#### 9.2.3.3 Project Management Plan Updates

Elements of the project management plan that may be updated include, but are not limited to, the human resource management plan. For example, the person assigned to a pre-defined role may not fulfill all staffing requirements outlined in the human resource management plan. When gaps occur, the project management plan needs to be updated to change the team structure, roles, or responsibilities.

## 9.3 Develop Project Team

Develop Project Team is the process of improving competencies, team member interaction, and overall team environment to enhance project performance. The key benefit of this process is that it results in improved teamwork, enhanced people skills and competencies, motivated employees, reduced staff turnover rates, and improved overall project performance. The inputs, tools and techniques, and outputs of this process are depicted in Figure 9-9. Figure 9-10 depicts the data flow diagram of the process.


**Figure 9-9. Develop Project Team: Inputs, Tools & Techniques, and Outputs**

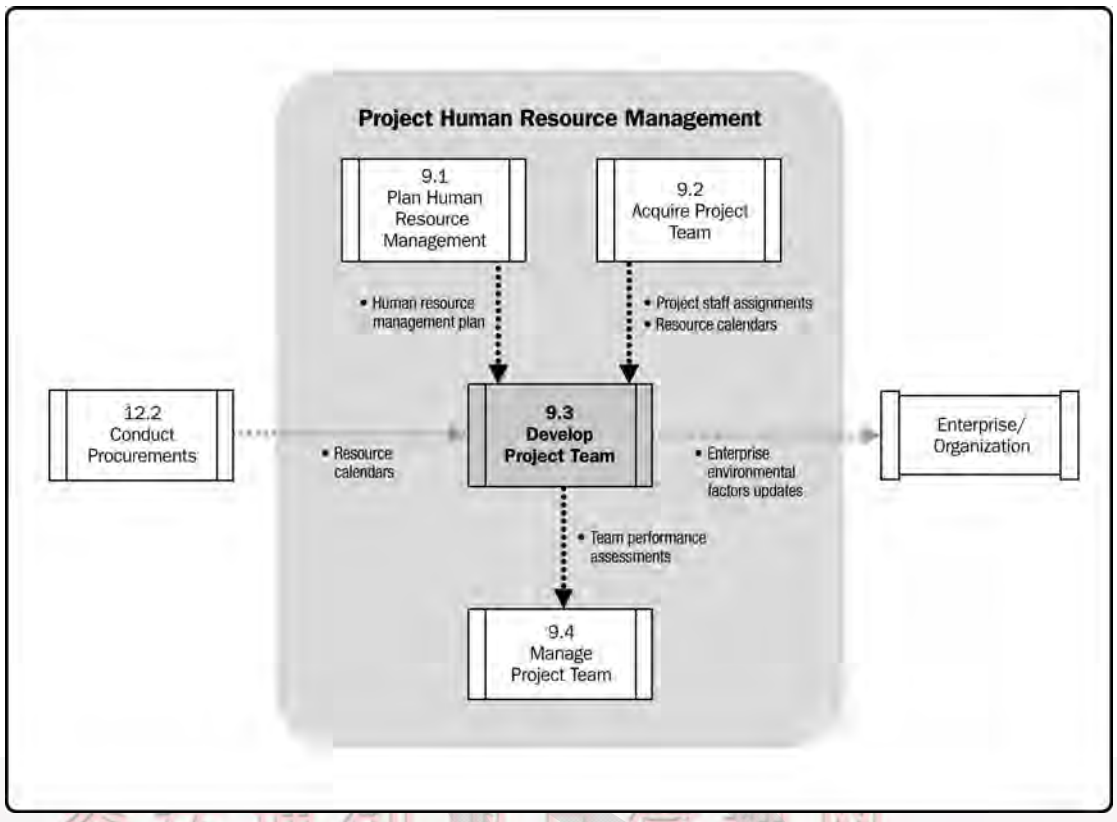



**Figure 9-10. Develop Project Team Data Flow Diagram**

Project managers should acquire skills to identify, build, maintain, motivate, lead, and inspire project teams to achieve high team performance and to meet the project's objectives. Teamwork is a critical factor for project success, and developing effective project teams is one of the primary responsibilities of the project manager. Project managers should create an environment that facilitates teamwork. Project managers should continually motivate their team by providing challenges and opportunities, by providing timely feedback and support as needed, and by recognizing and rewarding good performance. High team performance can be achieved by using open and effective communication, creating team building opportunities, developing trust among team members, managing conflicts in a constructive manner, and encouraging collaborative problem-solving and decision-making. The project manager should request management support and/or influence the appropriate stakeholders to acquire the resources needed to develop effective project teams.

Project managers operate in a global environment and work on projects characterized by cultural diversity. Team members often have diverse industry experience, know multiple languages, and sometimes operate in the "team language" that may be a different language or norm than their native one. The project management team should capitalize on cultural differences, focus on developing and sustaining the project team throughout the project life cycle, and promote working together interdependently in a climate of mutual trust. Developing the project team improves the people skills, technical competencies, and overall team environment and project performance. It requires clear, timely, effective, and efficient communication between team members throughout the life of the project. Objectives of developing a project team include, but are not limited to:

- Improving knowledge and skills of team members to increase their ability to complete project deliverables, while lowering costs, reducing schedules, and improving quality;
- Improving feelings of trust and agreement among team members to raise morale, lower conflict, and increase team work; and
- Creating a dynamic, cohesive, and collaborative team culture to (1) improve individual and team productivity, team spirit, and cooperation and (2) allow cross training and mentoring between team members to share knowledge and expertise.

## 9.3.1 Develop Project Team: Inputs

### 9.3.1.1 Human Resource Management Plan

Described in Section 9.1.3.1. The human resource management plan provides guidance on how project human resources should be defined, staffed, managed, controlled, and eventually released. It identifies training strategies and plans for developing the project team. Items such as rewards, feedback, additional training, and disciplinary actions can be added to the plan as a result of ongoing team performance assessments and other forms of project team management.

### 9.3.1.2 Project Staff Assignments

Described in Section 9.2.3.1. Team development starts with a list of the project team members. Project staff assignment documents identify the people who are on the team.

### 9.3.1.3 Resource Calendars

Described in Section 9.2.3.2. Resource calendars identify times when the project team members can participate in team development activities.

## 9.3.2 Develop Project Team: Tools and Techniques

### 9.3.2.1 Interpersonal Skills

Interpersonal skills, sometimes known as "soft skills," are behavioral competencies that include proficiencies such as communication skills, emotional intelligence, conflict resolution, negotiation, influence, team building, and group facilitation. These soft skills are valuable assets when developing the project team. For example, the project management team can use emotional intelligence to reduce tension and increase cooperation by identifying, assessing, and controlling the sentiments of project team members, anticipating their actions, acknowledging their concerns, and following up on their issues.

### 9.3.2.2 Training

Training includes all activities designed to enhance the competencies of the project team members. Training can be formal or informal. Examples of training methods include classroom, online, computer-based, on-the-job training from another project team member, mentoring, and coaching. If project team members lack the necessary management or technical skills, such skills can be developed as part of the project work. Scheduled training takes place as stated in the human resource management plan. Unplanned training takes place as a result of observation, conversation, and project performance appraisals conducted during the controlling process of managing the project team. Training costs could be included in the project budget, or supported by performing organization if the added skills may be useful for future projects. It could be performed by in-house or external trainers.

#### 9.3.2.3 Team-Building Activities

Team-building activities can vary from a 5-minute agenda item in a status review meeting to an off-site, professionally facilitated experience designed to improve interpersonal relationships. The objective of team-building activities is to help individual team members work together effectively. Team-building strategies are particularly valuable when team members operate from remote locations without the benefit of face-to-face contact. Informal communication and activities can help in building trust and establishing good working relationships.

As an ongoing process, team building is crucial to project success. While team building is essential during the initial stages of a project, it is a never-ending process. Changes in a project environment are inevitable, and to manage them effectively, a continued or a renewed team-building effort should be applied. The project manager should continually monitor team functionality and performance to determine if any actions are needed to prevent or correct various team problems.

One of the models used to describe team development is the Tuckman ladder (Tuckman, 1965; Tuckman & Jensen, 1977), which includes five stages of development that teams may go through. Although it's common for these stages to occur in order, it's not uncommon for a team to get stuck in a particular stage or slip to an earlier stage. Projects with team members who worked together in the past may skip a stage.

- **Forming.** This phase is where the team meets and learns about the project and their formal roles and responsibilities. Team members tend to be independent and not as open in this phase.
- **Storming.** During this phase, the team begins to address the project work, technical decisions, and the project management approach. If team members are not collaborative and open to differing ideas and perspectives, the environment can become counterproductive.
- **Norming.** In the norming phase, team members begin to work together and adjust their work habits and behaviors to support the team. The team learns to trust each other.
- **Performing.** Teams that reach the performing stage function as a well-organized unit. They are interdependent and work through issues smoothly and effectively.
- **Adjourning.** In the adjourning phase, the team completes the work and moves on from the project. This typically occurs when staff is released from the project as deliverables are completed or as part of carrying out the Close Project or Phase process (Section 4.6).

The duration of a particular stage depends upon team dynamics, team size, and team leadership. Project managers should have a good understanding of team dynamics in order to move their team members through all stages in an effective manner.

#### 9.3.2.4 Ground Rules

Ground rules establish clear expectations regarding acceptable behavior by project team members. Early commitment to clear guidelines decreases misunderstandings and increases productivity. Discussing ground rules in areas such as code of conduct, communication, working together, or meeting etiquette allows team members to discover values that are important to one

another. All project team members share responsibility for enforcing the rules once they are established.

#### 9.3.2.5 Colocation

Colocation, also referred to as "tight matrix," involves placing many or all of the most active project team members in the same physical location to enhance their ability to perform as a team. Colocation can be temporary, such as at strategically important times during the project, or for the entire project. Colocation strategies can include a team meeting room (sometimes called "war room"), places to post schedules, and other conveniences that enhance communication and a sense of community. While colocation is considered a good strategy, the use of virtual teams can bring benefits such as the use of more skilled resources, reduced costs, less travel, and relocation expenses and the proximity of team members to suppliers, customers, or other key stakeholders.

#### 9.3.2.6 Recognition and Rewards

Part of the team development process involves recognizing and rewarding desirable behavior. The original plans concerning ways in which to reward people are developed during the Plan Human Resource Management process. It is important to recognize that a particular reward given to any individual will be effective only if it satisfies a need which is valued by that individual. Award decisions are made, formally or informally, during the process of managing the project team through project performance appraisals (Section 9.4.2.2). Cultural differences should be considered when determining recognition and rewards.

People are motivated if they feel they are valued in the organization and this value is demonstrated by the rewards given to them. Generally, money is viewed as a tangible aspect of any reward system, but intangible rewards could be equally or even more effective. Most project team members are motivated by an opportunity to grow, accomplish, and apply their professional skills to meet new challenges. A good strategy for project managers is to give the team recognition throughout the life cycle of the project rather than waiting until the project is completed.

#### 9.3.2.7 Personnel Assessment Tools

Personnel assessment tools give the project manager and the project team insight into areas of strength and weakness. These tools help project managers assess the team preferences, aspirations, how they process and organize information, how they tend to make decisions, and how they prefer to interact with people.

Various tools are available such as attitudinal survey, assessments specific, structured interview, ability test, and focus group. These tools can provide improved understanding, trust, commitment, and communications among team members and facilitate more productive teams throughout the project.

### 9.3.3 Develop Project Team: Outputs

#### 9.3.3.1 Team Performance Assessments

As project team development efforts such as training, team building, and colocation are implemented, the project management team makes formal or informal assessments of the project team's effectiveness. Effective team development strategies and activities are expected to increase the team's performance, which increases the likelihood of meeting project objectives.

Team performance assessment criteria should be determined by all appropriate parties and incorporated in the Develop Project Team inputs.

The performance of a successful team is measured in terms of technical success according to agreed-upon project objectives (including quality levels), performance on project schedule (finished on time), and performance on budget (finished within financial constraints). High-performance teams are characterized by these task-oriented and results-oriented outcomes.

The evaluation of a team's effectiveness may include indicators such as:

- Improvements in skills that allow individuals to perform assignments more effectively,
- Improvements in competencies that help the team perform better as a team,
- Reduced staff turnover rate, and
- Increased team cohesiveness where team members share information and experiences openly and help each other to improve the overall project performance.

As a result of conducting an evaluation of the team's overall performance, the project management team can identify the specific training, coaching, mentoring, assistance, or changes required to improve the team's performance. This should also include identification of the appropriate or required resources necessary to achieve and implement the improvements identified in the assessment. These resources and recommendations for team improvement should be well documented and forwarded to the relevant parties.

#### 9.3.3.2 Enterprise Environmental Factors Updates

The enterprise environmental factors that may be updated as a result of the Develop Project Team process include, but are not limited to, personnel administration, employee training records, and skill assessments.



## 9.4 Manage Project Team

Manage Project Team is the process of tracking team member performance, providing feedback, resolving issues, and managing team changes to optimize project performance. The key benefit of this process is that it influences team behavior, manages conflict, resolves issues, and appraises team member performance. The inputs, tools and techniques, and outputs of this process are depicted in Figure 9-11. Figure 9-12 depicts the data flow diagram of the process.

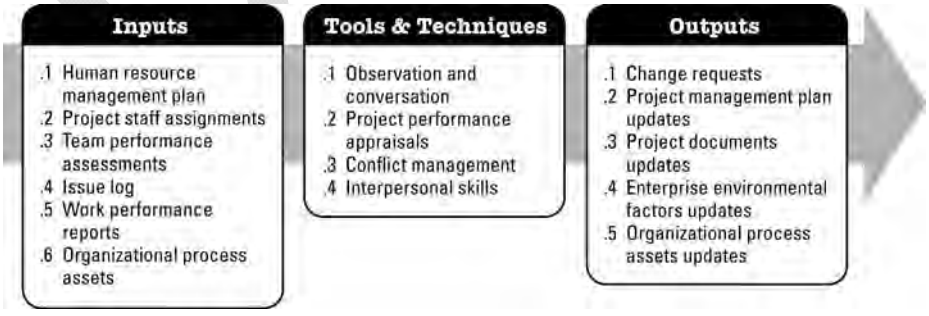



**Figure 9-11. Manage Project Team: Inputs, Tools & Techniques, and Outputs**

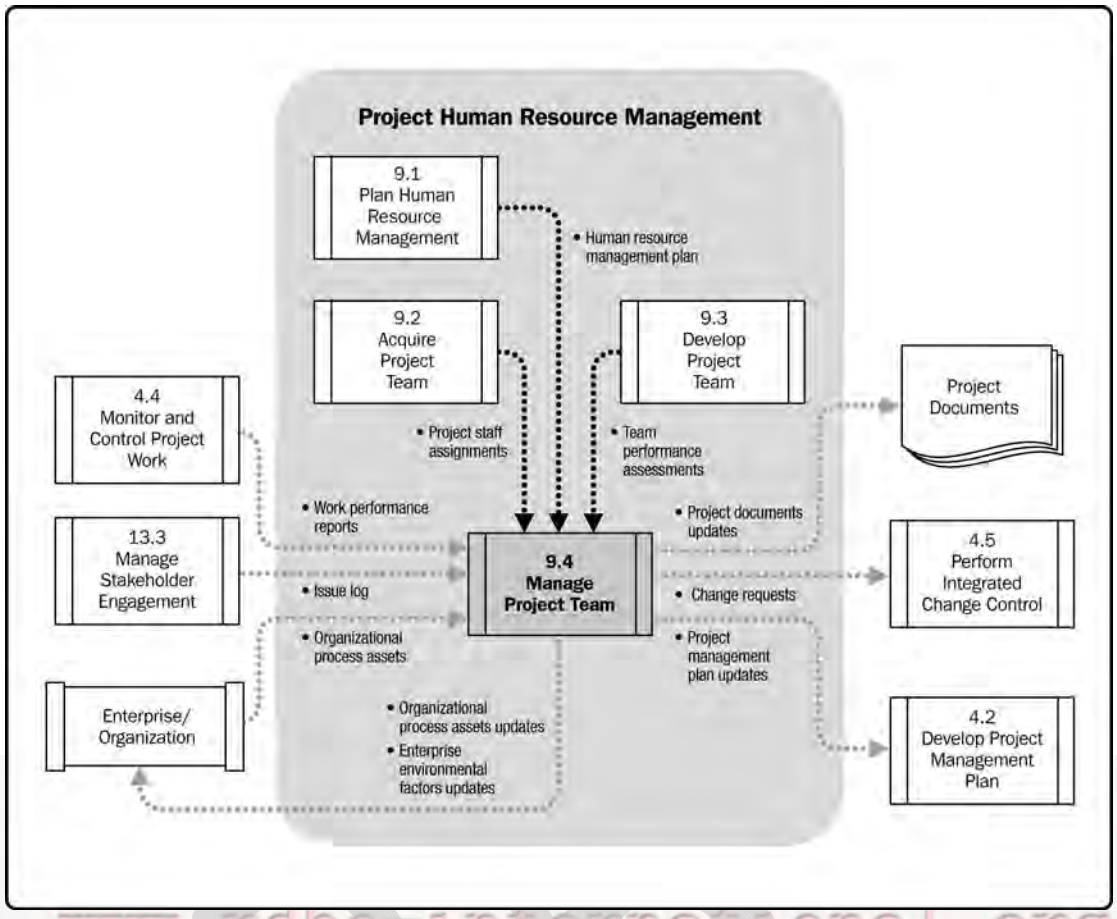



**Figure 9-12. Manage Project Team Data Flow Diagram**

As a result of managing the project team, change requests are submitted, the human resource management plan is updated, issues are resolved, input is provided for performance appraisals, and lessons learned are added to the organization's database.

Managing the project team requires a variety of management skills for fostering teamwork and integrating the efforts of team members to create high-performance teams. Team management involves a combination of skills with special emphasis on communication, conflict management, negotiation, and leadership. Project managers should provide challenging assignments to team members and provide recognition for high performance.

## 9.4.1 Manage Project Team: Inputs

### 9.4.1.1 Human Resource Management Plan

Described in Section 9.1.3.1. The human resource management plan provides guidance on how project human resources should be defined, staffed, managed, controlled, and eventually released. It includes, but is not limited to:

- Roles and responsibilities,
- Project organization, and
- Staffing management plan.

#### 9.4.1.2 Project Staff Assignments

Described in Section 9.2.3.1. Project staff assignments provide documentation, which includes the list of project team members.

