Journal of Engineering and Applied Sciences 12 (20): 5347-5352, 2017
ISSN: 1816-949X
© Medwell Journals, 2017

# Risk Management in Construction Projects

Petr Rehacek
Department of Systems Engineering, VSB-Technical University of Ostrava, Ostrava, Czech Republic

**Abstract:** No construction project is risk free. The risk factor in construction business is very high. Construction objects are unique and built mostly only once. Construction objects life cycle is full of various risks. Risks come from many sources: temporary project team that is collected from different companies, construction site, etc. Moreover, the size and complexity of construction objects are increasing which adds to the risks. This is in addition to the political, economic, social conditions where the object is to be undertaken. Object risk can be defined as an uncertain event or condition that if it occurs has a positive or negative effect on at least one construction project objective such as time, cost and quality. The risks cause cost and time overruns in construction projects. The study, presents risk assessment of construction projects and its aims to identify and analyze the risks associated with the construction projects.

**Key words:** Management, project, risk, standard, construction project, objective, cost and quality

## INTRODUCTION

Risk management is a concept which is used in all industries from IT related business, automobile or pharmaceutical industry to the construction sector. Each industry has developed their own risk management standards but the general ideas of the concept usually remain the same regardless of the sector.

Risk management should be conducted on all projects. The degree, level of detail, sophistication of tools and amount of time and resources applied to risk management should be in proportion to the characteristics of the project under management and the value that they can add to the outcome. Thus, a large project that provides value to an important customer would theoretically require more resources, time and attention to risk management than would a smaller, short-term, internal project that can be conducted in the background with a flexible deadline.

Specific criteria (PMI, 2013) for success of each risk management process include; recognize the value of risk management-risk management should be recognized as a valuable discipline that provides a positive potential return on investment for organizational management, project stakeholders (both internal and external), project management and team members.

Individual commitment/responsibility project participants and stakeholders should all accept responsibility for undertaking risk-related activities as required. Risk management is everybody's responsibility. Open and honest communication everyone should be involved in the risk management process. Any actions or attitudes that hinder communication about project risk reduce the effectiveness of risk management in terms of proactive approaches and effective decision-making.

Organizational commitment-organizational commitment can only be established if risk management is aligned with the organization's goals and values. Risk management may require a higher level of managerial support than other project management disciplines because handling some of the risks will require approval of or responses from others at levels above the project manager.

Risk effort scaled to project-risk management activities should be consistent with the value of the project to the organization and with its level of project risk, its scale and other organizational constraints. In particular, the cost of risk management should be appropriate to its potential value to the project and the organization.

Integration with project management-risk management does not exist in a vacuum, isolated from other project management processes. Successful risk management requires the correct execution of the other project management processes. These critical success factors for risk management are illustrated in Fig. 1.

The principles of risk management described should be appropriately applied based on the specifics of a project and the organizational environment. Risk management provides benefits when it is implemented according to good practice principles and with organizational commitment to taking the decisions and performing actions in an open and unbiased manner.

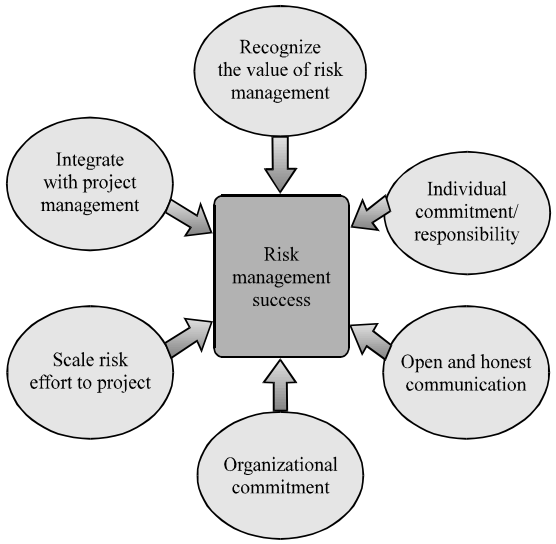


Fig. 1: Critical success factors for risk management (PMI, 2013)

## MATERIALS AND METHODS

**Risk management process in construction projects:** The risk management process in construction is extreme and important. Risk measure includes risk level determination of each objective and the risk analysis estimation by applying various approaches and technology. Risk control process evaluates performance of risk control.

