RISK FACTORS IN PROJECT MANAGEMENT LIFE CYCLE

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Abstract: Successful project management requires the identification of the factors impacting project scope definition, cost, schedule, contracting strategy and work execution plan. Risks can run across the life cycle of a project or they can appear at various times throughout the project. Identifying and mitigating project risks are crucial steps in managing successful projects.

Key words: project management (PM), risk analysis, project life cycle.

1. INTRODUCTION

Today, effectively managing risk is an essential element of successful project management. Failure to perform effective risk management can cause projects to exceed budget, fall behind schedule, miss critical performance targets, or exhibit any combination of these troubles. Projects management is critical to the organization success of any field. Projects increase sales, reduce costs, improve quality and customer satisfaction, enhance the work environment, and result in many other benefits. As organizations have recognized the criticality of projects to their success, project management has become a focal point of improvement efforts. More and more organizations have embraced project management as a key strategy for remaining competitive in today’s highly competitive business environment.

Risk analysis is the process of assessing risk, while risk management uses risk analysis to devise management strategies to reduce or ameliorate risk. In project management, these techniques are used to address the questions ‘how long will this project eventually take’ (schedule risk), “how much will it finally cost?” (cost risk), and “will its product perform according to specifications?” (performance risk).

2. PROJECT LIFE CYCLE

Because projects are unique undertakings, they involve a degree of uncertainty. Organizations performing projects will usually divide each project into several project phases to provide better management control and appropriate links to the ongoing operations of the performing organization. Collectively, the project phases are known as the project life cycle.

Each project phase normally a set of defined work products designed to establish the desired level of management control. The majority of these items are related to the primary phase deliverable, and the phases typically take their names from these items: requirements, design, build, text, start-up, turnover, and others as appropriate.

Project life cycles generally define:
- What technical work should be done in each phase?
- Who should be involved in each phase?

Each phase has a different requirement for successful completion. Fault Tree Analysis is used to modelling possible fault in every stage of project life cycle. Such assessment technique is capable of modelling all project management outcomes on one logic diagram. The structure of the diagram has been shown to have advantageous features in both its representation of the project failure logic and its subsequent
quantification, which could be applied to phased mission analysis.

2.1. Process Groups
Project management process can be organized into five (or more) processes each:

- Initiating process - recognizing that a project or phase should begin and committing to do so.
- Planning process - devising and maintaining a workable scheme to accomplish the business need that the project was undertaken to address.
- Executing process - coordinating people and other resources to carry out the plan.
- Controlling process - ensuring that project objectives are met by monitoring and measuring progress and taking corrective action when necessary.
- Closing process - formalizing acceptance of project or phase and bringing it to an orderly end.

In process groups are linked by the results they produce – the result or outcome of one becomes an input to another. Among the central process groups, the links are iterated – planning provide executing with a documented project plan early on, and then provides documented updates to plan as the project progress. The project management process groups are not discrete; they are overlapping activities which occur at varying levels of intensity throughout each phase of the project. Figure 1 illustrates how the process group overlap and within a phase [2].

2.2. Classification of risks
The basis approach to risk management should be based on principle that the party best able to manage a risk at least cost should mitigate it. The risk associated with infrastructure projects can be classified as in Fig. 2.

![Fig. 2. Project risks classification](image)

3. RISK MANAGEMENT
The purpose of the risk management is to identify problems before they occur. Risk management was initially part of process management. We should identify risks before they become problems. Identification of risks could be done by any approach: checklists, flowcharts, interviews, etc. (see Fig. 3).

![Fig. 3. Methods of risk management](image)

![Fig. 1. Project phases](image)
Risk assessment process helps quickly identify, classify, and prioritize previously unknown cost, schedule, technical, and performance risks. For risk assessment proper risk management can assist the project manager to mitigate risks on projects of all kinds (see Fig. 3). Risk in any transaction cannot be eliminated. It always exists for both parties to the contract. However, risk can be managed to an acceptable level, using the following protocol [7]:

- **Identify the risk**: What events or actions would adversely affect the cost, performance, timing or viability of a project? E.g. what would happen to the project if the inflation rate increased significantly? Determine the severity of the risk: What is the specific cost, time, delay or reduction in performance of this event happens?
- **Allocate the risk**: The “golden rule” of risk management in contracts is that a risk should be managed by the party best able to manage that risk. Shifting risk to party not able to manage that particular risk costs more, and creates even more risk to project.
- **Mitigate the risk**: Determine what must be done to reduce the likelihood of an adverse event.

### 4. METHODS FOR RISK ANALYSIS

Having identified a range of risks we now need to consider which the most serious risks are in order to determine where focus out attention and resources to. We need to understand both their relative priority and absolute significance.

#### 4.1. Qualitative Risk Analysis

Most of the risk analysis will be of a qualitative nature. Few of us have the skills, time or resources to undertake the kind of quantitative modelling that goes on in major projects. Disciplined and structured approach is possible to improve the objectivity of your analysis without getting into complex calculations or needing specialist software tools.

#### 4.2. Quantitative Risk Analysis

Estimating the probability and consequences of risks and estimating the implications for project objectives [7]. There are many methods and tools for project quantitative risk study (see Fig. 4). Some methods may be relevant, but are too complex. Therefore it is necessary choose right methods for project risk analysis.

![Fig. 4. Risk management techniques for projects.](image-url)
The method will be evaluated by a series of criteria:

- **Relevancy**: what kinds of fault could the method fail to uncover.
- **Complexity**: some methods may be relevant, but are too complex, needs much resources, documentations, etc.
- **Usability**: Some of the methods may be performed in collaboration with stakeholders; therefore the usability aspect of the method may be important. How does the project team execute the risk management plan? Monitor and control the execution of the plan with iterative, adaptive process.
- **Output**: corrective actions and updates to the risk management plan.