#### 9.4.1.3 Team Performance Assessments

Described in Section 9.3.3.1. The project management team makes ongoing formal or informal assessments of the project team's performance. By continually assessing the project team's performance, actions can be taken to resolve issues, modify communication, address conflict, and improve team interaction.

#### 9.4.1.4 Issue Log

Issues arise in the course of managing the project team. An issue log can be used to document and monitor who is responsible for resolving specific issues by a target date.

#### 9.4.1.5 Work Performance Reports

Described in Section 4.4.3.2. Work performance reports provide documentation about the current project status compared to project forecasts. Performance areas that can help with project team management include results from schedule control, cost control, quality control, and scope validation. The information from performance reports and related forecasts assists in determining future human resource requirements, recognition and rewards, and updates to the staffing management plan.

#### 9.4.1.6 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that can influence the Manage Project Team process include, but are not limited to:

- Certificates of appreciation,
- Newsletters,
- Websites,
- Bonus structures,
- Corporate apparel, and
- Other organizational perquisites.

### 9.4.2 Manage Project Team: Tools and Techniques

#### 9.4.2.1 Observation and Conversation

Observation and conversation are used to stay in touch with the work and attitudes of project team members. The project management team monitors progress toward project deliverables, accomplishments that are a source of pride for team members, and interpersonal issues.

#### 9.4.2.2 Project Performance Appraisals

Objectives for conducting performance appraisals during the course of a project can include clarification of roles and responsibilities, constructive feedback to team members, discovery of unknown or unresolved issues, development of individual training plans, and the establishment of specific goals for future time periods.

The need for formal or informal project performance appraisals depends on the length of the project, complexity of the project, organizational policy, labor contract requirements, and the amount and quality of regular communication.

### 9.4.2.3 Conflict Management

Conflict is inevitable in a project environment. Sources of conflict include scarce resources, scheduling priorities, and personal work styles. Team ground rules, group norms, and solid project management practices, like communication planning and role definition, reduce the amount of conflict.

Successful conflict management results in greater productivity and positive working relationships. When managed properly, differences of opinion can lead to increased creativity and better decision making. If the differences become a negative factor, project team members are initially responsible for their resolution. If conflict escalates, the project manager should help facilitate a satisfactory resolution. Conflict should be addressed early and usually in private, using a direct, collaborative approach. If disruptive conflict continues, formal procedures may be used, including disciplinary actions.

The success of project managers in managing their project teams often depends a great deal on their ability to resolve conflict. Different project managers may utilize different conflict resolution methods. Factors that influence conflict resolution methods include:

- Relative importance and intensity of the conflict,
- Time pressure for resolving the conflict,
- Position taken by persons involved, and
- Motivation to resolve conflict on a long-term or a short-term basis.

There are five general techniques for resolving conflict. As each one has its place and use, these are not given in any particular order:

- **Withdraw/Avoid.** Retreating from an actual or potential conflict situation, postponing the issue to be better prepared or to be resolved by others.
- **Smooth/Accommodate.** Emphasizing areas of agreement rather than areas of difference, conceding one's position to the needs of others to maintain harmony and relationships.
- **Compromise/Reconcile.** Searching for solutions that bring some degree of satisfaction to all parties in order to temporarily or partially resolve the conflict.
- **Force/Direct.** Pushing one's viewpoint at the expense of others; offering only win-lose solutions, usually enforced through a power position to resolve an emergency.
- **Collaborate/Problem Solve.** Incorporating multiple viewpoints and insights from differing perspectives; requires a cooperative attitude and open dialogue that typically leads to consensus and commitment.

### 9.4.2.4 Interpersonal Skills

Project managers use a combination of technical, personal, and conceptual skills to analyze situations and interact appropriately with team members. Using appropriate interpersonal skills allows project managers to capitalize on the strengths of all team members.

Examples of interpersonal skills that a project manager uses most often include:

- **Leadership.** Successful projects require strong leadership skills. Leadership is important through all phases of the project life cycle. There are multiple leadership theories defining leadership styles that should be used as needed for each situation or team. It is especially important to communicate the vision and inspire the project team to achieve high performance.
- **Influencing.** Because project managers often have little or no direct authority over team members in a matrix environment, their ability to influence stakeholders on a timely basis is critical to project success. Key influencing skills include:
  - Ability to be persuasive and clearly articulate points and positions;
  - High levels of active and effective listening skills;
  - Awareness of, and consideration for, the various perspectives in any situation; and
  - Gathering relevant and critical information to address important issues and reach agreements while maintaining mutual trust.
- **Effective decision making.** This involves the ability to negotiate and influence the organization and the project management team. Some guidelines for decision making include:
  - Focus on goals to be served,
  - Follow a decision-making process,
  - Study the environmental factors,
  - Analyze available information,
  - Develop personal qualities of the team members,
  - Stimulate team creativity, and
  - Manage risk.



## 9.4.3 Manage Project Team: Outputs

### 9.4.3.1 Change Requests

Staffing changes, whether by choice or by uncontrollable events, can affect the rest of the project management plan. When staffing issues disrupt the project team from adhering to the project management plan such as causing the schedule to be extended or the budget to be exceeded, a change request can be processed through the Perform Integrated Change Control process. Staffing changes may include moving people to different assignments, outsourcing some of the work, and replacing team members who leave.

Preventive actions are those actions that are developed to reduce the probability and/or impact of problems before they occur. These actions may include cross-training to reduce problems during project team member absences and additional role clarification to ensure all responsibilities are fulfilled.

### 9.4.3.2 Project Management Plan Updates

Elements of the project management plan that may be updated include, but are not limited to, the human resource management plan.

### 9.4.3.3 Project Documents Updates

Project documents that may indirectly be updated include, but are not limited to:

- Issue log,
- Roles description, and
- Project staff assignments.

#### 9.4.3.4 Enterprise Environmental Factors Updates

Enterprise environmental factors that may require updates as a result of the Manage Project Team process include, but are not limited to:

- Input to organizational performance appraisals, and
- Personnel skill updates.

#### 9.4.3.5 Organizational Process Assets Updates

Organizational process assets that may require updates as a result of the Manage Project Team process include, but are not limited to:

- Historical information and lessons learned documentation,
- Templates, and
- Organizational standard processes.

# 10

# PROJECT COMMUNICATIONS MANAGEMENT

Project Communications Management includes the processes that are required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the ultimate disposition of project information. Project managers spend most of their time communicating with team members and other project stakeholders, whether they are internal (at all organizational levels) or external to the organization. Effective communication creates a bridge between diverse stakeholders who may have different cultural and organizational backgrounds, different levels of expertise, and different perspectives and interests, which impact or have an influence upon the project execution or outcome.

Figure 10-1 provides an overview of the Project Communications Management processes, which are as follows:

**10.1 Plan Communications Management**—The process of developing an appropriate approach and plan for project communications based on stakeholder's information needs and requirements, and available organizational assets.

**10.2 Manage Communications**—The process of creating, collecting, distributing, storing, retrieving and the ultimate disposition of project information in accordance with the communications management plan.

**10.3 Control Communications**—The process of monitoring and controlling communications throughout the entire project life cycle to ensure the information needs of the project stakeholders are met.

These processes interact with each other and with processes in other Knowledge Areas as described in detail in Section 3 and Annex A1.

The communication activities involved in these processes may often have many potential dimensions that need to be considered, including, but not limited to:

- Internal (within the project) and external (customer, vendors, other projects, organizations, the public);
- Formal (reports, minutes, briefings) and informal (emails, memos, ad-hoc discussions);
- Vertical (up and down the organization) and horizontal (with peers);
- Official (newsletters, annual report) and unofficial (off the record communications); and
- Written and oral, and verbal (voice inflections) and nonverbal (body language).

Most communication skills are common for both general management and project management, such as, but not limited to:

- Listening actively and effectively;
- Questioning and probing ideas and situations to ensure better understanding;

- Educating to increase team's knowledge so that they can be more effective;
- Fact-finding to identify or confirm information;
- Setting and managing expectations;
- Persuading a person, a team, or an organization to perform an action;
- Motivating to provide encouragement or reassurance;
- Coaching to improve performance and achieve desired results;
- Negotiating to achieve mutually acceptable agreements between parties;
- Resolving conflict to prevent disruptive impacts; and
- Summarizing, recapping, and identifying the next steps.

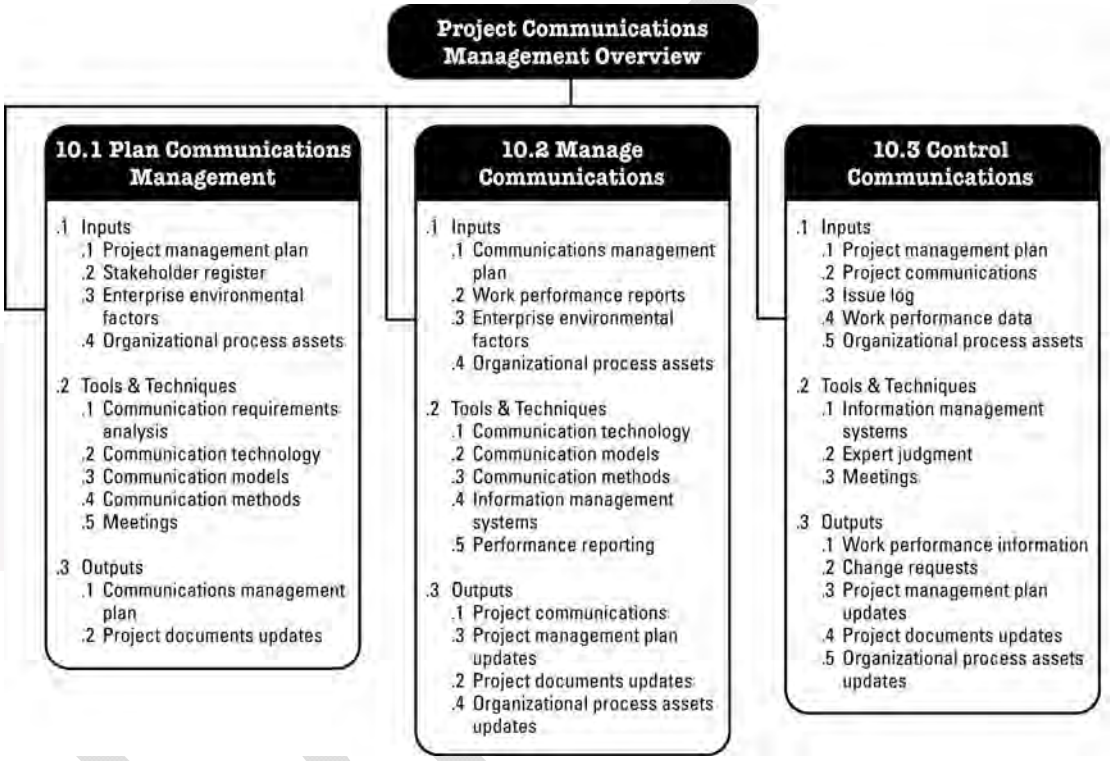



**Figure 10-1. Project Communications Management Overview**

## 10.1 Plan Communications Management

Plan Communications Management is the process of developing an appropriate approach and plan for project communications based on stakeholder's information needs and requirements, and available organizational assets. The key benefit of this process is that it identifies and documents the approach to communicate most effectively and efficiently with stakeholders. The inputs, tools and techniques, and outputs of this process are depicted in Figure 10-2. Figure 10-3 depicts the data flow diagram of the Plan Communications Management process.

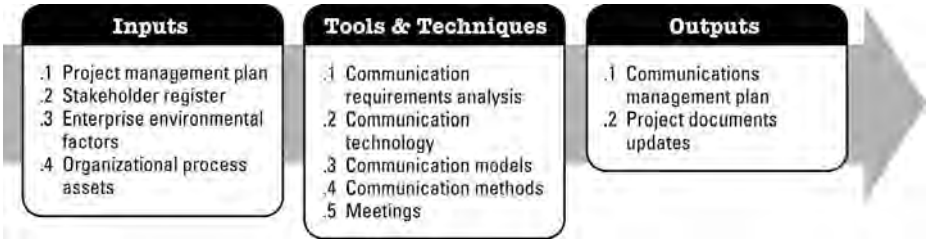



**Figure 10-2. Plan Communications Management: Inputs, Tools & Techniques, and Outputs**

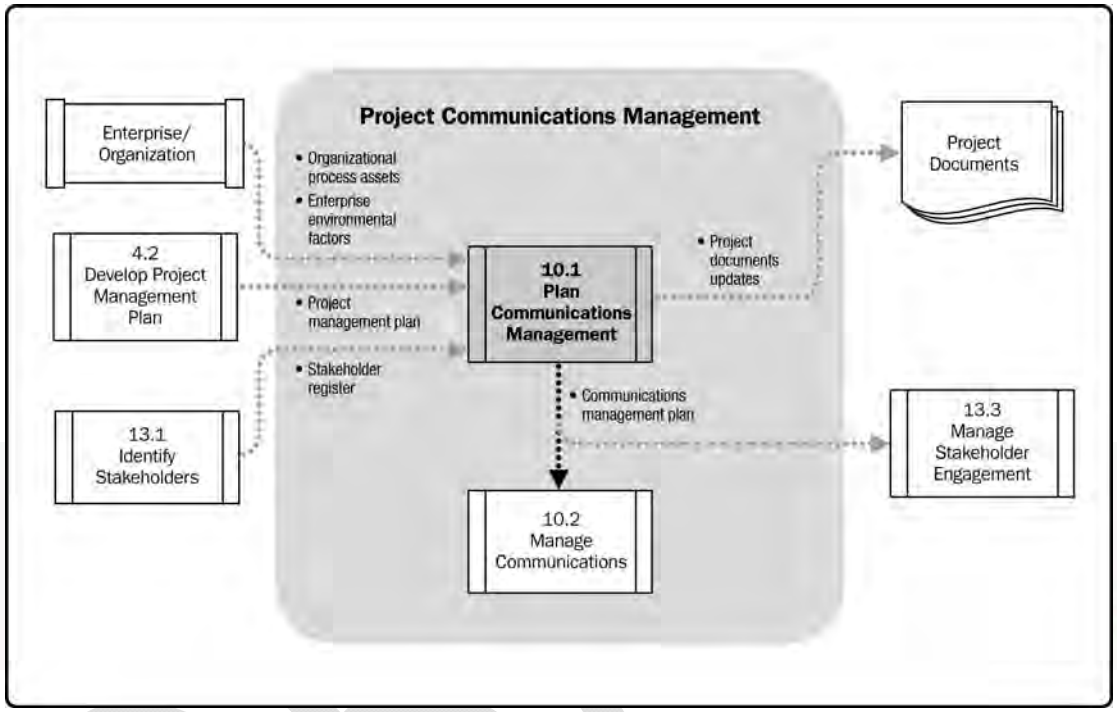



**Figure 10-3. Plan Communications Management Data Flow Diagram**

Planning the project communications is important to the ultimate success of any project. Inadequate communications planning may lead to problems such as delay in message delivery, communication of information to the wrong audience, or insufficient communication to the stakeholders and misunderstanding or misinterpretation of the message communicated.

On most projects, communication planning is performed very early, such as during project management plan development. This allows appropriate resources, such as time and budget, to be allocated to communication activities. Effective communication means that the information is provided in the right format, at the right time, to the right audience, and with the right impact. Efficient communication means providing only the information that is needed.

While all projects share the need to communicate project information, the information needs and methods of distribution may vary widely. In addition, the methods of storage, retrieval, and ultimate disposition of the project information need to be considered and appropriately documented during this process. Important considerations that may need to be taken into account include, but are not limited to:

- Who needs what information, and who is authorized to access that information;

- When they will need the information;
- Where the information should be stored;
- What format the information should be stored in;
- How the information can be retrieved; and
- Whether time zone, language barriers, and cross-cultural considerations need to be taken into account.

The results of the Plan Communications Management process should be reviewed regularly throughout the project and revised as needed to ensure continued applicability.

## 10.1.1 Plan Communications Management: Inputs

### 10.1.1.1 Project Management Plan

Described in Section 4.2.3.1. The project management plan provides information on how the project will be executed, monitored, controlled, and closed.

### 10.1.1.2 Stakeholder Register

Described in Section 13.1.3.1. The stakeholder register provides the information needed to plan the communication with project stakeholders.

### 10.1.1.3 Enterprise Environmental Factors

Described in Section 2.1.5. The Plan Communications Management process is tightly linked with enterprise environmental factors, since the structure of an organization will have a major effect on the project's communication requirements. All enterprise environmental factors described in Section 2.1.5 are used as inputs for this process, since communications need to be adapted to the project environment.

### 10.1.1.4 Organizational Process Assets

Described in Section 2.1.4. All organizational process assets described in Section 2.1.4 are used as inputs to the Plan Communications Management process. Of these, lessons learned and historical information are of particular importance because they can provide insights on both the decisions taken regarding communications issues and the results of those decisions in previous similar projects. These can be used as guiding information to plan the communication activities for the current project.

## 10.1.2 Plan Communications Management: Tools and Techniques

### 10.1.2.1 Communication Requirements Analysis

The analysis of the communication requirements determines the information needs of the project stakeholders. These requirements are defined by combining the type and format of information needed with an analysis of the value of that information. Project resources should be expended only on communicating information that contributes to the success of the project or where a lack of communication can lead to failure.

The project manager should also consider the number of potential communication channels or paths as an indicator of the complexity of a project's communications. The total number of potential communication channels is $n(n - 1)/2$, where $n$ represents the number of stakeholders. For example, a project with 10 stakeholders has $10(10 - 1)/2 = 45$ potential communication channels. As a result, a key component of planning the project's actual

communications is to determine and limit who will communicate with whom and who will receive what information.

Sources of information typically used to identify and define project communication requirements include, but are not limited to:

- Organizational charts;
- Project organization and stakeholder responsibility relationships;
- Disciplines, departments, and specialties involved in the project;
- Logistics of how many persons will be involved with the project and at which locations;
- Internal information needs (e.g., when communicating within organizations);
- External information needs (e.g., when communicating with the media, public, or contractors); and
- Stakeholder information and communication requirements from within the stakeholder register.

### 10.1.2.2 Communication Technology

The methods used to transfer information among project stakeholders may vary significantly. For example, a project team may use techniques from brief conversations to extended meetings, or from simple written documents to extensive materials (e.g., schedules, databases, and websites), which are accessible online as methods of communication.