Risk identification is the first and main step of risk management process. It is describing the competitiveness conditions and the clarification of risk and uncertainty factors (Rutkauskas, 2008; Zayed *et al*., 2008) recognition of potential sources of risk and uncertainty event responsibilities (Asgari, 2016). The project risks can be divided into three groups:

- External risks
- Project risks
- Internal risks

External risks are those risks that are beyond the control of the project management team. Internal risks can be divided according to the party who might be the originator of risk events such as stakeholders, designer, contractor, etc. There are various classification ways of risk management methods. The risk allocation structure of construction projects is presented in Fig. 2.

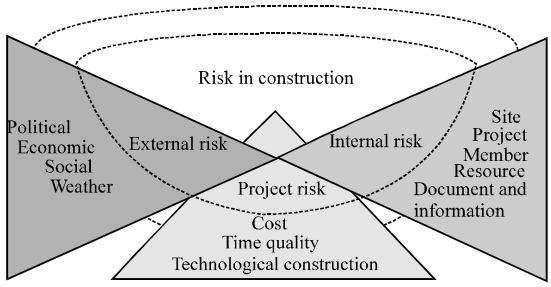


Fig. 2: The risk allocation structure in construction project (Zavadskas *et al*., 2008)

## RESULTS AND DISCUSSION

**External risks (Environmental criteria):**

- Political risk
- Economic risk
- Social risk
- Weather risk

**Political risks:** There are changes in government laws of legislative system, regulations and policy and improper administration system, etc. (Li and Liao, 2007).

**Economic risks:** There is inconstancy of economy in the country, repayment situation in manufacture sphere, inflation and funding. Considering the current economic situation, this result can be reasonably expected.

**Social risks:** Are the growing importance to any effort at risk allocation. It is an area in which political and social pressures from parties having little interest in a project but having a great impact on such a project greatly influence its outcome. The impact of the financial aid on social and economic development of the region is analyzed by Ginevicius and Podvezko (2009), risk communication in organizations is analyzed by Conchie and Burns (2008).

**Weather risk:** Except for extremely abnormal conditions, it is a risk for the contractor to assume as its impact on construction methods can be assessed by the contractor.

**Project risks (Construction process criteria):**

- Time risk
- Cost risk
- Work quality
- Construction risk
- Technological risk

**Time risk:** Can be determined by appraisal of the delay at construction, technology and for all researchs.

**Cost risk:** The cost of opportunity product grows due to neglecting of management (Zavadskas *et al*., 2008).

**Work quality:** Deflective work is considered a significant risk factor in this category because not only does it result in construction delays and additional cost to the contractor but it easily leads to disputes on the liability for the deflection.

**Construction risk:** The risks are involved in construction delay, changes in the work and construction technology.

**Technological risk:** Designing errors, lack of technologies, management errors, shortage of the qualified labour.

**Internal (Intrinsic) risks:**

- Resource risk
- Project member risk
- Stakeholder's risks
- Designers risk
- Contractor risk
- Subcontractor risk
- Suppliers risk
- Team risk
- Construction site risk
- Documents and information risk

**Resource risk:** Materials and equipment involve considerable risks. The availability and productivity of the resources necessary to construct the project are risks which are proper for the contractor to assume (Fisk, 2003).

**Project member risk:** Team risk refers to issues associated with the project team members which can increase the uncertainty of a project's outcome such as team member turnover, staffing build up, insufficient knowledge among team members, cooperation, motivation and team communication issues.

**Stakeholder's risks:** Rightfully belong to the stakeholder alone and should be retained by stakeholders except to the extent that they are influenced by construction methods determined by the contractor or created by suppliers controlled by the contractor. Stakeholder's influence on the external environment is analyzed by Mitkus and Sostak (2008).

**Designers risk:** The expansion of construction has placed great burdens upon the design professions. Maintaining performance standards in the face of this is quite difficult and occasionally, design or specification deflections occur that create construction problems. Design failures or constructability errors are becoming more and apparent and the architect should bear the true cost of such failures.

**Contractor risk:** The prime or general contractors are in the best position to assess the capacity of their subcontractors and therefore it is they who should bear the risk of not assessing the risk properly.

**Subcontractor risk:** It is properly assumed by the contractor except where it arises from one of the other listed risks attributable to stakeholder or architect (Fisk, 2003).

