



- Q. 3 Explain the relationship between people and efforts in project scheduling
- Q. 4 Describe the effort distribution in project scheduling in brief
- Q. 5 What is the need of a Gantt chart and explain it with an example.
- Q. 6 What is the need of PERT/CPM chart.
- Q. 7 Give the difference between PERT and CPM
- Q. 8 Explain a PERT/CPM chart with an example
- Q. 9 For the following data, draw the PERT/CPM network diagram.

Activity	Preceding Activity
A	-
B	A
C	A
D	B, C
E	B
F	D, E

- Q. 10 Draw the network diagram for the following problem.

Activity	Preceding Activity	Time(days)
A	-	10
B	-	14
C	A	8
D	A	7
E	B	5
F	B	10
G	C	9
H	D, E	11
I	G, H	5

- Q. 11 For a project that includes tasks like requirement analysis, designing, coding, testing and implementation; break the work down into small enough parts that you can estimate the time for completion.

Assignment 1: Build a WBS chart

Assignment 2: Use the WBS chart to create a Gantt chart.

Assignment 3: Use WBS chart to create a PERT/CPM Chart.

CHAPTER

9

Risk Management

UNIT III

Syllabus

Software Risks, Risk Identification, Risk Projection and Risk Refinement, RMMM Plan.

Syllabus Topic : Software Risks

9.1 Software Risks

- A risk is a probability of an occurrence of some adverse circumstance.
- Risks are categorized into three paths:
 1. Important Risks but not resolved
 4. Unimportant Risks that are not resolved and later ultimately change into Important Risks.
 3. Unidentified Risks that later become Important Risks
- In order to manage feasibility throughout the project, risk management is needed.
- Risk management seeks to balance risk and reward.
- Different organizations are more or less adverse to risk, i.e. They are willing to take greater risks in order to achieve greater rewards.
- Software Risks possess two characteristics :
 1. **Uncertainty** : The risk may or may not happen; i.e. there are no 100% probable risks.
 2. **Loss** : The risk becomes a reality, unwanted consequences or losses may occur.
- It is important to measure the level of uncertainty and degree of loss associated with each risk.
- **The two basic kinds of Risks**
 1. **Predictable risks** : These are caused due to staff turnover, poor communication with customer, dilution of staff performance.
 2. **Unpredictable risks** : These are extremely difficult to identify in advance.



9.1.1 Types of Risks

Q. Explain the different categories of Risks.

- **Project risks** affect project schedule and resources. These effect the project plan and resources. If these turns into a reality, it is likely that project schedule will fall and that costs will rise. They may affect the budget, schedule, personnel (staffing and organization), resource, stakeholder, and requirements problems and their impact on a software project.
- **Product (Technical) risks** affect product's quality and performance. These effect the quality and timeliness of the software to be produced. Implementation becomes difficult if this risk turns into a reality. They may affect design, implementation, interface, verification and maintenance problems. Also some of the risk factors include ambiguity in specifications, technical uncertainty, technical obsolescence (not used anymore).
- **Business risks** affect development organisation and procuring organization. These affect the viability of the software to be built. Business risks often create confusion in the project or the product. The top 5 business risks are:
 - o **Market risk** : Building an excellent product and selling it in the market where no one is in need of it
 - o **Strategic risk** : Building a product that no longer fits into the overall business strategy.
 - o **Sales risk** : Building a product where the sales team does not know how to sell it.
 - o **Management risk** : building a product with the least support of senior management.
 - o **Budget risk** : building the product which is out of budget or personnel commitment.

Table 9.1.1 : Software Risks

Reason of Risks	Risk Type	Description of Risks
Change in Staff	Project risk	Experienced and skilled staff leaves the project or organization before it is finished.
Change in Management	Project risk	Changes in various priorities lead to various changes in the Organisation.
Hardware unavailability	Project risk	Hardware on which the project has to be developed or deployed for test is not delivered on time.
Change in Requirements	Project and Product risk	Large number of changes in the requirements in later phases.
Specification delays	Project and Product risk	Specifications of necessary interfaces are not available on time.
Underestimating the size	Project and Product risk	The size of the system is underestimated which effects the scope, cost and schedule.
Poor performance of CASE tools	Product risk	CASE tools necessary for project development don't perform as expected.
Change in Technology	Business risk	The technology on which the system is built is outdated by some new technology.
Competition of Product	Business risk	Another competitive product is marketed before our product delivery and deployment is completed.