Factors that can affect the choice of communication technology include:

- **Urgency of the need for information.** There is a need to consider the urgency, frequency, and format of the information to be communicated as they may vary from project to project and also within different stages of a project.
- **Availability of technology.** There is a need to ensure that the technology that is required to facilitate communication is compatible, available, and accessible for all stakeholders throughout the life of the project.
- **Ease of Use.** There is a need to ensure that the choice of communication technologies is suitable for project participants and that appropriate training events are planned for, where appropriate.
- **Project environment.** There is a need to determine if the team will meet and operate on a face-to-face basis or in a virtual environment; whether they will be located in one or multiple time zones; whether they will use multiple languages for communication; and finally, whether there are any other project environmental factors, such as culture, which may affect communications.
- **Sensitivity and confidentiality of the information.** There is a need to determine if the information to be communicated is sensitive or confidential and whether or not additional security measures need to be taken. Also, the most appropriate way to communicate the information should be considered.

### 10.1.2.3 Communication Models

The communication models used to facilitate communications and the exchange of information may vary from project to project and also within different stages of the same project.

A basic communication model, shown in Figure 10-4, consists of two parties, defined as the sender and receiver. Medium is the technology medium and includes the mode of communication while noise includes any interference or barriers that might compromise the delivery of the message. The sequence of steps in a basic communication model is:

- **Encode.** Thoughts or ideas are translated (encoded) into language by the sender.
- **Transmit Message.** This information is then sent by the sender using communication channel (medium). The transmission of this message may be compromised by various factors (e.g., distance, unfamiliar technology, inadequate infrastructure, cultural difference, and lack of background information). These factors are collectively termed as noise.
- **Decode.** The message is translated by the receiver back into meaningful thoughts or ideas.
- **Acknowledge.** Upon receipt of a message, the receiver may signal (acknowledge) receipt of the message but this does not necessarily mean agreement with or comprehension of the message.
- **Feedback/Response.** When the received message has been decoded and understood, the receiver encodes thoughts and ideas into a message and then transmits this message to the original sender.

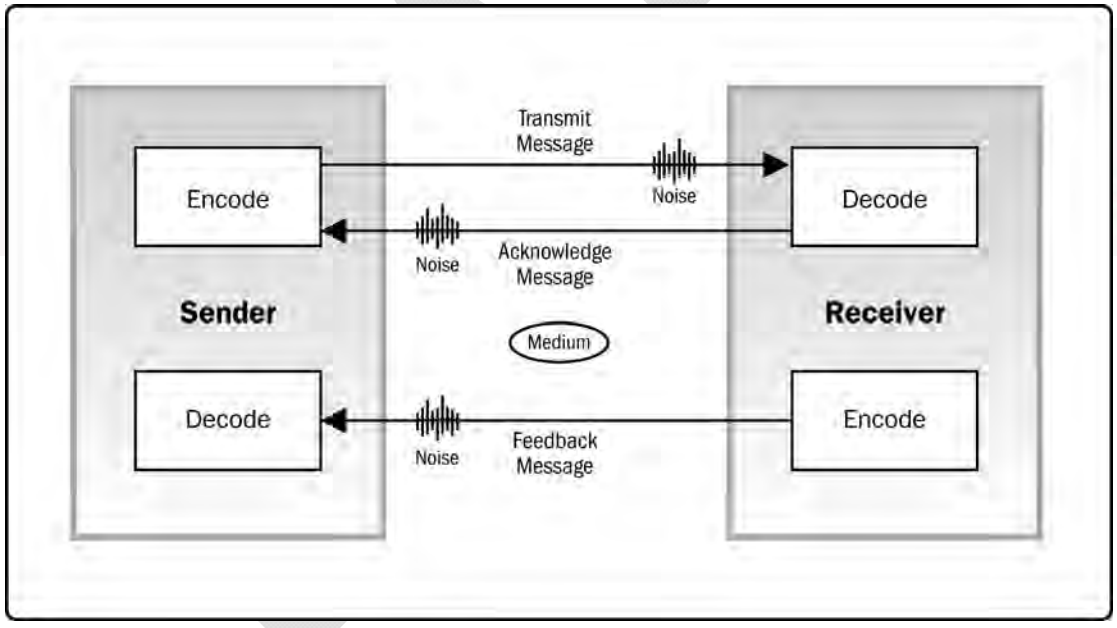



**Figure 10-4. Basic Communication Model**

The components of the basic communication model need to be considered when project communications are discussed. As part of the communications process, the sender is responsible for the transmission of the message, ensuring the information being communicated is clear and complete, and confirming the communication is correctly understood. The receiver is responsible for ensuring that the information is received in its entirety, understood correctly, and acknowledged or responded to appropriately.

There are many challenges in using these components to effectively communicate with project stakeholders, such as in a highly technical, multinational project team. Successful communication of a technical concept from one team member to another team member in a different country could involve encoding the message in the appropriate language, sending the message using a variety of technologies, and having the receiver decode the message into his or her native language and then reply or provide feedback. Any noise introduced along the way may compromise the original meaning of the message. In this example, there are multiple factors that may lead to the intended meaning of the message being misunderstood or misinterpreted.

### 10.1.2.4 Communication Methods

There are several communication methods that are used to share information among project stakeholders. These methods are broadly classified as follows:

- **Interactive communication.** Between two or more parties performing a multidirectional exchange of information. It is the most efficient way to ensure a common understanding by all participants on specified topics, and includes meetings, phone calls, instant messaging, video conferencing, etc.
- **Push communication.** Sent to specific recipients who need to receive the information. This ensures that the information is distributed but does not ensure that it actually reached or was understood by the intended audience. Push communications include letters, memos, reports, emails, faxes, voice mails, blogs, press releases, etc.
- **Pull communication.** Used for very large volumes of information, or for very large audiences, and requires the recipients to access the communication content at their own discretion. These methods include intranet sites, e-learning, lessons learned databases, knowledge repositories, etc.

The choices of communication methods that are used for a project may need to be discussed and agreed upon by the project stakeholders based on communication requirements; cost and time constraints; and familiarity and availability of the required tools and resources that may be applicable to the communications process.

### 10.1.2.5 Meetings

Described in Section 4.3.2.3. The Plan Communications Management process requires discussion and dialogue with the project team to determine the most appropriate way to update and communicate project information, and to respond to requests from various stakeholders for that information. These discussions and dialogue are commonly facilitated through meetings, which may be conducted face to face or online and in different locations, such as the project site or the customer's site.

There are several types of project-related meetings where project communications may occur. Most project meetings consist of stakeholders coming together for the purpose of resolving problems or making decisions. Although casual discussions may be construed as a meeting, most project meetings are more formal with a prearranged time, place, and agenda. Typical meetings begin with a defined list of issues to be discussed, which are circulated in advance with minutes and other information documented specifically for the meeting. This information is then disseminated to other appropriate stakeholders on an as-needed basis.

## 10.1.3 Plan Communications Management: Outputs

### 10.1.3.1 Communications Management Plan

The communications management plan is a component of the project management plan that describes how project communications will be planned, structured, monitored, and controlled. The plan contains the following information:

- Stakeholder communication requirements;
- Information to be communicated, including language, format, content, and level of detail;
- Reason for the distribution of that information;
- Time frame and frequency for the distribution of required information and receipt of acknowledgment or response, if applicable;
- Person responsible for communicating the information;
- Person responsible for authorizing release of confidential information;
- Person or groups who will receive the information;
- Methods or technologies used to convey the information, such as memos, e-mail, and/or press releases;
- Resources allocated for communication activities, including time and budget;
- Escalation process identifying time frames and the management chain (names) for escalation of issues that cannot be resolved at a lower staff level;
- Method for updating and refining the communications management plan as the project progresses and develops;
- Glossary of common terminology;
- Flow charts of the information flow in the project, workflows with possible sequence of authorization, list of reports, and meeting plans, etc.; and
- Communication constraints usually derived from a specific legislation or regulation, technology, and organizational policies, etc.

The communications management plan can also include guidelines and templates for project status meetings, project team meetings, e-meetings, and e-mail messages. The use of a project website and project management software can also be included if these are to be used in the project.

### 10.1.3.2 Project Documents Updates

Project documents that may be updated include, but are not limited to:

- Project schedule, and
- Stakeholder register.

## 10.2 Manage Communications

Manage Communications is the process of creating, collecting, distributing, storing, retrieving, and the ultimate disposition of project information in accordance to the communications management plan. The key benefit of this process is that it enables an efficient and effective communications flow between project stakeholders. The inputs, tools and

techniques, and outputs of this process are depicted in Figure 10-5. Figure 10-6 depicts the data flow diagram of the Manage Communications process.

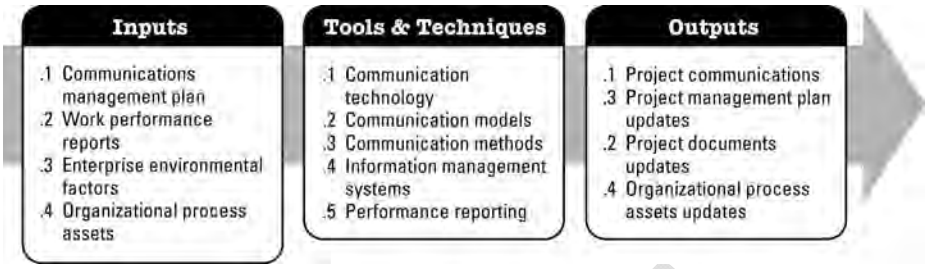



**Figure 10-5. Manage Communications: Inputs, Tools & Techniques, and Outputs**

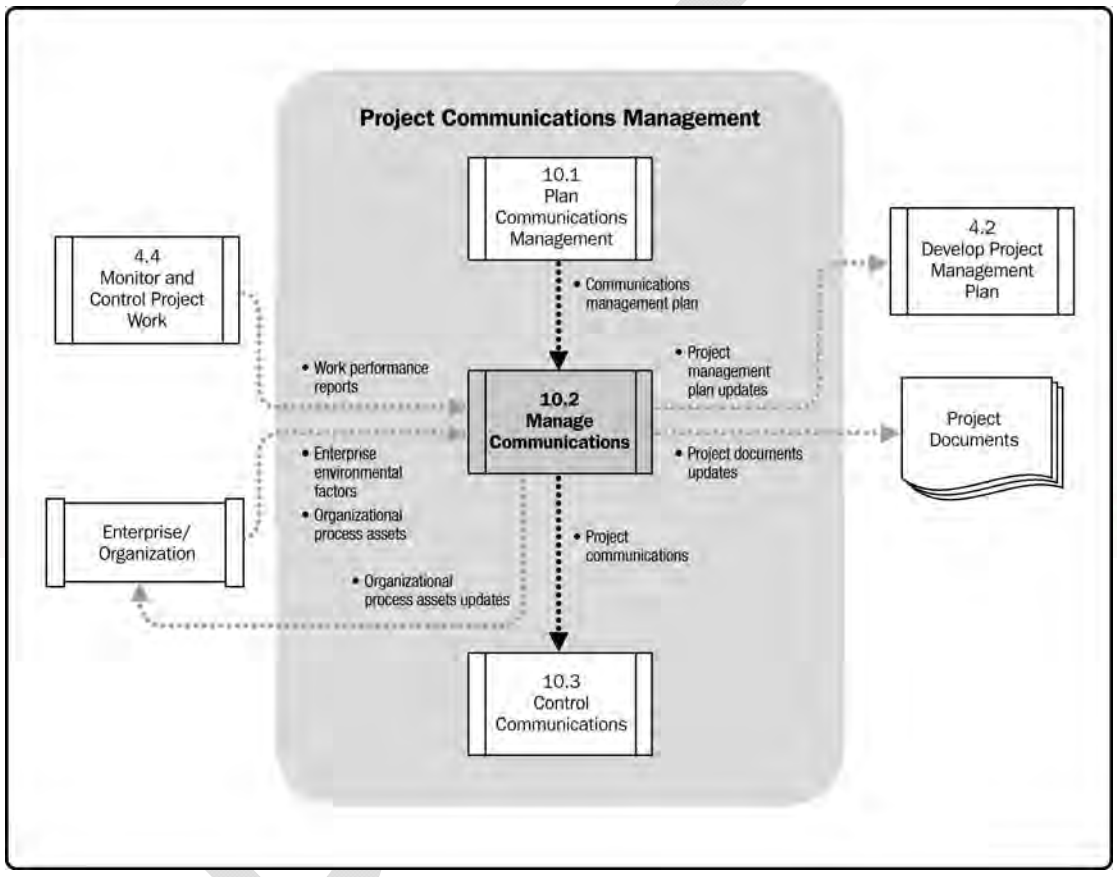



**Figure 10-6. Manage Communications Data Flow Diagram**

This process goes beyond the distribution of relevant information and seeks to ensure that the information being communicated to project stakeholders has been appropriately generated, as well as received and understood. It also provides opportunities for stakeholders to make requests for further information, clarification, and discussion. Techniques and considerations for effective communications management include, but are not limited to, the following:

- **Sender-receiver models.** Incorporating feedback loops to provide opportunities for interaction/participation and remove barriers to communication.

- **Choice of media.** Situation specifics as to when to communicate in writing versus orally, when to prepare an informal memo versus a formal report, and when to communicate face-to-face versus by e-mail.
- **Writing style.** Appropriate use of active versus passive voice, sentence structure, and word choice.
- **Meeting management techniques.** Preparing an agenda and dealing with conflicts.
- **Presentation techniques.** Awareness of the impact of body language and design of visual aids.
- **Facilitation techniques.** Building consensus and overcoming obstacles.
- **Listening techniques.** Listening actively (acknowledging, clarifying, and confirming understanding) and removal of barriers that adversely affect comprehension.

## 10.2.1 Manage Communications: Inputs

### 10.2.1.1 Communications Management Plan

Described in Section 10.1.3.1. The communications management plan describes how project communications will be planned, structured, monitored, and controlled.

### 10.2.1.2 Work Performance Reports

Described in Section 4.4.3.2. Work performance reports are a collection of project performance and status information that may be used to facilitate discussion and to create communications. To optimize this process, it is important that reports be comprehensive, accurate, and available in a timely manner.

### 10.2.1.3 Enterprise Environmental Factors

Described in Section 2.1.5. Specific enterprise environmental factors that can influence the Manage Communications process include, but are not limited to:

- Organizational culture and structure,
- Government or industry standards and regulations, and
- Project management information system.

### 10.2.1.4 Organizational Process Assets

Described in Section 2.1.4. Organizational process assets that can influence the Manage Communications process include, but are not limited to:

- Policies, procedures, processes, and guidelines regarding communications management;
- Templates; and
- Historical information and lessons learned.

## 10.2.2 Manage Communications: Tools and Techniques

### 10.2.2.1 Communication Technology

Described in Section 10.1.2.2. The choice of communication technology is an important consideration in the Manage Communications process. As this can vary significantly from project to project and also throughout the life of a project, the focus is to ensure that the choice is appropriate for the information that is being communicated.

#### 10.2.2.2 Communication Models

Described in Section 10.1.2.3. The choice of communication models is an important consideration in this process. As the components in the communications all contribute toward an effective and efficient communications process, the focus is to ensure that the choice of the communication model is appropriate for the project that is undertaken and that any barriers (noise) are identified and managed.

#### 10.2.2.3 Communication Methods

Described in Section 10.1.2.4. The choice of communication methods is an important consideration in this process. As there can be many potential barriers and challenges during this process, the focus is to ensure that the information that has been created and distributed has been received and understood to enable response and feedback.

#### 10.2.2.4 Information Management Systems

Project information is managed and distributed using a variety of tools, including:

- Hard-copy document management: letters, memos, reports, press releases;
- Electronic communications management: e-mail, fax, voice mail, telephone, video and web conferencing, websites, and web publishing; and
- Electronic project management tools: web interfaces to scheduling and project management software, meeting and virtual office support software, portals, and collaborative work management tools.

#### 10.2.2.5 Performance Reporting

Performance reporting is the act of collecting and distributing performance information, including status reports, progress measurements, and forecasts. Performance reporting involves the periodic collection and analysis of baseline versus actual data to understand and communicate the project progress and performance as well as to forecast the project results.

Performance reporting needs to provide information at an appropriate level for each audience. The format may range from a simple status report to more elaborate reports and may be prepared regularly or on an exception basis. A simple status report might show performance information, such as percent complete or status dashboards for each area (i.e., scope, schedule, cost, and quality). More elaborate reports may include:

- Analysis of past performance,
- Analysis of project forecasts (including time and cost),
- Current status of risks and issues,
- Work completed during the period,
- Work to be completed in the next period,
- Summary of changes approved in the period, and
- Other relevant information, which is reviewed and discussed.

### 10.2.3 Manage Communications: Outputs

#### 10.2.3.1 Project Communications

The Manage Communications process involves the activities that are required for information to be created, distributed, received, acknowledged, and understood. Project

communications may include but are not limited to: performance reports, deliverables status, schedule progress, and cost incurred. Project communications can vary significantly and are influenced by factors such as, but not limited to, the urgency and impact of the message, its method of delivery, and level of confidentiality.

#### 10.2.3.2 Project Management Plan Updates

The project management plan provides information on project baselines, communications management, and stakeholder management. Each of these areas may require updates based upon the current performance of the project against the performance measurement baseline (PMB). The performance measurement baseline is an approved plan for the project work to which the project execution is compared, and deviations are measured for management control. The performance measurement baseline typically integrates scope, schedule, and cost parameters of a project, but may also include technical and quality parameters.

#### 10.2.3.3 Project Documents Updates

Project documents that may be updated include, but are not limited to:

- Issue log,
- Project schedule, and
- Project funding requirements.

#### 10.2.3.4 Organizational Process Assets Updates

The organizational process assets, which may be updated include, but are not limited to:

- **Stakeholder notifications.** Information may be provided to stakeholders about resolved issues, approved changes, and general project status.
- **Project reports.** Formal and informal project reports describe project status and include lessons learned, issue logs, project closure reports, and outputs from other Knowledge Areas (Sections 4-13).
- **Project presentations.** The project team provides information formally or informally to any or all of the project stakeholders. The information and presentation method should be relevant to the needs of the audience.
- **Project records.** Project records may include correspondence, memos, meeting minutes, and other documents describing the project. This information should, to the extent possible and appropriate, be maintained in an organized manner. Project team members can also maintain records in a project notebook or register, which could be physical or electronic.
- **Feedback from stakeholders.** Information received from stakeholders concerning project operations is distributed and used to modify or improve future performance of the project.
- **Lessons learned documentation.** Documentation includes the causes of issues, reasoning behind the corrective action chosen, and other types of lessons learned about communications management. Lessons learned need to be documented and distributed so that it becomes part of the historical database for both the project and the performing organization.