**Suppliers risk:** Default from obligations of the supplier (Fisk, 2003).

**Team risk:** Team risk refers to issues associated with the project team members that can increase the uncertainty of a project's outcome such as team member turnover, staffing build up, insufficient knowledge among team members, cooperation, motivation and team communication issues. Working team must analyze the business activities of all alliance members and identify various risk factors in business activities and their characters (Li and Liao, 2007; Li *et al*., 2007).

**Construction site risk:** Accident exposures in workplace are inherent in the nature of the work and are best assessed by the contractors and their insurance and safety advisors (Fisk, 2003).

**Documents and information risk assumes:** contradiction in documents; pretermission; legal and communication. Changed order negotiation and delayed dispute resolution are significant risks during project construction. Communication is very important at all construction period and after finishing construction work.

Likewise, risk management has become a timely issue widely discussed across industries. However, with regard to the construction industry, risk management is not commonly used. More construction companies are starting to become aware of the risk management process, but are still not using models and techniques aimed for managing risks. This contradicts the fact that the industry is trying to be more cost and time efficient as well as have more control over projects. The construction industry operates in a very uncertain environment where conditions can change due to the complexity of each project (Sanvido *et al*., 1992). The aim of each organization is to be successful and risk management can facilitate it. However, it should be underlined that risk

Table 1: Project risk structure

| Natural phenomenon | Construction | Designer |
|---|---|---|
| Earthquake | New technology implementation | Constructability |
| Fire | Too high quality standard | Vague drawing specifications |
| High gale | Faulty job field survey | Incomplete construction area |
| Rainfall | Inadequate construction planning | Incompetent supervision skills |
| | Inadequate procurement planning | Frequent design change |
| **Economics/finance** | | Lack of fair stance |
| Increased materials cost | **Job site** | |
| Exchange rate fluctuation | Incompetent planning | **Contractor** |
| Difficulty of financing | Incompetent management | Stringent contractual terms |
| Low market demand | Incompetent coordinator | Deficit contracting |
| Strong competitor | | Short of manpower or experience |
| | **Safety/environment** | Higher cost than bid taking |
| **Politics/society** | Environment damage/pollution | Short of capital/equipment |
| Change of laws | Accident-related loss | Local jobsite particularity |
| War/revolution/riot | Traffic or work hour restriction | Shortage in machine tools and workers mobilization due to clashes of several projects |
| Bribery/corruption | Third party's objection | |
| Language/cultural barrier | | Low safety awareness |
| Lobby (legal/illegal) | **Client** | Erroneous allocation of human resource |
| Rigid bureaucracy | Feasibility study | Lack of trustworthy support by subcontractor |
| | Unreasonable demand | |
| **Contract** | Reference by subcontractors | Low working morale |
| Unequal contractual provisions | Relation with the third party | High personnel mobility |
| Dispute among entities | Late payment | |
| Unjust arbitrator | Reliance on architect /consultant | **Industrial characteristics** |
| Inadequate insurance coverage | Jobsite superintendent being incompetent | Monopolized bidding |
| Defect warranty | Financial problem/bankruptcy | Labour union |
| Misjudged cost estimation | Difficulty in choosing business dealer | |

management is not a tool which ensures success but rather a tool which helps to increase the probability of achieving success. Risk management is therefore a proactive rather than a reactive concept. These risk classifications for construction projects are presented in Table 1 (Tsai and Yang, 2010).

**Risk management methods in construction projects:** Risk Identification can be done by the following methods (Rajendhran and Sundar, 2011; Rehacek, 2017).

**Brainstorming:** This is one of the most popular techniques. Generally, it is used for idea generation; it is also very useful for risk identification. All relevant persons associated with project gather at one place. There is one facilitator who is briefing about various aspects with the participants and then after note down the factors. Before closing it the facilitator review the factors eliminate the unnecessary ones.

**Delphi technique:** This technique is similar to brainstorming but the participants in this do not know each other and they are not at the same place. They will identify the factors without consulting other participants. The facilitator like in brainstorming sums up the identified factors.

**Interview/expert opinion:** Experts or personnel with sufficient experience in a project can be a great help in avoiding/solving similar problems over and over again. All the participants or the relevant persons in the project can be interviewed for the identification of factors affecting risk.