9.2 Seven Principles of Risk Management

Q. Explain the seven principles of Risk Management.

1. **Maintain a global perspective**
View the software risks within the system context and business problem.
2. **Take a forward-looking view**
Think about the risks that may arise in the future and establish precautionary plans so that those risks even on existing can be manageable.
3. **Encourage open-communication**
Encourage all stakeholders and users to suggest risks at any time. Consider them even if told in an informal manner.
4. **Integrate**
Identify and consider those risks, which have to be integrated into the software process.
5. **Emphasize a continuous process**
Throughout the software process, the risk management team should be vigilant enough to modify identified risks as and more information is known and add new ones if more information is added.
6. **Develop a shared product vision**
Sharing the same vision of the software by all stakeholders can do better risk identification and assessment.
7. **Encourage teamwork**
The talents, skills and knowledge of all stakeholders should be pooled to get better idea about the risks involved.

9.3 Risk Management Process

Q. Write short notes on : Risk Management.

Q. What is Risk Management? Explain different stages involved in Risk Management.

- It is about identifying risks to ensure that these risks do not turn into major threats.
- It is about identifying risks and deriving plans to reduce their effect on the project.

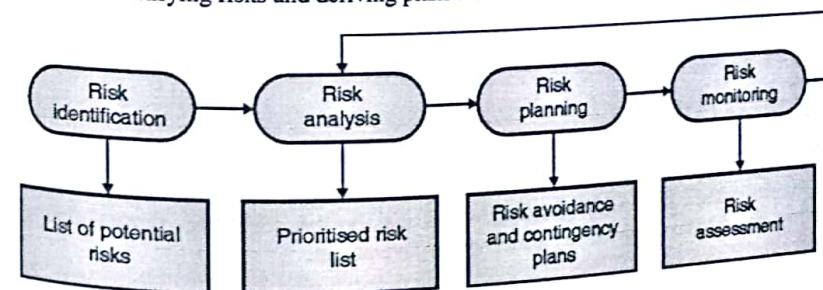


Fig. 9.3.1 : Risk Management Process

Syllabus Topic : Risk Identification

9.3.1 Risk Identification

Q. Explain Risk Identification.

- It is about identifying the project, product and business risks. Risk identification can start with source of problem or with the problem itself.

Risk	Affects
Technology	<ul style="list-style-type: none"> Database used in the system may be poor which cannot process as many transactions per second as expected. Reusable software components might contain defects that limit the system's functionality.
Staff	<ul style="list-style-type: none"> It is difficult to recruit skilled staff. Key staff are unavailable at critical times may because they are ill or out of station. Required training is not given to the staff.
Organizational	<ul style="list-style-type: none"> One project is handled by number of managerial groups of the organization. Organizational financial problems force cut-off in the project budget.
Case Tools	<ul style="list-style-type: none"> Insufficient code generated by CASE tools. Not able to integrate the designs in CASE tools.
Requirements	<ul style="list-style-type: none"> Changes in requirements lead to major changes in designs that lead to rework Customers fail to understand the side effect of frequent changes in requirements on the project.
Estimation	<ul style="list-style-type: none"> Time required to develop the software is underestimated. Size and scope of the software is underestimated. Defect Repair rate is underestimated.

Risk Identification can be done by two ways of analysis

(a) Source analysis

The target of risk management is to identify the sources of risk either internal or external to the system.

Examples : project stakeholders, company's employees.

(b) Problem Analysis

The threats which exist with various entitled mainly the Identified threats dealing with shareholders, customers, legislative bodies such as government.