## 10.3 Control Communications

Control Communications is the process of monitoring and controlling communications throughout the entire project life cycle to ensure the information needs of the project stakeholders are met. The key benefit of this process is that it ensures an optimal information flow among all communication participants, at any moment in time. The inputs, tools and techniques, and outputs of this process are depicted in Figure 10-7. Figure 10-8 depicts the data flow diagram of the Control Communications process.

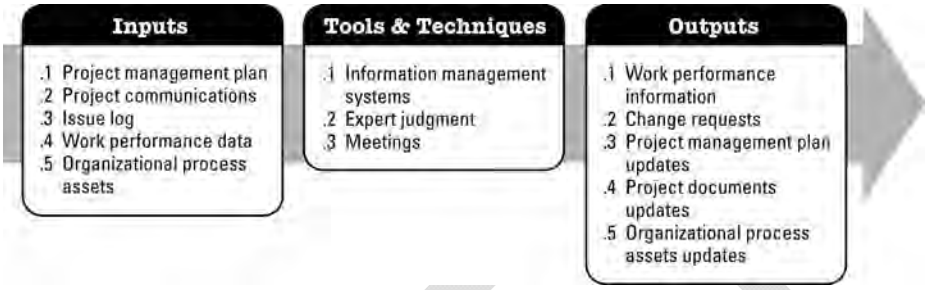



**Figure 10-7. Control Communications: Inputs, Tools & Techniques, and Outputs**

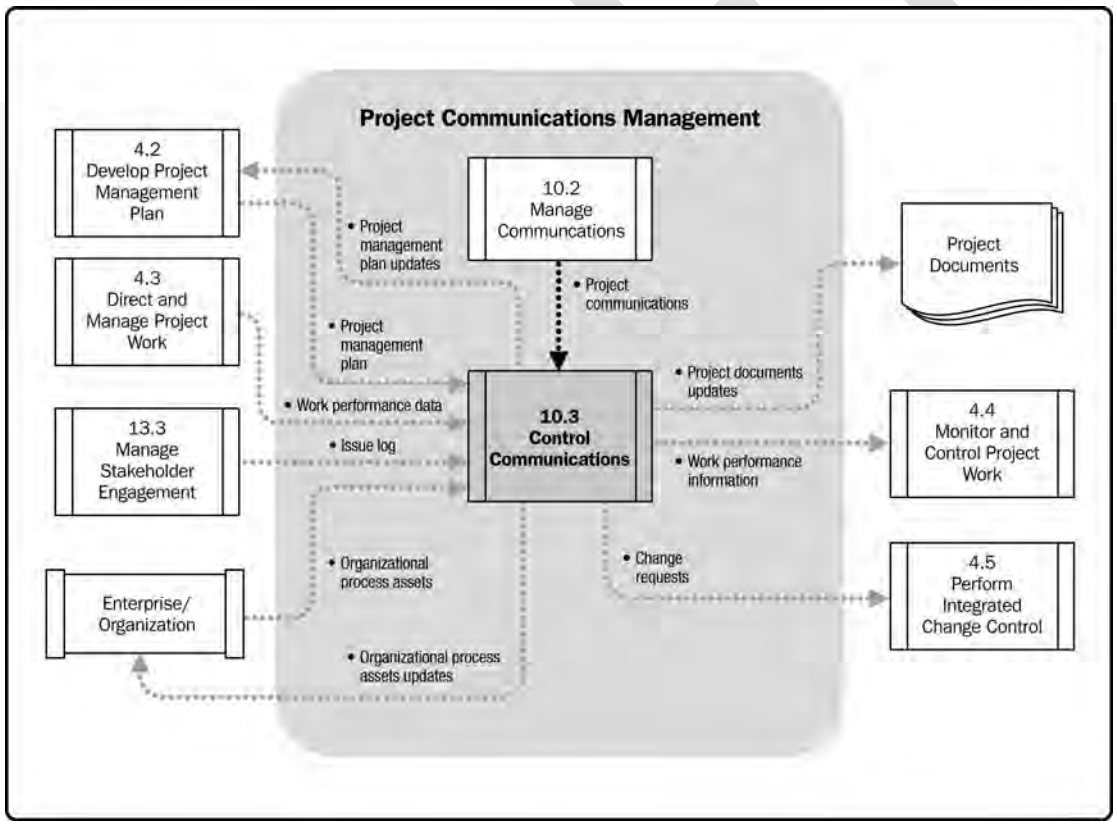



**Figure 10-8. Control Communications Data Flow Diagram**

The Control Communications process can trigger an iteration of the Plan Communications Management and/or Manage Communications processes. This iteration illustrates the continuous nature of the Project Communications Management processes. Specific communication elements, such as issues or key performance indicators (e.g., actual vs. planned

schedule, cost, and quality), may trigger an immediate revision, while others may not. The impact and repercussions of project communications should be carefully evaluated and controlled to ensure that the right message is delivered to the right audience at the right time.

## 10.3.1 Control Communications: Inputs

### 10.3.1.1 Project Management Plan

Described in Section 4.2.3.1. The project management plan describes how the project will be executed, monitored, controlled, and closed. It provides valuable information for the Control Communications process such as, but not limited to:

- Stakeholder communication requirements,
- Reason for the distribution of the information,
- Timeframe and frequency for the distribution of required information,
- Individual or group responsible for communication of the information, and
- Individual or group receiving the information.

### 10.3.1.2 Project Communications

Described in Section 10.2.3.1. The Control Communications process involves the activities that are required for information and communications to be monitored, acted upon, and released to stakeholders. Project communications come from multiple sources and may vary significantly in their format, level of detail, degree of formality and confidentiality. Project communications may include but are not limited to:

- Deliverables status,
- Schedule progress, and
- Costs incurred.



### 10.3.1.3 Issue Log

Described in Section 13.3.3.1. An issue log is used to document and monitor the resolution of issues. It may be used to facilitate communication and ensure a common understanding of issues. A written log documents and helps monitor who is responsible for resolving specific issues by a target date. Issue resolution addresses obstacles that can block the team from achieving its goals. This information is important to the Control Communications process as it provides both a repository for what has already happened in the project and a platform for subsequent communications to be delivered.

### 10.3.1.4 Work Performance Data

Described in Section 4.3.3.2. Work performance data organizes and summarizes the information gathered, and presents the results of comparative analysis to the performance measurement baseline.

### 10.3.1.5 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that may influence the Control Communications process include, but are not limited to:

- Report templates;
- Policies, standards, and procedures that define communications;
- Specific communication technologies available;

- Allowed communication media;
- Record retention policies; and
- Security requirements.

## 10.3.2 Control Communications: Tools and Techniques

### 10.3.2.1 Information Management Systems

An information management system provides a set of standard tools for the project manager to capture, store, and distribute information to stakeholders about the project's costs, schedule progress, and performance. Some software packages allow the project manager to consolidate reports from several systems and facilitate report distribution to the project stakeholders. Examples of distribution formats may include table reporting, spreadsheet analysis, and presentations. Graphic capabilities can be used to create visual representations of project performance information.

### 10.3.2.2 Expert Judgment

Expert judgment is often relied upon by the project team to assess the impact of the project communications, need for action or intervention, actions that should be taken, responsibility for taking such actions, and the timeframe for taking action. Expert judgment may need to be applied to technical and/or management details and may be provided by any group or individual with specialized knowledge or training, such as:

- Other units within the organization,
- Consultants,
- Stakeholders, including customers or sponsors,
- Professional and technical associations,
- Industry groups,
- Subject matter experts, and
- Project management office (PMO).

The project manager, in collaboration with the project team, then determines the actions required to ensure that the right message is communicated to the right audience at the right time.

### 10.3.2.3 Meetings

The Control Communications process requires discussion and dialogue with the project team to determine the most appropriate way to update and communicate project performance, and to respond to requests from stakeholders for information. These discussions and dialogues are commonly facilitated through meetings, which may be conducted face to face or online and in different locations, such as the project site or the client's site. Project meetings also include discussions and dialog with suppliers, vendors, and other project stakeholders.

## 10.3.3 Control Communications: Outputs

### 10.3.3.1 Work Performance Information

Described in Section 4.4.1.5. Work performance information organizes and summarizes the performance data gathered. This performance data typically provides status and progress information on the project at the level of detail required by the various stakeholders. This information is then communicated to the appropriate stakeholders.

### 10.3.3.2 Change Requests

Described in Section 4.3.3.3. The Control Communications process often results in the need for adjustment, action, and intervention. As a result, change requests will be generated as an output. These change requests are processed through the Perform Integrated Change Control process (Section 4.5) and may result in:

- New or revised cost estimates, activity sequences, schedule dates, resource requirements, and analysis of risk response alternatives;
- Adjustments to the project management plan and documents;
- Recommendations of corrective actions that may bring the expected future performance of the project back in line with the project management plan; and
- Recommendations of preventive actions that may reduce the probability of incurring future negative project performance.

### 10.3.3.3 Project Management Plan Updates

Control Communications process may trigger updates to the communications management plan as well as other components of the project management plan (e.g. stakeholders and human resource management plans).

### 10.3.3.4 Project Documents Updates

Project documents may be updated as a result of the Control Communications process. These updates may include, but are not limited to:

- Forecasts,
- Performance reports, and
- Issue log.



### 10.3.3.5 Organizational Process Assets Updates

The organizational process assets that may be updated include, but are not limited to, report formats and lessons learned documentation. This documentation may become part of the historical database for both this project and the performing organization and may include the causes of issues, reasons behind the corrective action chosen, and other types of lessons learned during the project.

# 11

# PROJECT RISK MANAGEMENT

Project Risk Management includes the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project. The objectives of project risk management are to increase the likelihood and impact of positive events, and decrease the likelihood and impact of negative events in the project.

Figure 11-1 provides an overview of the Project Risk Management processes, which are as follows:

**11.1 Plan Risk Management**—The process of defining how to conduct risk management activities for a project.

**11.2 Identify Risks**—The process of determining which risks may affect the project and documenting their characteristics.

**11.3 Perform Qualitative Risk Analysis**—The process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact.

**11.4 Perform Quantitative Risk Analysis**—The process of numerically analyzing the effect of identified risks on overall project objectives.

**11.5 Plan Risk Responses**—The process of developing options and actions to enhance opportunities and to reduce threats to project objectives.

**11.6 Control Risks**—The process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the project.

These processes interact with each other and with processes in other Knowledge Areas as described in detail in Section 3 and Annex A1.

Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality. A risk may have one or more causes and, if it occurs, it may have one or more impacts. A cause may be a given or potential requirement, assumption, constraint, or condition that creates the possibility of negative or positive outcomes. For example, causes could include the requirement of an environmental permit to do work, or having limited personnel assigned to design the project. The risk is that the permitting agency may take longer than planned to issue a permit; or, in the case of an opportunity, additional development personnel may become available who can participate in design, and they can be assigned to the project. If either of these uncertain events occurs, there may be an impact on the project, scope, cost, schedule, quality, or performance. Risk conditions may include aspects of the project's or organization's environment that contribute to project risk, such as immature project management practices, lack of integrated management systems, concurrent multiple projects, or dependency on external participants who are outside the project's direct control.

Project risk has its origins in the uncertainty present in all projects. Known risks are those that have been identified and analyzed, making it possible to plan responses for those risks.

Known risks that cannot be managed proactively, should be assigned a contingency reserve. Unknown risks cannot be managed proactively and therefore may be assigned a management reserve. A negative project risk that has occurred is considered an issue.

Individual project risks are different from overall project risk. Overall project risk represents the effect of uncertainty on the project as a whole. It is more than the sum of the individual risks within a project, since it includes all sources of project uncertainty. It represents the exposure of stakeholders to the implications of variations in project outcome, both positive and negative.

Organizations perceive risk as the effect of uncertainty on projects and organizational objectives. Organizations and stakeholders are willing to accept varying degrees of risk depending on their risk attitude. The risk attitudes of both the organization and the stakeholders may be influenced by a number of factors, which are broadly classified into three themes:

- *Risk appetite,* which is the degree of uncertainty an entity is willing to take on in anticipation of a reward.
- *Risk tolerance,* which is the degree, amount, or volume of risk that an organization or individual will withstand.
- *Risk threshold,* which refers to measures along the level of uncertainty or the level of impact at which a stakeholder may have a specific interest. Below that risk threshold, the organization will accept the risk. Above that risk threshold, the organization will not tolerate the risk.

For example, an organization's risk attitude may include its appetite for uncertainty, its threshold for risk levels that are unacceptable, or its risk tolerance at which point the organization may select a different risk response.

Positive and negative risks are commonly referred to as opportunities and threats. The project may be accepted if the risks are within tolerances and are in balance with the rewards that may be gained by taking the risks. Positive risks that offer opportunities within the limits of risk tolerances may be pursued in order to generate enhanced value. For example, adopting an aggressive resource optimization technique is a risk taken in anticipation of a reward for using fewer resources.

Individuals and groups adopt attitudes toward risk that influence the way they respond. These risk attitudes are driven by perception, tolerances, and other biases, which should be made explicit wherever possible. A consistent approach to risk should be developed for each project, and communication about risk and its handling should be open and honest. Risk responses reflect an organization's perceived balance between risk taking and risk avoidance.

To be successful, an organization should be committed to address risk management proactively and consistently throughout the project. A conscious choice should be made at all levels of the organization to actively identify and pursue effective risk management during the life of the project. Project risk could exist at the moment a project is initiated. Moving forward on a project without a proactive focus on risk management is likely to lead to more problems arising from unmanaged threats.

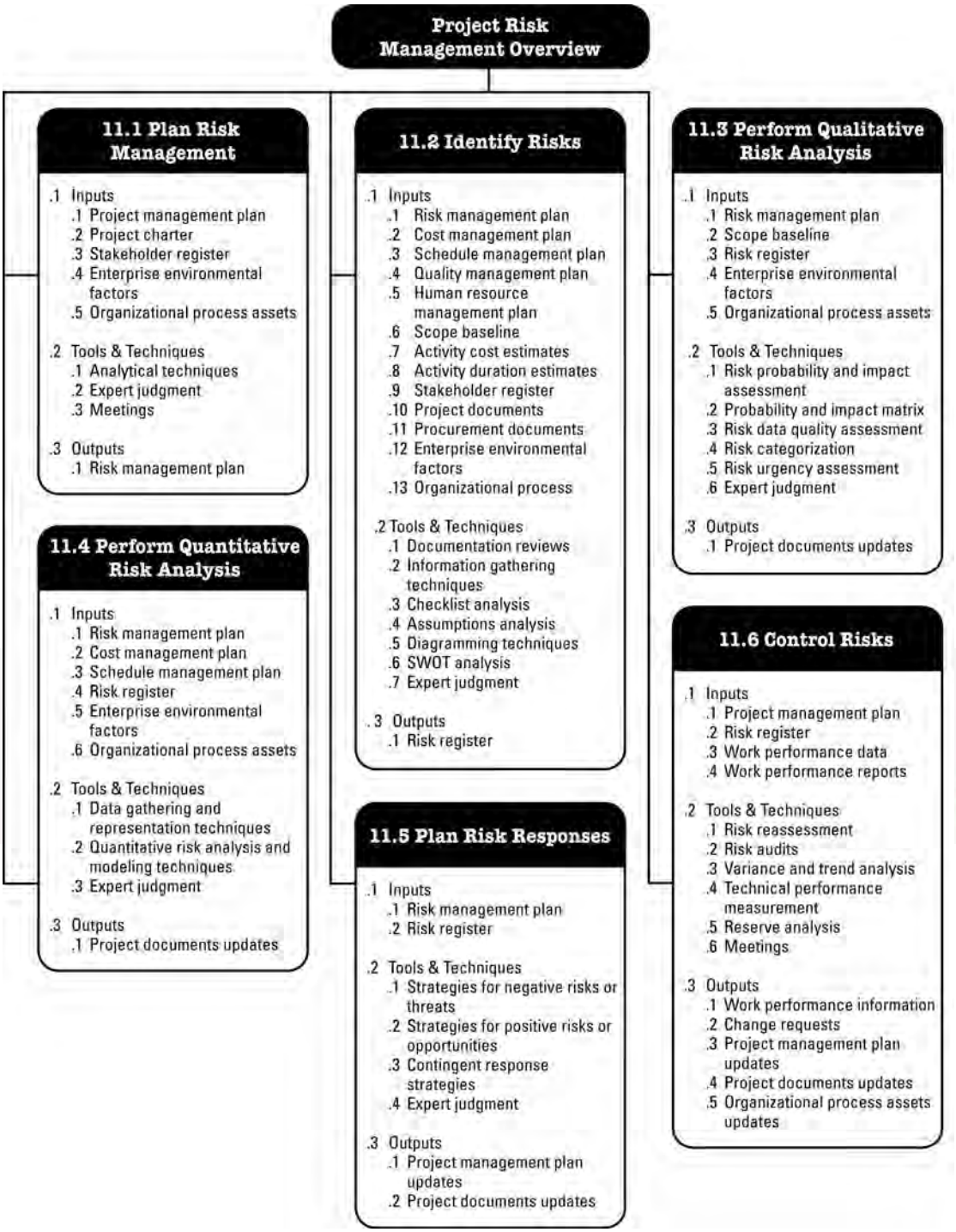



**Figure 11-1. Project Risk Management Overview**

## 11.1 Plan Risk Management

Plan Risk Management is the process of defining how to conduct risk management activities for a project. The key benefit of this process is it ensures that the degree, type, and visibility of risk management are commensurate with both the risks and the importance of the project to the organization. The risk management plan is vital to communicate with and obtain

agreement and support from all stakeholders to ensure the risk management process is supported and performed effectively over the project life cycle. The inputs, tools and techniques, and outputs of this process are depicted in Figure 11-2. Figure 11-3 depicts the data flow diagram of the process.