**Past experience:** Past experience from the same kind of project, the analogy can be formed for identification of the factors. When comparing the characteristics of projects will provide insight about the common factors.

**Checklists:** These are simple but very useful predetermined lists of factors that are possible for the project. The check list which contains a list of the risks identified in projects undertaken in the past and the responses to those risks provides a head start in risk identification.

Risk assessment can be done by the following methods (Rajendhran and Sundar, 2011; Rehacek, 2017) (Fig. 3):

Qualitative method: PI factor =

Probability of risk×impact of risk

**Quantitative methods sensitivity analysis:** This is carried out to identify the uncertain project components which will have maximum impact on the outcome of the project. After a risk model is made a sensitivity analysis is carried out to check the sensitivity of different elements of the model on project outcome. To do these the values of one variable at a time is changed and the impact of these changes is then seen on the project.

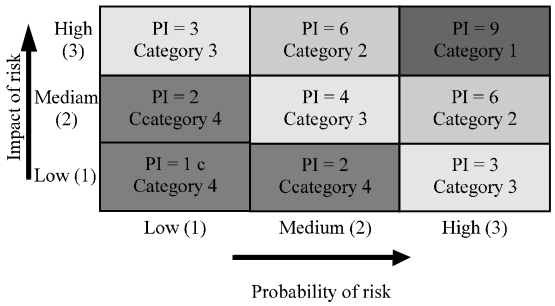


Fig. 3: Four categories for PI factor; Category 1-PI factor 9 which requires maximum attention; Category 2-PI factor 6 which requires a good amount of attention; Category 3-PI factor 3 which requires comparatively less attention; Category 4-PI factors of 1 and 2, requires less attention

**Scenario analysis:** Scenario analysis gives the impact of different scenario of the project or impact of different risk if that occurs simultaneously. A fair decision can be made after this analysis, the option which will give lesser loss or hazards that option can be opted. Probabilistic analysis (Monte Carlo Simulation) a project simulation is done using a model to show the potential impact of different level of uncertainties on project objectives. Monte Carlo Simulation is generally used for this analysis. It can quantify the effect of uncertainties and risks on project budget and schedule. It simulates the full system many times each time randomly choosing a value for each factor from its probability distribution. It uses three point estimates like most likely, worst case and best case duration for each task in time management.

**Decision trees:** This analysis is carried out by decision tree diagram. Decision trees are very helpful to both formulate the problem and evaluate options. In this analysis there are graphical models used to represents project and can clearly reflect the effects of each decision taken in the project.

Risk response planning can be done by the following methods (Rajendhran and Sundar, 2011; Rehacek, 2017).

**Risk avoidance:** Risk can be warded off by removing the cause of the risk of executing the project in a different direction while still aiming to accomplish project objectives. Change project management plan to eliminate a threat to isolate project objectives from the risk's impact or to relax the project objective that is in jeopardy such as extending schedule or reducing the scope.

**Risk transfer:** Transferring risk involves finding some other party who is willing to accept responsibility for its management and who will bear the liability of the risk should it occur. Transferring a threat does not eliminate it; the threat still exists however it is owned and managed by another party. Transferring risk can be an effective way to deal with financial risk exposure. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively.

**Risk mitigation/reduction:** Risk mitigation reduces the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective.

**Risk exploit:** This strategy seeks to eliminate the uncertainty associated with a particular upside risk by creating the opportunity definitely happens. Eliminate the uncertainty associated with a particular upside risk. An opportunity is defined as a risk event that if it occurs will have a positive effect on achievement of project objectives.

**Risk share:** Allocate risk ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does happen. Transferring threats and sharing opportunities are similar in that a third party is used those to whom the threats are transferred take on the liability and those to whom opportunities are allocated should also be allowed to share in the potential benefits.

**Risk enhance:** This response aims to alter the "size" of the positive risk. The opportunity is enhanced by increasing its probability and/or impact, thereby maximizing the benefits gained from the project. Seeking to facilitate or strengthen the cause of the opportunity and proactively targeting and reinforcing its trigger conditions.