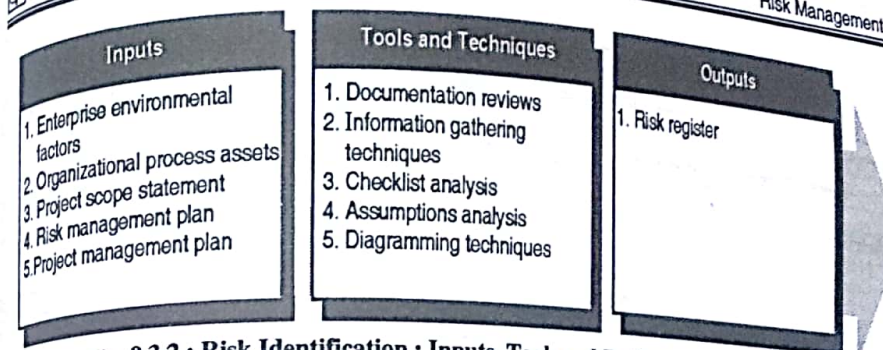


Fig. 9.3.2 : Risk Identification : Inputs, Tools and Techniques and Outputs

σ Risk Identification Methods

Q. Explain the methods involved in it

The Risk Identification methods depend on industry, practice, culture and compliance.

→ 1. Objectives-based

Any event that may endanger an organization or a project team in achieving their objective partly or completely.

→ 2. Scenario-based

Scenarios are designed so that they can be an alternative way to achieve an objective.

→ 3. Taxonomy-based

Based on taxonomy (breakdown of possible risk sources) and knowledge of best practices, a questionnaire is compiled. The answers to questions reveal risks.

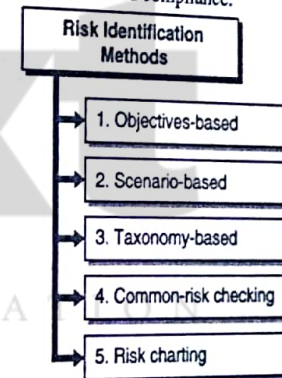


Fig. C9.1 : Risk Identification Methods

→ 4. Common-risk checking

For application in a particular situation, each risk in the common list maintained by several industries can be checked.

→ 5. Risk charting

This method combines the above approaches y listing resources at risk, threats to them, modifying facts which may increase/decrease the risk and consequences which can be avoided.

9.3.2 Risk Analysis

- Assess the probability and consequences of these risks.
- Probability scale ranges from *very low*, *low*, *moderate*, *high* or *very high*.
- Risk effects may range from *catastrophic*, *serious*, and *tolerable* to *insignificant*.

Table 9.3.2 : Risks, their Probability and Effects

Risk	Probability	Effects
Organizational financial problems force cut-off in the project budget.	Low	Catastrophic
It is difficult to recruit skilled staff.	High	Catastrophic
Key staff are unavailable at critical times	Moderate	Serious
Reusable software components might contain defects that limit the system's functionality.	Moderate	Serious
Changes in requirements lead to major changes in designs that lead to rework	Moderate	Serious
One project is handled by number of managerial groups of the organization	High	Serious

Risk analysis helps to define preventive measures to reduce the probability of risks and identify counter measures to successfully deal with these risks.

9.3.3 Risk Planning

Q. Write short notes on : Risk Planning.

- A risk management plan is a document prepared by a project manager to estimate the risks, to estimate the consequences and seriousness of these risks and to create response plans to avoid/solve them.
- A risk management plan contains an analysis of likely risk with both high and low impact as well as mitigation strategies to help the project avoid being derailed when any common problems arise.
- A risk management plan should be periodically reviewed by the project team so that the analysis does not become stale and not reflective of actual potential risk.
- It includes the following tasks :
 - o Draw up plans to avoid or reduce the risks.
 - o Design strategies to handle the risks.
 - o Design avoidance strategies to avoid the probability of risk occurrence.
 - o Design minimization strategies to reduce the probability of risk occurrence.
- Design Contingency plan so that if the risk arise, contingency plan is used to deal with that risk.

Table 9.3.3 : Risks and Strategies to overcome the risks

Risk	Strategy to overcome the risk
Organisational financial problems	Prepare a briefing document for senior management showing how the project makes an important contribution in achieving the goals of the business.
Requirement Change problems	Warn the customer regarding the potential difficulties caused by specification delays.
Staff Unavailability problems	Reorganise the development team so that there is more overlap of work and therefore, team members will more easily understand each other's jobs.
Defective Reusable components	Replace potentially defective components with components of known reliability.