**Figure 11-2. Plan Risk Management: Inputs, Tools & Techniques, and Outputs**

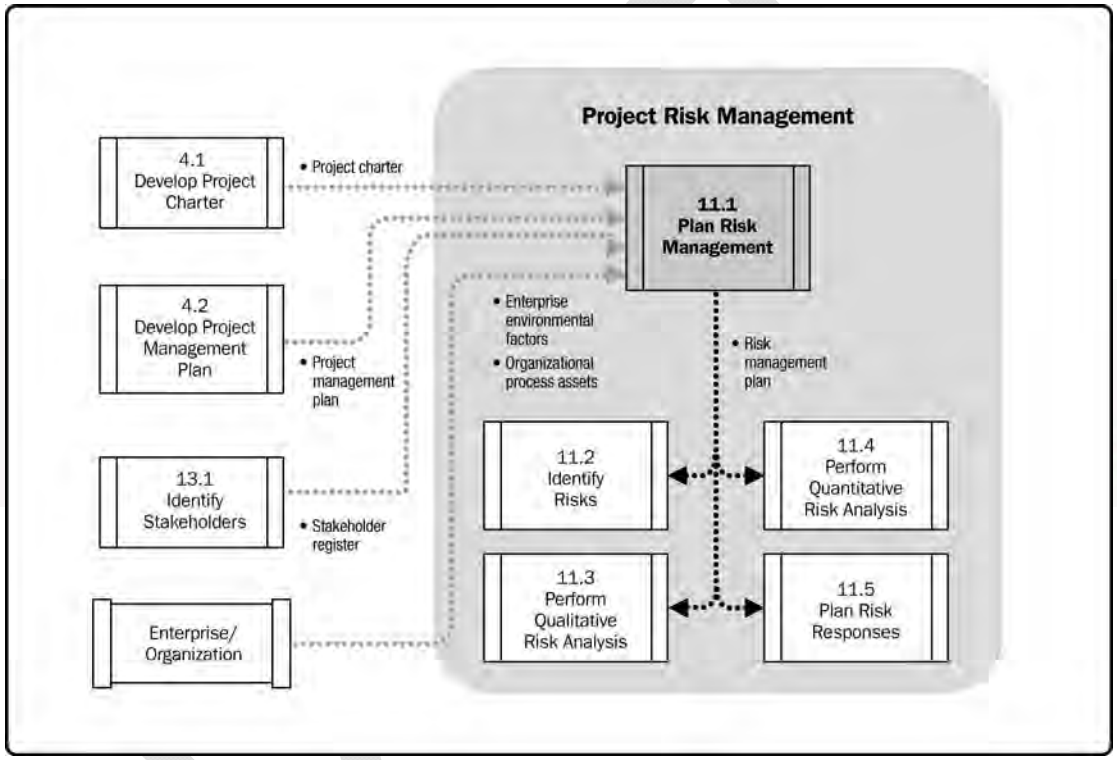



**Figure 11-3. Plan Risk Management Data Flow Diagram**

Careful and explicit planning enhances the probability of success for other risk management processes. Planning is also important to provide sufficient resources and time for risk management activities and to establish an agreed-upon basis for evaluating risks. The Plan Risk Management process should begin when a project is conceived and should be completed early during project planning.

## 11.1.1 Plan Risk Management: Inputs

### 11.1.1.1 Project Management Plan

In planning risk management, all approved subsidiary management plans and baselines should be taken into consideration in order to make the risk management plan consistent with them. The risk management plan is also a component of the project management plan. The

project management plan provides baseline or current state of risk affected areas including scope, schedule, and cost.

#### 11.1.1.2 Project Charter

Described in Section 4.1.3.1. The project charter can provide various inputs such as high-level risks, high-level project descriptions, and high-level requirements.

#### 11.1.1.3 Stakeholder Register

Described in Section 13.1.3.1. The stakeholder register, which contains all details related to the project's stakeholders, provides an overview of their roles.

#### 11.1.1.4 Enterprise Environmental Factors

Described in Section 2.1.5. The enterprise environmental factors that can influence the Plan Risk Management process include, but are not limited to, risk attitudes, thresholds and tolerances that describe the degree of risk that an organization will withstand.

#### 11.1.1.5 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that can influence the Plan Risk Management process include, but are not limited to:

- Risk categories,
- Common definitions of concepts and terms,
- Risk statement formats,
- Standard templates,
- Roles and responsibilities,
- Authority levels for decision making, and
- Lessons learned.



### 11.1.2 Plan Risk Management: Tools and Techniques

#### 11.1.2.1 Analytical Techniques

Analytical techniques are used to understand and define the overall risk management context of the project. Risk management context is a combination of stakeholder risk attitudes and the strategic risk exposure of a given project based on the overall project context. For example, a stakeholder risk profile analysis may be performed to grade and qualify the project stakeholder risk appetite and tolerance. Other techniques, such as the use of strategic risk scoring sheets, are used to provide a high-level assessment of the risk exposure of the project based on the overall project context. Depending on these assessments, the project team can allocate appropriate resources and focus on the risk management activities.

#### 11.1.2.2 Expert Judgment

To ensure a comprehensive establishment of the risk management plan, judgment, and expertise should be considered from groups or individuals with specialized training or knowledge on the subject area, such as:

- Senior management,
- Project stakeholders,

- Project managers who have worked on projects in the same area (directly or through lessons learned),
- Subject matter experts (SMEs) in business or project area,
- Industry groups and consultants, and
- Professional and technical associations.

#### 11.1.2.3 Meetings

Project teams hold planning meetings to develop the risk management plan. Attendees at these meetings may include the project manager, selected project team members and stakeholders, anyone in the organization with responsibility to manage the risk planning and execution activities, and others, as needed.

High-level plans for conducting the risk management activities are defined in these meetings. Risk management cost elements and schedule activities should be developed for inclusion in the project budget and schedule, respectively. Risk contingency reserve application approaches may be established or reviewed. Risk management responsibilities should be assigned. General organizational templates for risk categories and definitions of terms such as levels of risk, probability by type of risk, impact by type of objectives, and the probability and impact matrix will be tailored to the specific project. If templates for other steps in the process do not exist, they may be generated in these meetings. The outputs of these activities are summarized in the risk management plan.

### 11.1.3 Plan Risk Management: Outputs

#### 11.1.3.1 Risk Management Plan

The risk management plan is a component of the project management plan and describes how risk management activities will be structured and performed. The risk management plan includes the following:

- **Methodology.** Defines the approaches, tools, and data sources that will be used to perform risk management on the project.
- **Roles and responsibilities.** Defines the lead, support, and risk management team members for each type of activity in the risk management plan, and clarifies their responsibilities.
- **Budgeting.** Estimates funds needed, based on assigned resources, for inclusion in the cost baseline and establishes protocols for application of contingency and management reserves.
- **Timing.** Defines when and how often the risk management processes will be performed throughout the project life cycle, establishes protocols for application of schedule contingency reserves, and establishes risk management activities for inclusion in the project schedule.
- **Risk categories.** Provide a means for grouping potential causes of risk. Several approaches can be used, for example, a structure based on project objectives by category. A risk breakdown structure (RBS) helps the project team to look at many sources from which project risk may arise in a risk identification exercise. Different RBS structures will be appropriate for different types of projects. An organization can use a previously prepared custom categorization framework, which may take the form

of a simple list of categories or may be structured into an RBS. The RBS is a hierarchical representation of risks according to their risk categories. An example is shown in Figure 11-4.

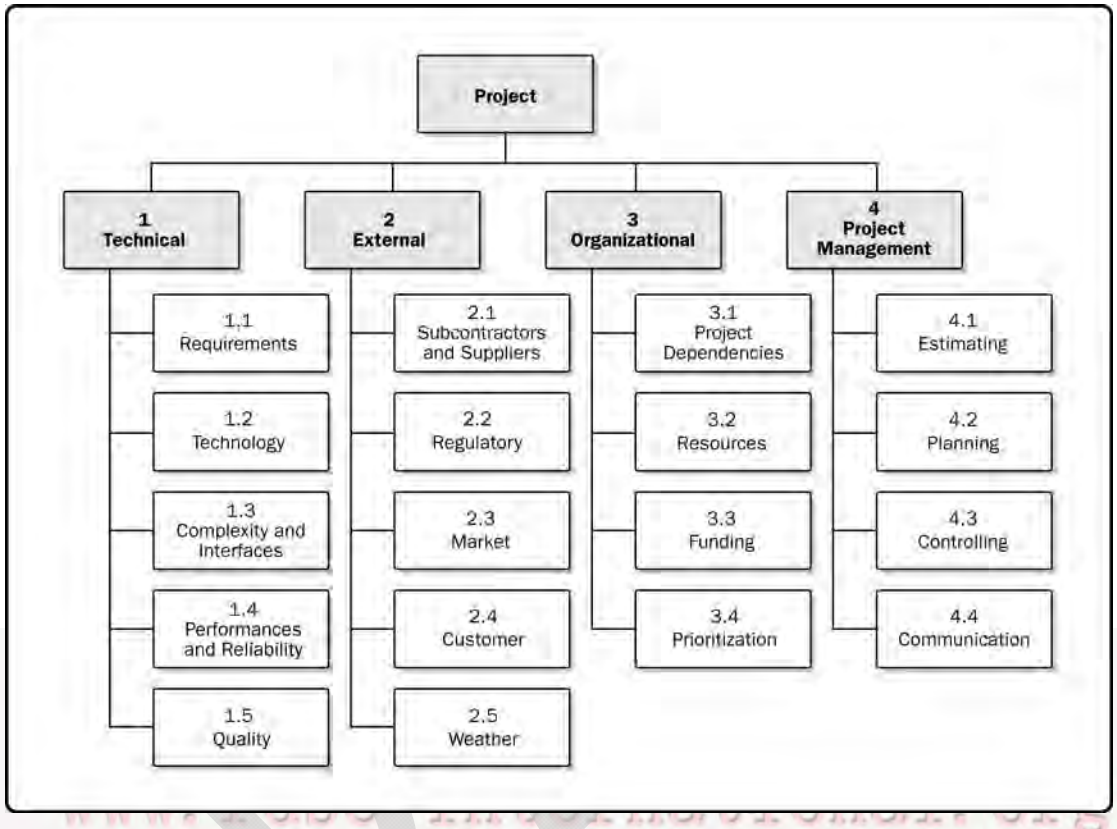



**Figure 11-4. Example of a Risk Breakdown Structure (RBS)**

- **Definitions of risk probability and impact.** The quality and credibility of the risk analysis requires that different levels of risk probability and impact be defined that are specific to the project context. General definitions of probability levels and impact levels are tailored to the individual project during the Plan Risk Management process for use in subsequent processes. Table 11-1 is an example of definitions of negative impacts that could be used in evaluating risk impacts related to four project objectives. (Similar tables may be established with a positive impact perspective). Table 11-1 illustrates both relative and numerical (in this case, nonlinear) approaches.

**Table 11-1. Definition of Impact Scales for Four Project Objectives**

| Defined Conditions for Impact Scales of a Risk on Major Project Objectives (Examples are shown for negative impacts only) | | | | | |
|---|---|---|---|---|---|
| | Relative or numerical scales are shown | | | | |
| **Project Objective** | Very low /0.05 | Low /0.10 | Moderate /0.20 | High /0.40 | Very high /0.80 |
| **Cost** | Insignificant cost increase | < 10% cost increase | 10 – 20% cost increase | 20 – 40% cost increase | > 40% cost increase |
| **Time** | Insignificant time increase | < 5% time increase | 5 – 10% time increase | 10 – 20% time increase | > 20% time increase |
| **Scope** | Scope decrease barely noticeable | Minor areas of scope affected | Major areas of scope affected | Scope reduction unacceptable to sponsor | Project end item is effectively useless |
| **Quality** | Quality degradation barely noticeable | Only very demanding applications are affected | Quality reduction requires sponsor approval | Quality reduction unacceptable to sponsor | Project end item is effectively useless |
| This table presents examples of risk impact definitions for four different project objectives. They should be tailored in the Risk Management Planning process to the individual project and to the organization's risk thresholds. Impact definitions can be developed for opportunities in a similar way. | | | | | |

- **Probability and impact matrix.** A probability and impact matrix is a grid for mapping the probability of each risk occurrence and its impact on project objectives if that risk occurs. Risks are prioritized according to their potential implications for having an effect on the project's objectives. A typical approach to prioritizing risks is to use a look-up table or a probability and impact matrix. The specific combinations of probability and impact that lead to a risk being rated as "high," "moderate," or "low" importance are usually set by the organization.
- **Revised stakeholders' tolerances.** Stakeholders' tolerances, as they apply to the specific project, may be revised in the Plan Risk Management process.
- **Reporting formats.** Reporting formats define how the outcomes of the risk management process will be documented, analyzed, and communicated. It describes the content and format of the risk register as well as any other risk reports required.
- **Tracking.** Tracking documents how risk activities will be recorded for the benefit of the current project and how risk management processes will be audited.

## 11.2 Identify Risks

Identify Risks is the process of determining which risks may affect the project and documenting their characteristics. The key benefit of this process is the documentation of existing risks and the knowledge and ability it provides to the project team to anticipate events. The inputs, tools and techniques, and outputs of this process are depicted in Figure 11-5. Figure 11-6 depicts the data flow diagram of the process.

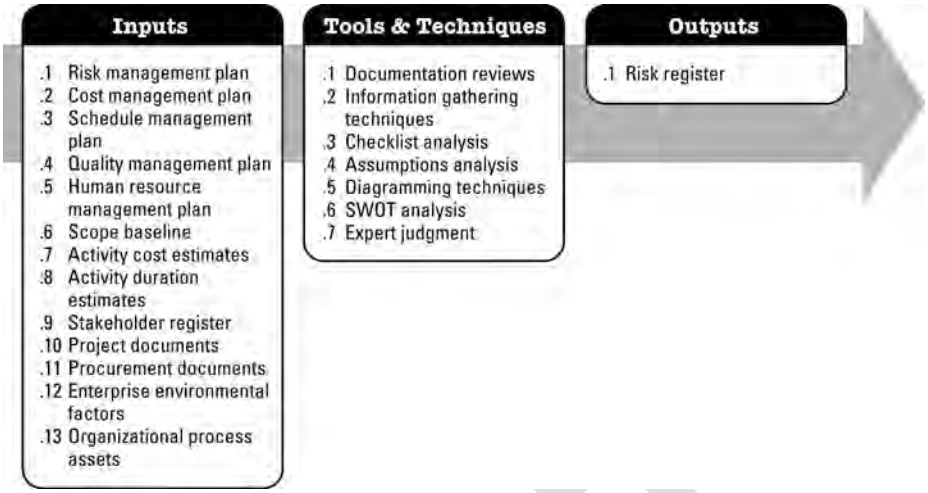



**Figure 11-5. Identify Risks: Inputs, Tools & Techniques, and Outputs**

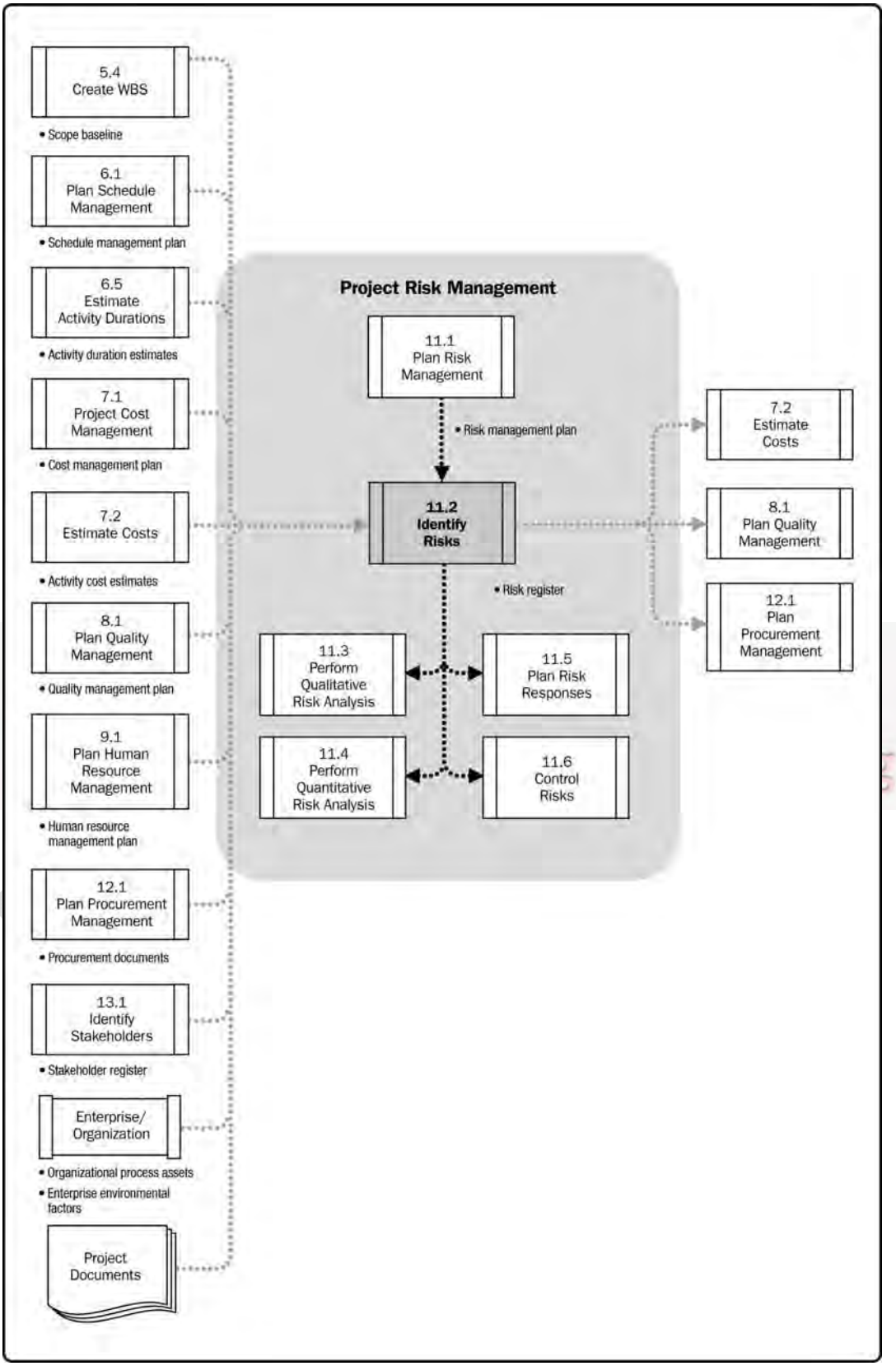



**Figure 11-6. Identify Risks Data Flow Diagram**

Participants in risk identification activities may include the following: project manager, project team members, risk management team (if assigned), customers, subject matter experts from outside the project team, end users, other project managers, stakeholders, and risk management experts. While these personnel are often key participants for risk identification, all project personnel should be encouraged to identify potential risks.