**Risk acceptance:** Ultimately it is not possible to eliminate all threats or take advantage of all opportunities we can document them and at least provide awareness that these exist and have been identified, some term this "passive acceptance". This strategy is adopted when it is not possible or practical to respond to the risk by the other strategies or a response is not justified by the grandness of the risk. When the project manager and the project team decide to accept a risk they are agreeing to address the risk if and when it happens. This involves the use of a fallback (contingency) plan if a risk occurs. Contingencies can also be in the form of sometime kept in reserve to deal with unknown risks or in the form of costs to deal with unknown risks.

Risk control is the final step of the process (Rajendhran and Sundar, 2011; Rehacek, 2017). After, we have implemented response actions we must track and record their effectiveness and any changes to the project risk profile. Did the response actions have a positive or negative effect on achieving project objectives? Responses taken in risks should also be documented for future reference and project plans.

## CONCLUSION

Decision-making is very important in the construction management such as risk assessment results in construction projects, contractor and supplier selection, etc. Each project manager should have a basic knowledge about risks associated to a project and how to handle them.

Risks are being managed every day in the industry but not in such a structured way as the literature describes. However, information provided in those sources is rather messy. Some theories provided by risk management literature are not at all applicable to construction industry. As also other researchers confirmed, the knowledge of risk management is close to zero, even though the concept of risk management is becoming more popular in the construction sector.

Professionals in the construction industry are using techniques described in the literature concerning risk management but are not aware of it. Risk management technique rarely used by the participants in construction projects. The participants used to handle the risks with an informal approach. This technique is not employed because of less knowledge and awareness among the construction industry. The risk management technique should be applied into any construction project at the initial stage of the project to get maximum benefit of the technique. Hence, there is thriving need to have a well-documented procedure which should be a one stop solution to all hazards that are likely to occur during project life cycle. There should be more wholesome approach towards risk management instead of the present sporadic approach towards the risks.

## REFERENCES


Asgari, S., 2016. Insulated Concrete Formwork systems (ICFs) from the perspective of project management. J. Eng. Appl. Sci., 100: 876-883.

Conchie, S.M. and C. Burns, 2008. Trust and risk communication in high-risk organizations: A test of principles from social risk research. Risk Anal., 28: 141-149.

Fisk, E.R., 2003. Construction Project Administration. 7th Edn., Prentice Hall, Upper Saddle River, New Jersey, USA., ISBN:9780130984722, Pages: 637.

Ginevicius, R. and V. Podvezko, 2009. Evaluating the changes in economic and social development of Lithuanian counties by multiple criteria methods. Technol. Econ. Dev. Economy, 15: 418-436.

Li, G.D., D. Yamaguchi and M. Nagai, 2007. A grey-based decision-making approach to the supplier selection problem. Mathe. Comput. Modell., 46: 573-581.

Li, Y. and X. Liao, 2007. Decision support for risk analysis on dynamic alliance. Decis. Support Syst., 42: 2043-2059.

Mitkus, S. and O.R. Sostak, 2008. Modelling the process for defence of third party rights infringed while imp lementing construction investment projects. Technol. Econ. Dev. Economy, 14: 208-223.

PMI., 2013. A Guide to the Project Management Body of Knowledge (PMBOK Guide). 5th Edn., Project Management Institute, Newton Square, PA., USA.

Rajendhran, N. and P. Sundar, 2011. A study of risk assessment and management in construction. Master Thesis, PSG College of Technology, Coimbatore, India.

Rehacek, P., 2017. Application and usage of the standards for project management and their comparison. J. Eng. Appl. Sci., 12: 994-1002.

Rutkauskas, A.V., 2008. On the sustainability of regional competitiveness development considering risk. Technol. Econ. Dev. Economy, 14: 89-99.

Sanvido, V., F. Grobler, K. Parfitt, M. Guvenis and M. Coyle, 1992. Critical success factors for construction projects. J. Constr. Eng. Manage., 118: 94-111.

Tsai, T.C. and M.L. Yang, 2010. Risk assessment of design-bid-build and design-build building projects. J. Oper. Res. Soc. Japan, 53: 20-39.

Zavadskas, E.K., Z. Turskis and J. Tamosaitiene, 2008. Contractor selection of construction in a competitive environment. J. Bus. Econ. Manage., 9: 181-187.

Zayed, T., M. Amer and J. Pan, 2008. Assessing risk and uncertainty inherent in Chinese highway projects using AHP. Intl. J. Project Manage., 26: 408-419.