- The 4 potential strategies, which are included in the Risk Management Plan, are :
1. Accept risk : assume that the negative impact occurs.
 2. Avoid risk : Change plan to prevent the problem
 3. Mitigate risk : minimizing its impact through intermediate steps.
 4. Transfer risk : Outsource risk management tasks to a third party.

9.3.4 Risk Monitoring and Control

Q. Write short notes on : Risk Monitoring.

- It is about monitoring and controlling the risks throughout the project development.
- Assess each and every identified risk regularly so as to check whether or not it is becoming less or higher.
- Assess whether or not the effects of the risk have reduced.
- Discuss each key risk in the management progress meetings.
- To overcome the risks, *line of Business Organization* is maintained.
- It is the process of identifying, analyzing and planning to overcome the newly discovered risks and managing identified risks.

Inputs to Risk Monitoring and Control

- Risk management plan : Plan to approach and manage project risks.
- Risk register : Comprehensive risk listing for projects.
- Approved changer requests : Necessary adjustments to work methods, contracts, project scope, and project schedule.
- Work performance information : Status of scheduled activities being performed to accomplish project work.
- Performance reports : Project's performance with respect to cost, scope, schedule, resources, quality and risk are shown using bar charts, s-curves, tables, histograms to organize and summarized information such as earned value analysis and project work progress.

Best practices followed In Risk monitoring and control

1. Risk reassessment

Risks are reassessed on a regular scheduled basis. Reassessment enables the project manager to evaluate risk impact, risk rating (urgent), determine old or new risks. These are normally addressed at status meetings.

2. Status meeting

Team members share their experiences in this forum and inform other members about their progress and plans and this is mostly done through open discussions in the presence of project manager.

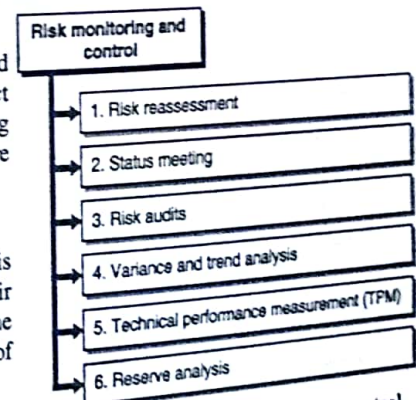


Fig. C9.2 : Risk monitoring and control

→ 3. Risk audits

They examine and document the effectiveness of planned risk responses and their impact on schedule and budget. Performed by risk auditors who specialize in risk assessment and auditing techniques. They are from outside the project team.

→ 4. Variance and trend analysis

Variance analysis = planned budget - actual budget / schedule.

Trend Analysis = project performance / time. This tells if performance is getting better or worse.

→ 5. Technical performance measurement (TPM)

Identifies deficiencies in fulfilling the system requirements, provides early warning of technical problems and monitor the technical risks.

→ 6. Reserve analysis

Compares contingency measures and the remaining amount of risk to ascertain if there is enough reserve in the pool. Contingency measures are buffers of time, funds or resources set aside to handle risks that arise as project grows.

Syllabus Topic : Risk Projection

9.4 Risk Projection (Estimation)

Q. Write short notes on : Risk Projection.

Risk projection is also known as risk estimation. It rates the risks based on two ways :

1. Probability that the risk is real
2. Consequences of the problems associated with that risk

Steps in Risk Projection (Estimation)

The project planner performs four risk projection activities :

1. Define a scale that reflects the probability of the risks. For example, 1-low ... 10-high.
2. Define the consequences of the risks
3. Project (estimate) the impact of the risk on the project and the product
4. Define the overall accuracy of the risk projection

9.4.1 Risk Table

Risk table consists of five columns which is helpful in efficient risk projection.