Identify risks is an iterative process, because new risks may evolve or become known as the project progresses through its life cycle. The frequency of iteration and participation in each cycle will vary by situation. The format of the risk statements should be consistent to ensure that each risk is understood clearly and unambiguously in order to support effective analysis and response development. The risk statement should support the ability to compare the relative effect of one risk against others on the project. The process should involve the project team so they can develop and maintain a sense of ownership and responsibility for the risks and associated risk response actions. Stakeholders outside the project team may provide additional objective information.

## 11.2.1 Identify Risks: Inputs

### 11.2.1.1 Risk Management Plan

Described in Section 11.1.3.1. Key elements of the risk management plan that contribute to the Identify Risks process are the assignments of roles and responsibilities, provision for risk management activities in the budget and schedule, and categories of risk, which are sometimes expressed as a risk breakdown structure (Figure 11-4).

### 11.2.1.2 Cost Management Plan

Described in Section 7.1.3.1. The cost management plan provides processes and controls that can be used to help identify risks across the project.

### 11.2.1.3 Schedule Management Plan

Described in Section 6.1.3.1. The schedule management plan provides insight to project time/schedule objectives and expectations which may be impacted by risks (known and unknown).

### 11.2.1.4 Quality Management Plan

Described in Section 8.1.3.1. The quality management plan provides a baseline of quality measures and metrics for use in identifying risks.

### 11.2.1.5 Human Resource Management Plan

Described in Section 9.1.3.1. The human resource management plan provides guidance on how project human resources should be defined, staffed, managed, and eventually released. It can also contain roles and responsibilities, project organization charts, and the staffing management plan, which form a key input to identify risk process.

### 11.2.1.6 Scope Baseline

Described in Section 5.4.3.1. Project assumptions are found in the project scope statement. Uncertainty in project assumptions should be evaluated as potential causes of project risk.

The WBS is a critical input to identifying risks as it facilitates an understanding of the potential risks at both the micro and macro levels. Risks can be identified and subsequently tracked at summary, control account, and/or work package levels.

#### 11.2.1.7 Activity Cost Estimates

Described in Section 7.2.3.1. Activity cost estimate reviews are useful in identifying risks as they provide a quantitative assessment of the likely cost to complete scheduled activities and ideally are expressed as a range, with the width of the range indicating the degree(s) of risk. The review may result in projections indicating the estimate is either sufficient or insufficient to complete the activity (i.e., pose a risk to the project).

#### 11.2.1.8 Activity Duration Estimates

Described in Section 6.5.3.1. Activity duration estimate reviews are useful in identifying risks related to the time allowances for the activities or project as a whole, again with the width of the range of such estimates indicating the relative degree(s) of risk.

#### 11.2.1.9 Stakeholder Register

Described in Section 13.1.3.1. Information about the stakeholders is useful for soliciting inputs to identify risks, as this will ensure that key stakeholders, especially the stakeholder, sponsor, and customer are interviewed or otherwise participate during the Identify Risks process.

#### 11.2.1.10 Project Documents

Project documents provide the project team with information about decisions that help better identify project risks. Project documents improve cross-team and stakeholder communications and include, but are not limited to:

- Project charter,
- Project schedule,
- Schedule network diagrams,
- Issue log,
- Quality checklist, and
- Other information proven to be valuable in identifying risks.

#### 11.2.1.11 Procurement Documents

Defined in Section 12.1.3.3. If the project requires external procurement of resources, procurement documents become a key input to the Identify Risks process. The complexity and the level of detail of the procurement documents should be consistent with the value of, and risks associated with, planned procurement.

#### 11.2.1.12 Enterprise Environmental Factors

Described in Section 2.1.5. Enterprise environmental factors that can influence the Identify Risks process include, but are not limited to:

- Published information, including commercial databases,
- Academic studies,
- Published checklists,
- Benchmarking,
- Industry studies, and

- Risk attitudes.

#### 11.2.1.13 Organizational Process Assets

Described in Section 2.1.4. Organizational process assets that can influence the identify risks process include, but are not limited to:

- Project files, including actual data,
- Organizational and project process controls,
- Risk statement formats or templates, and
- Lessons learned.

### 11.2.2 Identify Risks: Tools and Techniques

#### 11.2.2.1 Documentation Reviews

A structured review may be performed of the project documentation, including plans, assumptions, previous project files, agreements, and other information. The quality of the plans, as well as consistency between those plans and the project requirements and assumptions, may be indicators of risk in the project.

#### 11.2.2.2 Information Gathering Techniques

Examples of information gathering techniques used in identifying risks can include:

- **Brainstorming.** The goal of brainstorming is to obtain a comprehensive list of project risks. The project team usually performs brainstorming, often with a multidisciplinary set of experts who are not part of the team. Ideas about project risk are generated under the leadership of a facilitator, either in a traditional free-form brainstorm session or structured mass interviewing techniques. Categories of risk, such as in a risk breakdown structure, can be used as a framework. Risks are then identified and categorized by type of risk and their definitions are refined.
- **Delphi technique.** The Delphi technique is a way to reach a consensus of experts. Project risk experts participate in this technique anonymously. A facilitator uses a questionnaire to solicit ideas about the important project risks. The responses are summarized and are then recirculated to the experts for further comment. Consensus may be reached in a few rounds of this process. The Delphi technique helps reduce bias in the data and keeps any one person from having undue influence on the outcome.
- **Interviewing.** Interviewing experienced project participants, stakeholders, and subject matter experts helps to identify risks.
- **Root cause analysis.** Root-cause analysis is a specific technique used to identify a problem, discover the underlying causes that lead to it, and develop preventive action.

#### 11.2.2.3 Checklist Analysis

Risk identification checklists are developed based on historical information and knowledge that has been accumulated from previous similar projects and from other sources of information. The lowest level of the RBS can also be used as a risk checklist. While a checklist may be quick and simple, it is impossible to build an exhaustive one, and care should be taken to ensure the checklist is not used to avoid the effort of proper risk identification. The team should also explore items that do not appear on the checklist. Additionally, the checklist should be

pruned from time to time to remove or archive related items. The checklist should be reviewed during project closure to incorporate new lessons learned and improve it for use on future projects.

### 11.2.2.4 Assumptions Analysis

Every project and its plan is conceived and developed based on a set of hypotheses, scenarios, or assumptions. Assumptions analysis explores the validity of assumptions as they apply to the project. It identifies risks to the project from inaccuracy, instability, inconsistency, or incompleteness of assumptions.

### 11.2.2.5 Diagramming Techniques

Risk diagramming techniques may include:

- **Cause and effect diagrams.** These are also known as Ishikawa or fishbone diagrams and are useful for identifying causes of risks.
- **System or process flow charts.** These show how various elements of a system interrelate and the mechanism of causation.
- **Influence diagrams.** These are graphical representations of situations showing causal influences, time ordering of events, and other relationships among variables and outcomes, as shown in Figure 11-7.

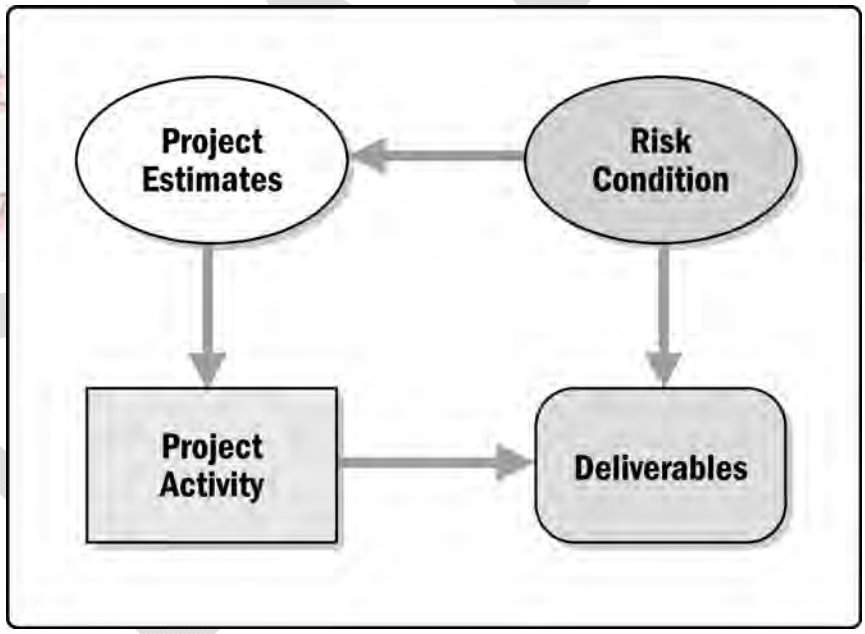



**Figure 11-7. Influence Diagram**

### 11.2.2.6 SWOT Analysis

This technique examines the project from each of the strengths, weaknesses, opportunities, and threats (SWOT) perspectives to increase the breadth of identified risks by including internally generated risks. The technique starts with identification of strengths and weaknesses of the organization, focusing on either the project, organization, or the business area in general. SWOT analysis then identifies any opportunities for the project that arise from organizational strengths, and any threats arising from organizational weaknesses. The analysis

also examines the degree to which organizational strengths offset threats, as well as identifying opportunities that may serve to overcome weaknesses.

#### 11.2.2.7 Expert Judgment

Risks may be identified directly by experts with relevant experience with similar projects or business areas. Such experts should be identified by the project manager and invited to consider all aspects of the project and suggest possible risks based on their previous experience and areas of expertise. The experts' bias should be taken into account in this process.

### 11.2.3 Identify Risks: Outputs

#### 11.2.3.1 Risk Register

The primary output from Identify Risks is the initial entry into the risk register. The risk register is a document in which the results of risk analysis and risk response planning are recorded. It contains the outcomes of the other risk management processes as they are conducted, resulting in an increase in the level and type of information contained in the risk register over time. The preparation of the risk register begins in the Identify Risks process with the following information, and then becomes available to other project management and risk management processes:

- **List of identified risks**. The identified risks are described in as much detail as is reasonable. A structure for describing risks using risk statements may be applied, for example, EVENT may occur causing IMPACT, or If CAUSE exists, EVENT may occur leading to EFFECT. In addition to the list of identified risks, the root causes of those risks may become more evident. These are the fundamental conditions or events that may give rise to one or more identified risks. They should be recorded and used to support future risk identification for this and other projects.
- **List of potential responses.** Potential responses to a risk may sometimes be identified during the Identify Risks process. These responses, if identified in this process, should be used as inputs to the Plan Risk Responses process.

## 11.3 Perform Qualitative Risk Analysis

Perform Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact. The key benefit of this process is that it enables project managers to reduce the level of uncertainty and to focus on high-priority risks. The inputs, tools and techniques, and outputs of this process are depicted in Figure 11-8. Figure 11-9 depicts the data flow diagram of the process.


**Figure 11-8. Perform Qualitative Risk Analysis: Inputs, Tools & Techniques, and Outputs**

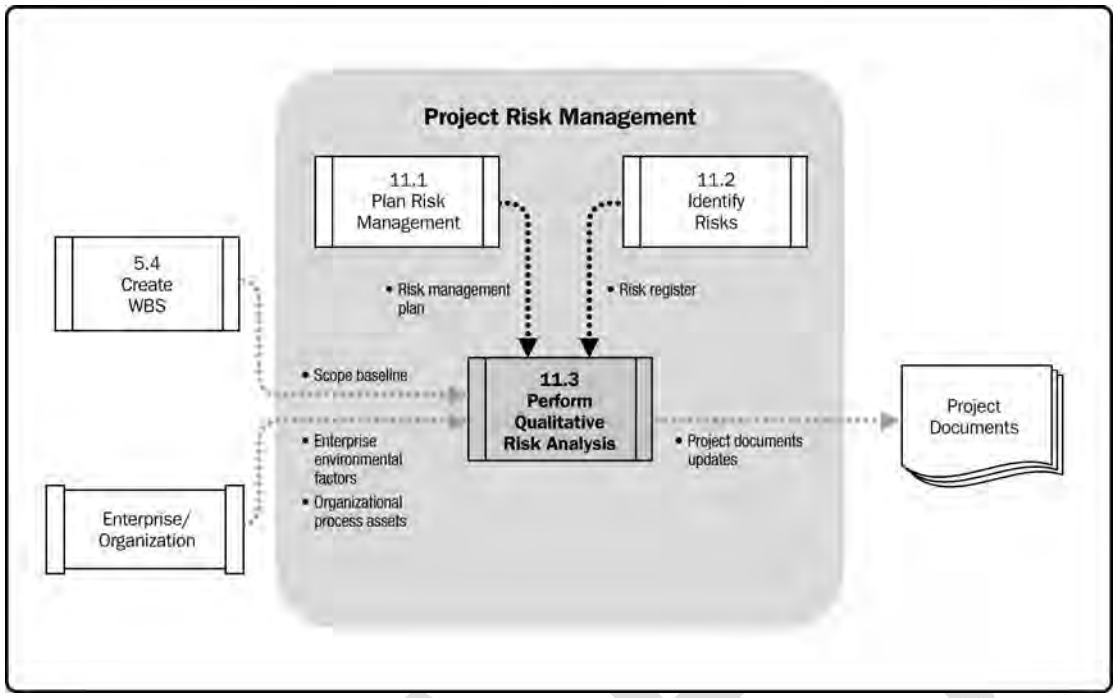



**Figure 11-9. Perform Qualitative Risk Analysis Data Flow Diagram**

Perform Qualitative Risk Analysis assesses the priority of identified risks using their relative probability or likelihood of occurrence, the corresponding impact on project objectives if the risks occur, as well as other factors such as the time frame for response and the organization's risk tolerance associated with the project constraints of cost, schedule, scope, and quality. Such assessments reflect the risk attitude of the project team and other stakeholders. Effective assessment therefore requires explicit identification and management of the risk approaches of key participants in the Perform Qualitative Risk Analysis process. Where these risk approaches introduce bias into the assessment of identified risks, attention should be paid to identifying bias and correcting for it.

Establishing definitions of the levels of probability and impact can reduce the influence of bias. The time criticality of risk-related actions may magnify the importance of a risk. An evaluation of the quality of the available information on project risks also helps to clarify the assessment of the risk's importance to the project.

Perform Qualitative Risk Analysis is usually a rapid and cost-effective means of establishing priorities for Plan Risk Responses and lays the foundation for Perform Quantitative Risk Analysis, if required. The Perform Qualitative Risk Analysis process is performed regularly throughout the project life cycle, as defined in the project's risk management plan. This process can lead into Perform Quantitative Risk Analysis (Section 11.4) or directly into Plan Risk Responses (Section 11.5).

## 11.3.1 Perform Qualitative Risk Analysis: Inputs

### 11.3.1.1 Risk Management Plan

Described in Section 11.1.3.1. Key elements of the risk management plan used in the Perform Qualitative Risk Analysis process include roles and responsibilities for conducting risk management, budgets, schedule activities for risk management, risk categories, definitions of

probability and impact, the probability and impact matrix, and revised stakeholders' risk tolerances. These inputs are usually tailored to the project during the Plan Risk Management process. If they are not available, they may be developed during the Perform Qualitative Risk Analysis process.

#### 11.3.1.2 Scope Baseline

Described in Section 5.4.3.1. Projects of a common or recurrent type tend to have more well-understood risks. Projects using state-of-the-art or first-of-its-kind technology, and highly complex projects, tend to have more uncertainty. This can be evaluated by examining the scope baseline.

#### 11.3.1.3 Risk Register

Described in Section 11.2.3.1. The risk register contains the information that will be used to assess and prioritize risks.

#### 11.3.1.4 Enterprise Environmental Factors

Described in Section 2.1.5. Enterprise environmental factors may provide insight and context to the risk assessment, such as:

- Industry studies of similar projects by risk specialists, and
- Risk databases that may be available from industry or proprietary sources.

#### 11.3.1.5 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that can influence the Perform Qualitative Risk Analysis process include information on prior, similar completed projects.

### 11.3.2 Perform Qualitative Risk Analysis: Tools and Techniques

#### 11.3.2.1 Risk Probability and Impact Assessment

Risk probability assessment investigates the likelihood that each specific risk will occur. Risk impact assessment investigates the potential effect on a project objective such as schedule, cost, quality, or performance, including both negative effects for threats and positive effects for opportunities.

Probability and impact are assessed for each identified risk. Risks can be assessed in interviews or meetings with participants selected for their familiarity with the risk categories on the agenda. Project team members and knowledgeable persons external to the project are included.

The level of probability for each risk and its impact on each objective is evaluated during the interview or meeting. Explanatory detail, including assumptions justifying the levels assigned, are also recorded. Risk probabilities and impacts are rated according to the definitions given in the risk management plan. Risks with low ratings of probability and impact will be included within the risk register as part of the watch list for future monitoring.

#### 11.3.2.2 Probability and Impact Matrix

Risks can be prioritized for further quantitative analysis and planning risk responses based on their risk rating. Ratings are assigned to risks based on their assessed probability and impact. Evaluation of each risk's importance and priority for attention is typically conducted

using a look-up table or a probability and impact matrix. Such a matrix specifies combinations of probability and impact that lead to rating the risks as low, moderate, or high priority. Descriptive terms or numeric values can be used depending on organizational preference.

Each risk is rated on its probability of occurrence and impact on an objective if it does occur. The organization should determine which combinations of probability and impact result in a classification of high risk, moderate risk, and low risk. In a black-and-white matrix, these conditions are denoted using different shades of gray. Specifically in Figure 11-10, the dark gray area (with the largest numbers) represents high risk: the medium gray area (with the smallest numbers) represents low risk, and the light gray area (with in-between numbers) represents moderate risk. Usually, these risk-rating rules are specified by the organization in advance of the project and included in organizational process assets. Risk rating rules can be tailored in the Plan Risk Management process to the specific project.

