preparation of projects and cost planning. Subsequent costs of resolving these errors, are higher than the race wages of employees and thereby improve their performance and at the same time to avoid the migration of experienced staff. Additionally, employees are evaluated with a low pay rate and receive bonuses only after the successful implementation of the project. Very important is defining the forms of communication at the beginning of the project, clear definition of responsibilities and allocation of responsibilities for each member of the project team.

I suppose as a final measure to implement komplex system of risk management, which will be based on the risk monitoring table. Risks must be sought in the beginning of every project and written on in the table.

Measures I suggested will help to save a financial resources of the company and above that, will help to improve an internal working conditions.

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