1. **Risk Summary** : short description of the risk. List all risks in the first column
2. **Risk Category** : Mark the category of each risk
3. **Probability** : Estimate the probability of each risk occurring based on group input
4. **Impact** : Assess the impact of each risk based on an averaging of the four risk components to determine an overall impact value : (1) catastrophic (2) critical (3) marginal (4) negligible. Sort the rows by probability and impact in descending order
5. **RMMM** : Risk Mitigation, Monitoring, and Management Plan

Impact of Risks

Three factors of risks that affect the consequences are :

1. **nature** : indicates the problems that are likely to happen if the risk occurs
2. **scope** : combines the severity of the risk with its overall distribution
3. **timing** : considers when and for how long the impact will be felt

Overall **risk exposure** formula is $RE = P \times C$

where,

- o P : probability of occurrence for a risk
- o C : cost to the project if the risk actually occurs

Example :

Consider the Probability : 80%

Cost estimation : If 90 reusable software components were planned. If only 60% of it can be used, 36 components need to be developed from scratch. Since the average component is 100 LOC and local data indicate that the software engineering cost for each LOC is \$12.00, therefore the overall Cost (impact) to develop the components would be $36 \times 100 \times 12 = \$43,200$

Risk exposure : $RE = P \times C = 0.8 \times 43,200 \sim \$34,560$.

Syllabus Topic : Risk Refinement

9.5 Risk Refinement

Q. Write short notes on : Risk Refinement.

- The process of restating the risks in more details which will be easier to mitigate, monitor, and manage is called Risk Refinement.
- In this process, the risks are represented and detailed in the CTC (condition-transition-consequence) format. This shows that; for the given <condition> then there is a possible <consequence>.

Example of detailing the risk using CTC format

Given **condition** that all reusable software components must conform to specific design standards and that some do not conform, then there is **concern (possibly consequence)** that only 60% of the planned reusable modules may actually be integrated into the built system, resulting in the need to develop the remaining 40% of components.

Syllabus Topic : RMMM Plan

9.6 RMMM Plan

Q. Explain RMMM plan in detail.

RMMM stands for Risk Mitigation, Monitoring, and Management. RMMM is an effective strategy for dealing with risks.

Mitigation

It is a primary strategy and is achieved through a proper planning.

For example : risk of high staff turnover.

☛ Strategy for reducing staff turnover

- Discussions with current staff to identify the causes for reduced turnover for example, poor working condition, low pay, competitive market.
- Mitigate those causes that are under our control before the project begins.
- Organize project teams such a way that you can monitor the development activities of each team.
- Document the standards and establish mechanisms so as to ensure that documents are developed in a timely manner.
- Conduct peer review of all the work.
- Plan a backup for every staff member and for every complex technology and tool.

☛ Monitoring

The project manager monitors the risks :

- Assess predicted risk
- Assure about risk aversion
- Collect useful information for future risk

☛ Risk monitoring has three objectives

1. To assess whether predicted risks occur
2. To ensure that risk avoidance steps are taken
3. To collect information i.e. useful in future risk analysis

The findings from risk monitoring helps the project manager to know which risks caused which problems throughout the project and whether the risks have decreased or still the same.

☛ Management

- Risk management and contingency planning assume that mitigation efforts have failed and that the risk has become a reality.
- Prepare RMMM plan. The RMMM plan can be the part of an SDLC plan or can be a separate document.
- RMMM plan is a document of all work performed as a part of risk analysis and used by project manager as a part of overall project plan
- Once RMMM has been documented and the project has begun, the risk mitigation, and monitoring steps begin
 - o Risk mitigation is a problem avoidance activity
 - o Risk monitoring is a project tracking activity

☛ Steps of risk management

- Risk assessment - Identify, Analyze and priorities
- Risk control - Planning, Resolution and monitoring.

MCQs

- Q. 1 Which of the following would you use to help identify risks?
(Select as many as apply)
- (a) Contractual requirements or statements of work (SOWs)

- (b) Supplier contracts or customer agreements (c) Project plan assumptions
(d) Lessons learned files from previous projects
(e) Project schedule

Q. 2 Risk exposure is a combination of what two things?

- (a) Probability and impact (b) Impact and severity
(c) Frequency and impact (d) Severity and frequency

Q. 3 What is included in a list of identified risks?

- (a) Probability (b) Impact
(c) Frequency (d) Both probability and impact

Q. 4 The primary objective of risk response planning is to:

- (a) Determine what, if anything should be done with a risk.
(b) Take the guesswork out of the risk response management process.
(c) Compare the cost of risk response to the expected monetary value.
(d) Improve the accuracy of risk assessment.