**Probability and Impact Matrix**

| Probability | Threats | | | | | Opportunities | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **0.90** | 0.05 | 0.09 | 0.18 | 0.36 | 0.72 | 0.72 | 0.36 | 0.18 | 0.09 | 0.05 |
| **0.70** | 0.04 | 0.07 | 0.14 | 0.28 | 0.56 | 0.56 | 0.28 | 0.14 | 0.07 | 0.04 |
| **0.50** | 0.03 | 0.05 | 0.10 | 0.20 | 0.40 | 0.40 | 0.20 | 0.10 | 0.05 | 0.03 |
| **0.30** | 0.02 | 0.03 | 0.06 | 0.12 | 0.24 | 0.24 | 0.12 | 0.06 | 0.03 | 0.02 |
| **0.10** | 0.01 | 0.01 | 0.02 | 0.04 | 0.08 | 0.08 | 0.04 | 0.02 | 0.01 | 0.01 |
| | 0.05/ Very Low | 0.10/ Low | 0.20/ Moderate | 0.40/ High | 0.80/ Very High | 0.80/ Very High | 0.40/ High | 0.20/ Moderate | 0.10/ Low | 0.05/ Very Low |

Impact (numerical scale) on an objective (e.g., cost, time, scope or quality)

Each risk is rated on its probability of occurring and impact on an objective if it does occur. The organization's thresholds for low, moderate or high risks are shown in the matrix and determine whether the risk is scored as high, moderate or low for that objective.

**Figure 11-10 Probability and Impact Matrix**

As illustrated in Figure 11-10, an organization can rate a risk separately for each objective (e.g., cost, time, and scope). In addition, it may develop ways to determine one overall rating for each risk. Finally, opportunities and threats are handled in the same matrix using definitions of the different levels of impact that are appropriate for each.

The risk score helps guide risk responses. For example, risks that have a negative impact on objectives, otherwise known as threats if they occur, and that are in the high-risk (dark gray) zone of the matrix, may require priority action and aggressive response strategies. Threats found in the low-risk (medium gray) zone may not require proactive management action beyond being placed in the risk register as part of the watch list or adding a contingency reserve. Similarly for opportunities, those in the high-risk (dark gray) zone, which may be obtained most easily and offer the greatest benefit, should be targeted first. Opportunities in the low-risk (medium gray) zone should be monitored.

#### 11.3.2.3 Risk Data Quality Assessment

Risk data quality assessment is a technique to evaluate the degree to which the data about risks is useful for risk management. It involves examining the degree to which the risk is understood and the accuracy, quality, reliability, and integrity of the data about the risk.

The use of low-quality risk data may lead to a qualitative risk analysis of little use to the project. If data quality is unacceptable, it may be necessary to gather better data. Often, the collection of information about risks is difficult, and consumes more time and resources than originally planned. The values used in the example in Figure 11-10 are representative. The numbers of steps in the scale are usually established when defining the risk attitude of the organization.

#### 11.3.2.4 Risk Categorization

Risks to the project can be categorized by sources of risk (e.g., using the RBS), the area of the project affected (e.g., using the WBS), or other useful categories (e.g., project phase) to determine the areas of the project most exposed to the effects of uncertainty. Risks can also be categorized by common root causes. This technique helps determine work packages, activities, project phases or even roles in the project, which can lead to the development of effective risk responses.

#### 11.3.2.5 Risk Urgency Assessment

Risks requiring near-term responses may be considered more urgent to address. Indicators of priority may include probability of detecting the risk, time to affect a risk response, symptoms and warning signs, and the risk rating. In some qualitative analyses, the assessment of risk urgency is combined with the risk ranking that is determined from the probability and impact matrix to give a final risk severity rating.

#### 11.3.2.6 Expert Judgment

Expert judgment is required to assess the probability and impact of each risk to determine its location in the matrix shown in Figure 11-10. Experts generally are those having experience with similar, recent projects. Gathering expert judgment is often accomplished with the use of risk facilitation workshops or interviews. The experts' bias should be taken into account in this process.

### 11.3.3 Perform Qualitative Risk Analysis: Outputs

#### 11.3.3.1 Project Documents Updates

Project documents that may be updated include, but are not limited to:

- **Risk register updates.** As new information becomes available through the qualitative risk assessment, the risk register is updated. Updates to the risk register may include assessments of probability and impacts for each risk, risk ranking or scores, risk urgency information or risk categorization, and a watch list for low probability risks or risks requiring further analysis.
- **Assumptions log updates.** As new information becomes available through the qualitative risk assessment, assumptions could change. The assumptions log needs to be revisited to accommodate this new information. Assumptions may be incorporated into the project scope statement or in a separate assumptions log.

## 11.4 Perform Quantitative Risk Analysis

Perform Quantitative Risk Analysis is the process of numerically analyzing the effect of identified risks on overall project objectives. The key benefit of this process is that it produces quantitative risk information to support decision making in order to reduce project uncertainty. The inputs, tools and techniques, and outputs of this process are depicted in Figure 11-11. Figure 11-12 depicts the data flow diagram of the process.


**Figure 11-11. Perform Quantitative Risk Analysis: Inputs, Tools & Techniques, and Outputs**

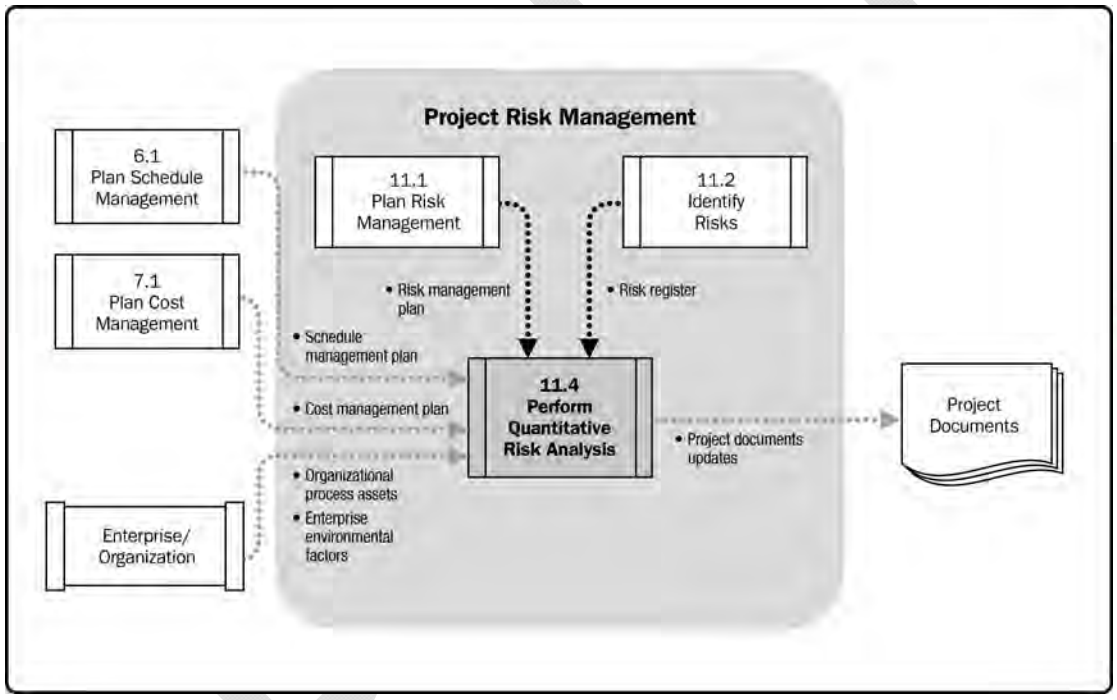



**Figure 11-12. Perform Quantitative Risk Analysis Data Flow Diagram**

Perform Quantitative Risk Analysis is performed on risks that have been prioritized by the Perform Qualitative Risk Analysis process as potentially and substantially impacting the project's competing demands. The Perform Quantitative Risk Analysis process analyzes the effect of those risks on project objectives. It is used mostly to evaluate the aggregate effect of all risks affecting the project. When the risks drive the quantitative analysis, the process may be used to assign a numerical priority rating to those risks individually.

Perform Quantitative Risk Analysis generally follows the Perform Qualitative Risk Analysis process. In some cases, it may not be possible to execute the Perform Quantitative Risk Analysis process due to lack of sufficient data to develop appropriate models. The project

manager should exercise expert judgment to determine the need for and the viability of quantitative risk analysis. The availability of time and budget, and the need for qualitative or quantitative statements about risk and impacts, will determine which method(s) to use on any particular project. Perform Quantitative Risk Analysis should be repeated, as needed, as part of the Control Risks process to determine if the overall project risk has been satisfactorily decreased. Trends may indicate the need for more or less focus on appropriate risk management activities.

## 11.4.1 Perform Quantitative Risk Analysis: Inputs

### 11.4.1.1 Risk Management Plan

Described in Section 11.1.3.1. The risk management plan provides guidelines, methods, and tools to be used in quantitative risk analysis.

### 11.4.1.2 Cost Management Plan

Described in Section 7.1.3.1. The cost management plan provides guidelines on establishing and managing risk reserves.

### 11.4.1.3 Schedule Management Plan

Described in Section 6.1.3.1. The schedule management plan provides guidelines on establishing and managing risk reserves.

### 11.4.1.4 Risk Register

Described in Section 11.2.3.1. The risk register is used as a reference point for performing quantitative risk analysis.

### 11.4.1.5 Enterprise Environmental Factors

Described in Section 2.1.5. Enterprise environmental factors may provide insight and context to the risk analysis, such as:

- Industry studies of similar projects by risk specialists, and
- Risk databases that may be available from industry or proprietary sources.

### 11.4.1.6 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that can influence the Perform Quantitative Risk Analysis process include information from prior, similar completed projects.

## 11.4.2 Perform Quantitative Risk Analysis: Tools and Techniques

### 11.4.2.1 Data Gathering and Representation Techniques

- **Interviewing.** Interviewing techniques draw on experience and historical data to quantify the probability and impact of risks on project objectives. The information needed depends upon the type of probability distributions that will be used. For instance, information would be gathered on the optimistic (low), pessimistic (high), and most likely scenarios for some commonly used distributions. Examples of three-point estimates for cost are shown in Figure 11-13. Additional information on three-point estimates appears in Estimate Activity Durations (Section 6.5) and Estimate Costs (Section 7.2). Documenting the rationale of the risk ranges and the assumptions

behind them are important components of the risk interview because they can provide insight on the reliability and credibility of the analysis.

**Range of Project Cost Estimates**

| WBS Element | Low | Most Likely | High |
|---|---|---|---|
| Design | $4M | $6M | $10M |
| Build | $16M | $20M | $35M |
| Test | $11M | $15M | $23M |
| Total Project | $31M | $41M | $68M |

Interviewing relevant stakeholders helps determine the three-point estimates for each WBS element for triangular, beta or other distributions. In this example, the likelihood of completing the project at or below the most likely estimate of $41 million is relatively small as shown in the simulation results in Figure 11-17 (Cost Risk Simulation Results).

**Figure 11-13. Range of Project Cost Estimates Collected During the Risk Interview**

- **Probability distributions.** Continuous probability distributions, which are used extensively in modeling and simulation, represent the uncertainty in values such as durations of schedule activities and costs of project components. Discrete distributions can be used to represent uncertain events, such as the outcome of a test or a possible scenario in a decision tree. Two examples of widely used continuous distributions are shown in Figure 11-14. These distributions depict shapes that are compatible with the data typically developed during the quantitative risk analysis. Uniform distributions can be used if there is no obvious value that is more likely than any other between specified high and low bounds, such as in the early concept stage of design.

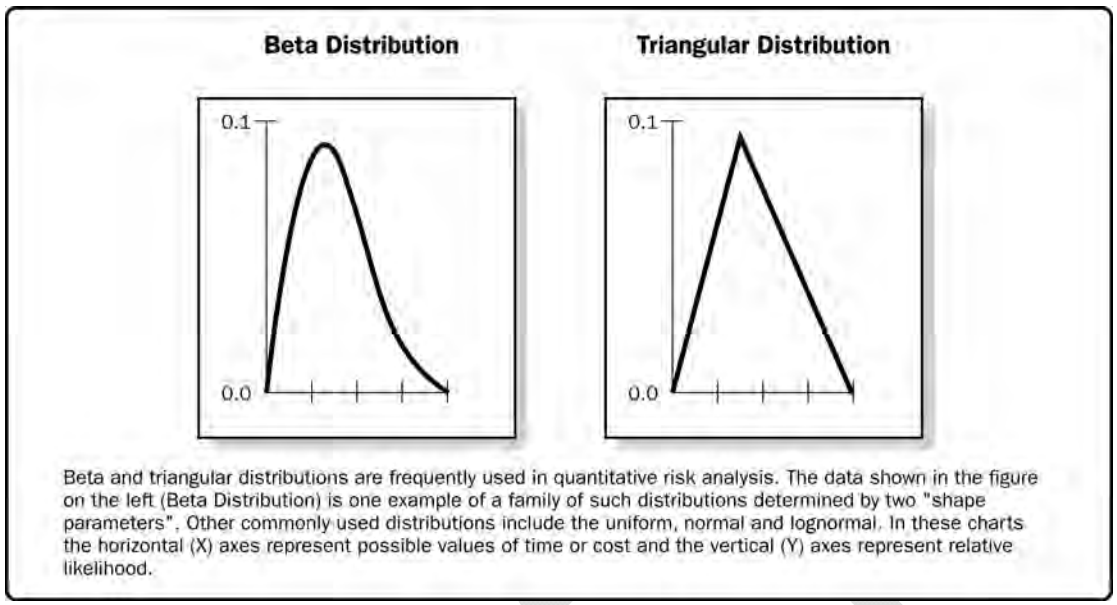



**Figure 11-14. Examples of Commonly Used Probability Distributions**

### 11.4.2.2 Quantitative Risk Analysis and Modeling Techniques

Commonly used techniques use both event-oriented and project-oriented analysis approaches, including:

- **Sensitivity analysis.** Sensitivity analysis helps to determine which risks have the most potential impact on the project. It helps to understand how the variations in project's objectives correlate with variations in different uncertainties. Conversely, it examines the extent to which the uncertainty of each project element affects the objective being studied when all other uncertain elements are held at their baseline values. One typical display of sensitivity analysis is the tornado diagram (Figure 11-15), which is useful for comparing relative importance and impact of variables that have a high degree of uncertainty to those that are more stable. The Tornado diagram is also helpful in analyzing risk-taking scenarios enabled on specific risks whose quantitative analysis highlights possible benefits greater than corresponding identified negative impacts. A tornado diagram is a special type of bar chart used in sensitivity analysis for comparing the relative importance of the variables. In a tornado diagram, the Y-axis contains each type of uncertainty at base values, and the X-axis contains the spread or correlation of the uncertainty to the studied output. In this figure, each uncertainty contains a horizontal bar and is ordered vertically to show uncertainties with a decreasing spread from the base values.

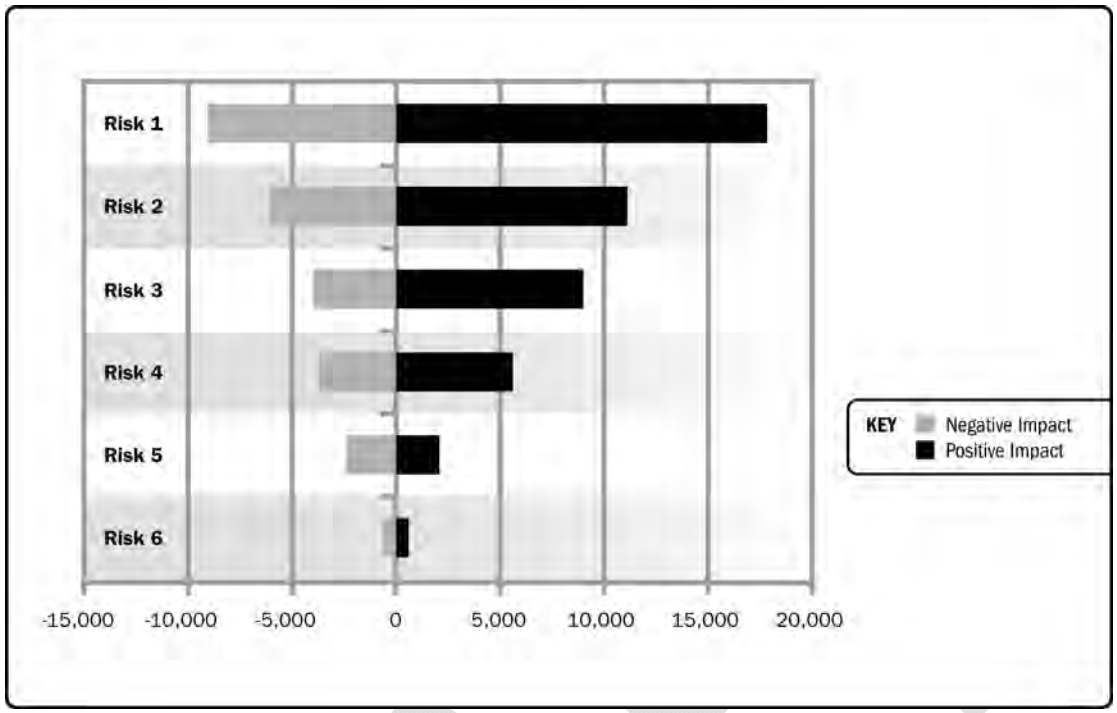
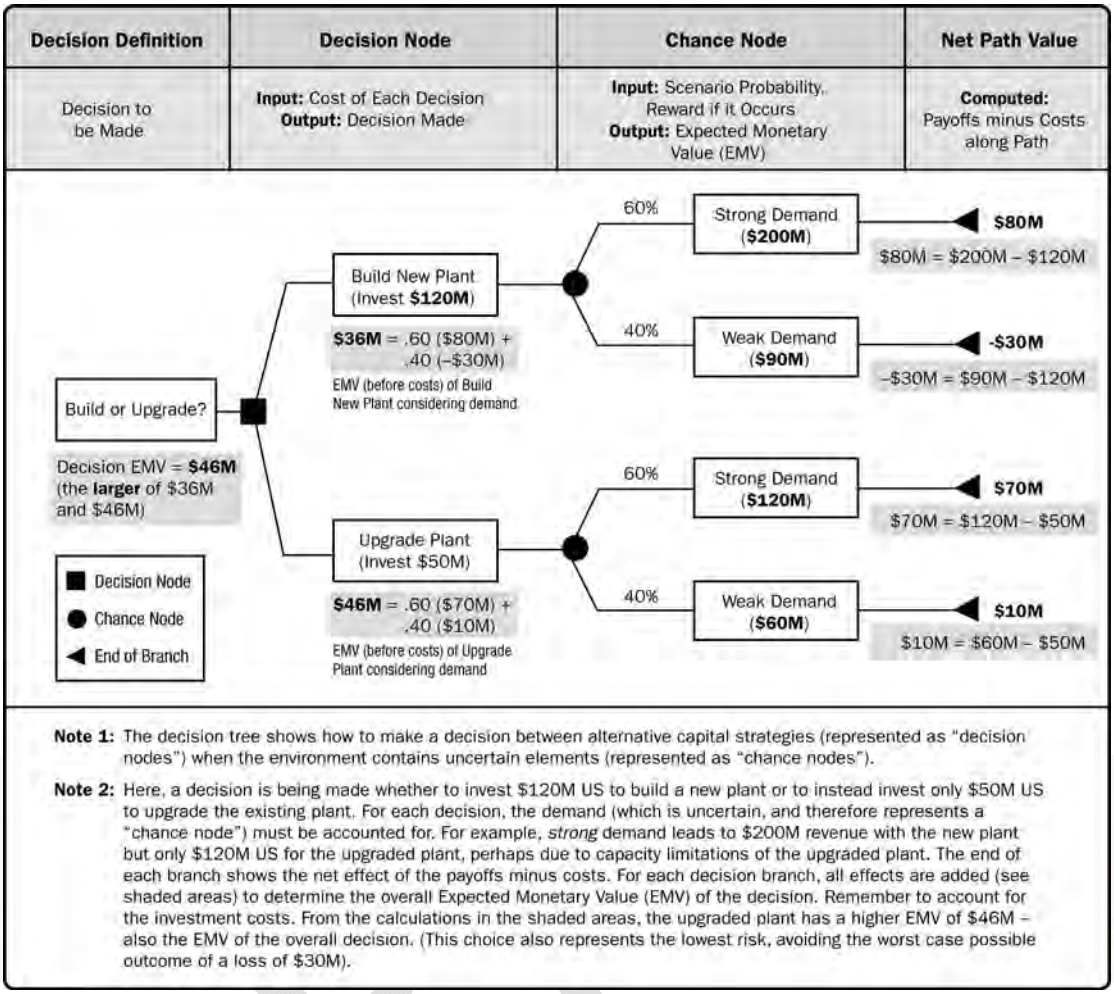



**Figure 11-15. Example of Tornado Diagram**

- **Expected monetary value analysis.** Expected monetary value (EMV) analysis is a statistical concept that calculates the average outcome when the future includes scenarios that may or may not happen (i.e., analysis under uncertainty). The EMV of opportunities are generally expressed as positive values, while those of threats are expressed as negative values. EMV requires a risk-neutral assumption—neither risk averse nor risk seeking. EMV for a project is calculated by multiplying the value of each possible outcome by its probability of occurrence and adding the products together. A common use of this type of analysis is a decision tree analysis (Figure 11-16).