### 4.3. Complex approach of risks analysis

For more complex projects is necessary use some risk analysis methods as offers Hermansen [3]. In Fig. 5 is introduced conceptual model of enterprise and corresponding risk analysis methods in every level.

**Fig. 5. Methods for enterprise risk analysis studying [3]**

**PHA and Use Case Diagram** will describe the system at a very early point of development. The use case will explain the functional requirements of the system, that is, how do the stakeholders want the system to function.

**FMEA and Component Diagram** depict the subsystems and services such as databases and external services, which is very good foundation to reason about the implication of loss of service. The FMEA method forces us to consider the interaction between them.

**FTA or Fault Tree Analysis** is the most widely used method for analysing risks. It is a logical diagram used to express the link between an unwanted event in the system and the faults that cause this event. The method is divided into five steps:
1. Problem definition and analytical boundaries.
2. Fault Tree construction.
3. Estimate minimal cut sets and path sets.
4. Qualitative analysis of the fault tree.
5. Quantitative analysis of the fault tree.

**CCA or Cause-Consequence Analysis** starts by defining a set of triggering events. Denial of service would be a suitable candidate for such an event. CCA like FTA is a logical diagram. Whilst FTA starts from an unwanted event and finds the initiating critical events, the CCA starts from the other end.

### 5. PROJECT LIFE CYCLE RISK ANALYSIS

There are three basic concerns in project management:

1. **Schedule.** Will the project go over schedule?
2. **Cost.** Will the project go over schedule?
3. **Performance.** Will the output satisfy the goals of the project

At the start and up until the end of a project, the answer to each of these questions is unknown, and a yes answer to any or all the questions is taken to be an undesirable consequence.

#### 5.1. Failures of the project

Reasons for project "failure":

- Unclear over-arching corporate objectives;
- Misalignment with corporate strategy, objectives;
- Lack of a project management culture;
- Lack of project governance;
- Inadequate financing or functional authority;
- Too many projects in a portfolio;
- Too many concurrent projects;
- Lack of contact with the client or sponsor;
- Indifferent support from the customer;
- Insufficient stakeholder consultation;
- Unclear roles and responsibilities;
- Lack of management skills;
- Lack of methodology, process; and many others...

5.2. Project life cycle faults

Fault tree analysis (FTA) is a graphical representation of the major faults associated with a product, their causes and potential countermeasures. FTA has been widely used to investigate the reliability of complex and large systems and for diagnostic applications [5]. The procedures of designating the reliability of critical systems are included in the international standard ICE 1508 Functional Safety: Safety related systems.

The following simple rules should be kept in mind during construction and analysing of fault trees:

- Use an OR gate to express the failure caused by any of several possible lower level failures. The unavailability of a subsystem represented by the OR gate is a sum of the faults of a device.
- Use an AND gate to express the failure caused only when all the lower level failures occur. The unavailability of a subsystem represented by the AND gate is the product of the faults of a device.

There are other gates besides the AND and OR ones. However, many fault trees require only the abovementioned gates, and in the present paper we restrict our discussion to these basic items. The probability of a high-level event occurring for the AND events faults multiplied and for the OR events faults summed.

A rough estimation of project management risk factors during project life-cycle using FTA method is presented in Fig. 6. The main risk factors are estimated on various project life-cycle stages and their probabilities are subjectively defined. For events $E_1$, $E_2$, … $E_n$, which are mutually exclusive (OR events), the general formula can be expressed as $[6]$, $[7]$.

![Fig. 6. Analysis of a total project risk](image-url)
\[
P(E_1 \text{or} E_2 \text{or} ... \text{or} E_n) = 
\sum_{i=1}^{n} P(E_i) - \sum_{j=1}^{n-1} \sum_{i=1}^{n} P(E_i \text{or} E_j) + 
\sum_{j=1}^{n-2} \sum_{i=1}^{n-1} \sum_{k=j+1}^{n} P(E_i \text{and} E_j \text{and} E_k)...
\]

If we ignore the possibility of any two or more of the events \(E_i\) occurring simultaneously, equation 3 will be reduced to:

\[
P(E_1 \text{or} E_2 \text{or} ... \text{or} E_n) = \sum_{i=1}^{n} P(E_i)
\]

(2)

The probability of occurrence of the top event \(P_{TPR}\) defines as following (Fig. 6):

\[
P_{TPR} = P_P(\sum P_{PI}) \cup P_{PP}(\sum P_{PP}) \cup P_{PE}(\sum P_{PE}) \cup P_{PC}(\sum P_{PC})
\]

(3)

Where:

\(P_{TPR}\) - probability of total project risk;
\(P_{PI}\) - probability of project initiating risk;
\(P_{PP}\) - probability of project planning risk;
\(P_{PE}\) - probability of project executing risk;
\(P_{PC}\) - probability of closing risk.

Total project risk generally is defined in the FTA model (see Fig. 6) as 0.0252. For the particular project the \(P_{TPR}\) may be far different. From introduced fault tree we can see that most fallible part in life cycle is project execution and little less planning.

6. CONCLUSIONS

The aim of the paper was to survey how quantitative risk management and risk analysis methods were applied to the planning and execution of complex projects.

In the paper introduced classification of a project risk analysis methods and the range of application.

The cost of safety assessment can grow rapidly if the objectives and ground rules are not clearly laid out. The ability to see the knock-on effects of the plan needs experience and knowledge of the benefits and pitfalls associated with the project management process.

7. REFERENCES