Q. 5 Which of the following are factors that affect the selection of a risk mitigation strategy?

- (a) Customer satisfaction
(b) The project manager's authority, accountability, and ability
(c) Commitment from the project manager and upper management
(d) All of the above

Q. 6 How is the project risk exposure determined?

- (a) By turning it into a known risk
(b) By determining whether it is a business risk or a pure risk
(c) By analyzing its probability and impact
(d) By determining what part of the life cycle it is in

Q. 7 Match the type of risk with its definition.

- (a) Business - A. Normal risk of doing business with opportunity for gain or loss. For example, the release of a new product.
(b) Pure - B. Risk that can be anticipated. These risks can be managed and controlled. For example, sales slowdown after Christmas.
(c) Known - C. Risk that presents an opportunity for loss only. For example, an earthquake.
(d) Unknown - D. Risk not planned for and not recognized. For example, release of a competitive product.

Q. 8 _____ is a framework for the iterative process of planning, tracking, and reacting to risk.

- (a) Risk analysis (b) Risk management
(c) Project management (d) Project analysis

- Q. 9 Which step in the risk management process defines the probability and impact of each risk to determine the severity?
- (a) Risk Identification (b) Risk Analysis
(c) Risk Planning (d) Risk Tracking and control
- Q. 10 Which of the following is true about risk identification?
- (a) Risk events should be identified early and projects reviewed regularly to ensure that no significant risk events are missed.
(b) The risk identification process should be repeated on a regular basis as part of your key checkpoints.
(c) Be extremely detailed about possible risks, even if they do not at first seem realistic risks; this allows for coverage of all possibilities.
(d) Start a new risk register at the beginning of each project phase.
- Q. 11 Which of the following is done to create a risk management plan?
- (a) Accept that risk might not change any of the project elements.
(b) Identify risks, analyze risks, and define what, if anything, should be done about the risks.
(c) Assign the actions to project team members.
(d) Both B and C.
- Q. 12 Which of the following is true about the importance of risk management?
- (a) It ensures that the project will be on budget.
(b) It helps reduce the impact of risk in a project.
(c) It eliminates the impact of all risk.
(d) It ensures that the project will be on schedule.

Review Questions

- Q. 1 Write short notes on :
- (a) Risk Management (b) Risk Planning
(c) Risk Monitoring (d) Risk Projection (e) Risk Refinement
- Q. 2 Explain the seven principles of Risk Management.
- Q. 3 Explain Risk Identification and the methods involved in it.
- Q. 4 Explain the different categories of Risks.
- Q. 5 Explain the different types of risks?
- Q. 6 What is Risk Management? Explain different stages involved in Risk Management.
- Q. 7 Explain RMMM plan in detail.

CHAPTER

10

Software Quality Assurance

UNIT III

Syllabus

Elements of SQA, SQA Tasks, Goals, Metrics, Formal Approaches to SQA, Six Sigma, Software Reliability, The ISO 9000 Quality Standards, Capability Maturity Model.

10.1 Quality

Definition

"Conformance to explicitly stated functional and performance requirements, explicitly documented development standards, and implicit characteristics that are expected from all professionally developed software."

10.1.1 Quality Perceptions

The software is developed by an engineer, it is required by the customer, and is used by various end users. Thus, each of them has a different perception about quality that decides whether the software is good or not.

- Engineer may judge :
 - o User satisfaction,
 - o Portability,
 - o Maintainability,
 - o Robustness
 - o Efficiency
- Customer may judge : cost
- User may judge :
 - o Reliability (i.e. No Defects that may either stop computing or may produce unexpected results),
 - o Usability.

10.1.2 Importance of Software Quality

Q. Why is software quality important?

- Aim of Quality Measure is : Satisfying Customer