**Note 1:** The decision tree shows how to make a decision between alternative capital strategies (represented as "decision nodes") when the environment contains uncertain elements (represented as "chance nodes").

**Note 2:** Here, a decision is being made whether to invest $120M US to build a new plant or to instead invest only $50M US to upgrade the existing plant. For each decision, the demand (which is uncertain, and therefore represents a "chance node") must be accounted for. For example, *strong* demand leads to $200M revenue with the new plant but only $120M US for the upgraded plant, perhaps due to capacity limitations of the upgraded plant. The end of each branch shows the net effect of the payoffs minus costs. For each decision branch, all effects are added (see shaded areas) to determine the overall Expected Monetary Value (EMV) of the decision. Remember to account for the investment costs. From the calculations in the shaded areas, the upgraded plant has a higher EMV of $46M – also the EMV of the overall decision. (This choice also represents the lowest risk, avoiding the worst case possible outcome of a loss of $30M).

**Figure 11-16. Decision Tree Diagram**

- **Modeling and simulation.** A project simulation uses a model that translates the specified detailed uncertainties of the project into their potential impact on project objectives. Simulations are typically performed using the Monte Carlo technique. In a simulation, the project model is computed many times (iterated), with the input values (e.g., cost estimates or activity durations) chosen at random for each iteration from the probability distributions of these variables. A histogram (e.g., total cost or completion date) is calculated from the iterations. For a cost risk analysis, a simulation uses cost estimates. For a schedule risk analysis, the schedule network diagram and duration estimates are used. The output from a cost risk simulation using the three-element model and risk ranges is shown in Figure 11-17. It illustrates the respective probability of achieving specific cost targets. Similar curves can be developed for other project objectives.

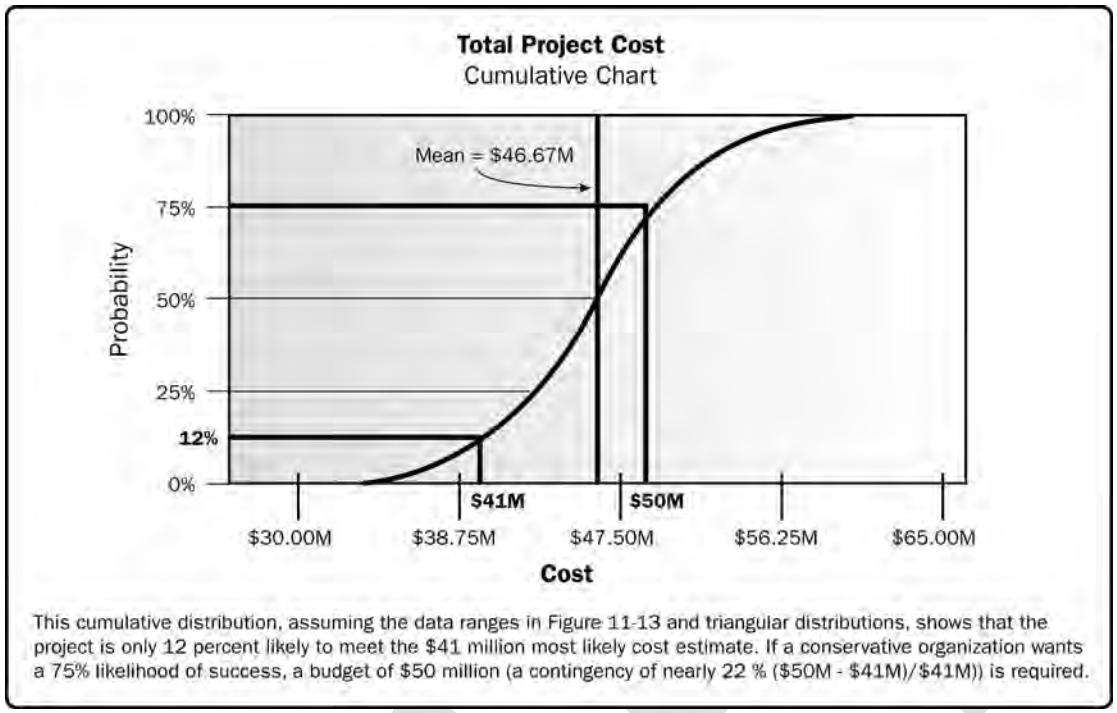



**Figure 11-17. Cost Risk Simulation Results**

### 11.4.2.3 Expert Judgment

Expert judgment (ideally using experts with relevant, recent experience) is required to identify potential cost and schedule impacts, to evaluate probability, and to define inputs such as probability distributions into the tools.

Expert judgment also comes into play in the interpretation of the data. Experts should be able to identify the weaknesses of the tools as well as their strengths. Experts may determine when a specific tool may or may not be more appropriate given the organization's capabilities and culture.

## 11.4.3 Perform Quantitative Risk Analysis: Outputs

### 11.4.3.1 Project Documents Updates

Project documents are updated with information resulting from quantitative risk analysis. For example, risk register updates could include:

- **Probabilistic analysis of the project.** Estimates are made of potential project schedule and cost outcomes listing the possible completion dates and costs with their associated confidence levels. This output, often expressed as a cumulative frequency distribution, is used with stakeholder risk tolerances to permit quantification of the cost and time contingency reserves. Such contingency reserves are needed to bring the risk of overrunning stated project objectives to a level acceptable to the organization.
- **Probability of achieving cost and time objectives.** With the risks facing the project, the probability of achieving project objectives under the current plan can be estimated using quantitative risk analysis results. For instance, in Figure 11-17, the likelihood of achieving the cost estimate of US$41 million is about 12%.

- **Prioritized list of quantified risks.** This list includes those risks that pose the greatest threat or present the greatest opportunity to the project. These include the risks that may have the greatest effect on cost contingency and those that are most likely to influence the critical path. These risks may be evaluated, in some cases, through a tornado diagram generated as a result of the simulation analysis.
- **Trends in quantitative risk analysis results.** As the analysis is repeated, a trend may become apparent that leads to conclusions affecting risk responses. Organizational historical information on project schedule, cost, quality, and performance should reflect new insights gained through the Perform Quantitative Risk Analysis process. Such history may take the form of a quantitative risk analysis report. This report may be separate from, or linked to, the risk register.

## 11.5 Plan Risk Responses

Plan Risk Responses is the process of developing options and actions to enhance opportunities and to reduce threats to project objectives. The key benefit of this process is that it addresses the risks by their priority, inserting resources and activities into the budget, schedule and project management plan as needed. The inputs, tools and techniques, and outputs of this process are depicted in Figure 11-18. Figure 11-19 depicts the data flow diagram of the process.


**Figure 11-18. Plan Risk Responses: Inputs, Tools & Techniques, and Outputs**

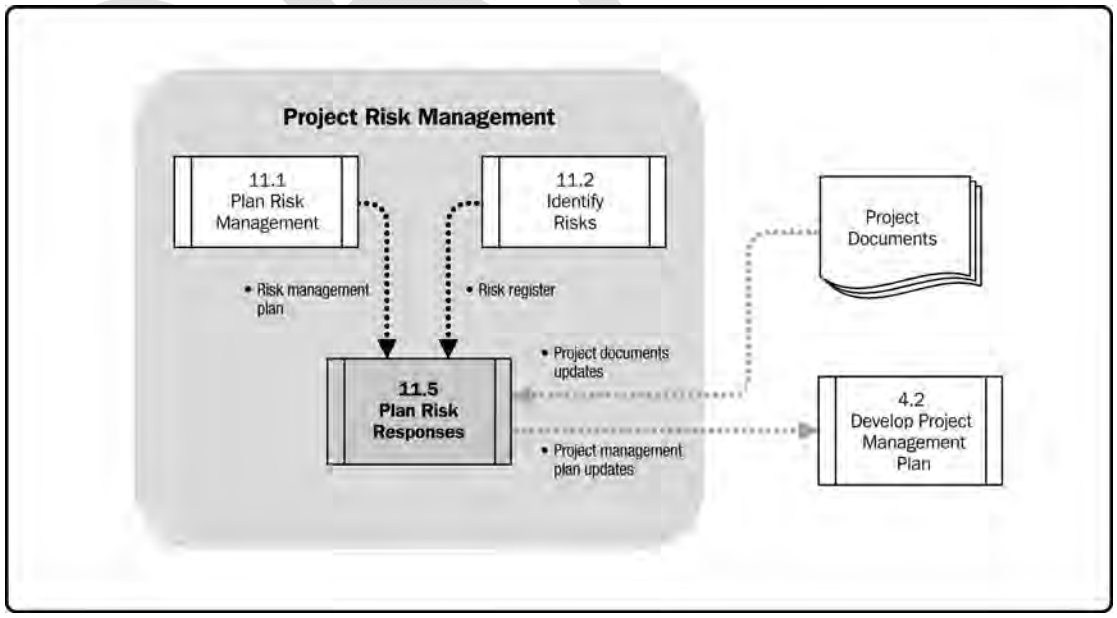



**Figure 11-19. Plan Risk Responses Data Flow Diagram**

The Plan Risk Responses process follows the Perform Quantitative Risk Analysis process (if used). Each risk response requires an understanding of the mechanism by which it will address the risk. This is the mechanism used to analyze if the risk response plan is having the desired effect. It includes the identification and assignment of one person (an owner for risk response) to take responsibility for each agreed-to and funded risk response. Risk responses should be appropriate for the significance of the risk, cost effective in meeting the challenge, realistic within the project context, agreed upon by all parties involved, and owned by a responsible person. Selecting the optimum risk response from several options is often required.

The Plan Risk Responses process presents commonly used approaches to planning responses to the risks. Risks include threats and opportunities that can affect project success, and responses are discussed for each.

## 11.5.1 Plan Risk Responses: Inputs

### 11.5.1.1 Risk Management Plan

Important components of the risk management plan include roles and responsibilities, risk analysis definitions, timing for reviews (and for eliminating risks from review), and risk thresholds for low, moderate, and high risks. Risk thresholds help identify those risks for which specific responses are needed.

## 11.5.1.2 Risk Register

The risk register refers to identified risks, root causes of risks, lists of potential responses, risk owners, symptoms and warning signs, the relative rating or priority list of project risks, risks requiring responses in the near term, risks for additional analysis and response, trends in qualitative analysis results, and a watch list, which is a list of low-priority risks within the risk register.



## 11.5.2 Plan Risk Responses: Tools and Techniques

Several risk response strategies are available. The strategy or mix of strategies most likely to be effective should be selected for each risk. Risk analysis tools, such as decision tree analysis (Section 11.4.2.2), can be used to choose the most appropriate responses. Specific actions are developed to implement that strategy, including primary and backup strategies, as necessary. A fallback plan can be developed for implementation if the selected strategy turns out not to be fully effective or if an accepted risk occurs. Secondary risks should also be reviewed. Secondary risks are risks that arise as a direct result of implementing a risk response. A contingency reserve is often allocated for time or cost. If developed, it may include identification of the conditions that trigger its use.

### 11.5.2.1 Strategies for Negative Risks or Threats

Three strategies, which typically deal with threats or risks that may have negative impacts on project objectives if they occur, are: *avoid, transfer,* and *mitigate*. The fourth strategy, *accept,* can be used for negative risks or threats as well as positive risks or opportunities. Each of these risk response strategies have varied and unique influence on the risk condition. These strategies should be chosen to match the risk's probability and impact on the project's overall objectives. Avoidance and mitigation strategies are usually good strategies for critical risks with high impact, while transference and acceptance are usually good strategies for threats that are less

critical and with low overall impact. The four strategies for dealing with negative risks or threats are further described as follows:

- **Avoid.** Risk avoidance is a risk response strategy whereby the project team acts to eliminate the threat or protect the project from its impact. It usually involves changing the project management plan to eliminate the threat entirely. The project manager may also isolate the project objectives from the risk's impact or change the objective that is in jeopardy. Examples of this include extending the schedule, changing the strategy, or reducing scope. The most radical avoidance strategy is to shut down the project entirely. Some risks that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.
- **Transfer.** Risk transference is a risk response strategy whereby the project team shifts the impact of a threat to a third party, together with ownership of the response. Transferring the risk simply gives another party responsibility for its management—it does not eliminate it. Transferring does not mean disowning the risk by transferring it to a later project or another person without his or her knowledge or agreement. Risk transference nearly always involves payment of a risk premium to the party taking on the risk. Transferring liability for risk is most effective in dealing with financial risk exposure. Transference tools can be quite diverse and include, but are not limited to, the use of insurance, performance bonds, warranties, guarantees, etc. Contracts or agreements may be used to transfer liability for specified risks to another party. For example, when a buyer has capabilities that the seller does not possess, it may be prudent to transfer some work and its concurrent risk contractually back to the buyer. In many cases, use of a cost-plus contract may transfer the cost risk to the buyer, while a fixed-price contract may transfer risk to the seller.
- **Mitigate.** Risk mitigation is a risk response strategy whereby the project team acts to reduce the probability of occurrence or impact of a risk. It implies a reduction in the probability and/or impact of an adverse risk to be within acceptable threshold limits. Taking early action to reduce the probability and/or impact of a risk occurring on the project is often more effective than trying to repair the damage after the risk has occurred. Adopting less complex processes, conducting more tests, or choosing a more stable supplier are examples of mitigation actions. Mitigation may require prototype development to reduce the risk of scaling up from a bench-scale model of a process or product. Where it is not possible to reduce probability, a mitigation response might address the risk impact by targeting linkages that determine the severity. For example, designing redundancy into a system may reduce the impact from a failure of the original component.
- **Accept.** Risk acceptance is a risk response strategy whereby the project team decides to acknowledge the risk and not take any action unless the risk occurs. This strategy is adopted where it is not possible or cost-effective to address a specific risk in any other way. This strategy indicates that the project team has decided not to change the project management plan to deal with a risk, or is unable to identify any other suitable response strategy. This strategy can be either passive or active. Passive acceptance requires no action except to document the strategy, leaving the project team to deal with the risks as they occur, and to periodically review the threat to ensure that it does

not change significantly. The most common active acceptance strategy is to establish a contingency reserve, including amounts of time, money, or resources to handle the risks.

#### 11.5.2.2 Strategies for Positive Risks or Opportunities

Three of the four responses are suggested to deal with risks with potentially positive impacts on project objectives. The fourth strategy, *accept*, can be used for negative risks or threats as well as positive risks or opportunities. These strategies, described below, are to exploit, share, enhance, and accept.

- **Exploit.** The exploit strategy may be selected for risks with positive impacts where the organization wishes to ensure that the opportunity is realized. This strategy seeks to eliminate the uncertainty associated with a particular upside risk by ensuring the opportunity definitely happens. Examples of directly exploiting responses include assigning an organization's most talented resources to the project to reduce the time to completion or using new technologies or technology upgrades to reduce cost and duration required to realize project objectives.
- **Enhance.** The enhance strategy is used to increase the probability and/or the positive impacts of an opportunity. Identifying and maximizing key drivers of these positive-impact risks may increase the probability of their occurrence. Examples of enhancing opportunities include adding more resources to an activity to finish early.
- **Share.** Sharing a positive risk involves allocating some or all of the ownership of the opportunity to a third party who is best able to capture the opportunity for the benefit of the project. Examples of sharing actions include forming risk-sharing partnerships, teams, special-purpose companies, or joint ventures, which can be established with the express purpose of taking advantage of the opportunity so that all parties gain from their actions.
- **Accept.** Accepting an opportunity is being willing to take advantage of the opportunity if it arises, but not actively pursuing it.

#### 11.5.2.3 Contingent Response Strategies

Some responses are designed for use only if certain events occur. For some risks, it is appropriate for the project team to make a response plan that will only be executed under certain predefined conditions, if it is believed that there will be sufficient warning to implement the plan. Events that trigger the contingency response, such as missing intermediate milestones or gaining higher priority with a supplier, should be defined and tracked. Risk responses identified using this technique are often called contingency plans or fallback plans and include identified triggering events that set the plans in effect.

#### 11.5.2.4 Expert Judgment

Expert judgment is input from knowledgeable parties pertaining to the actions to be taken on a specific and defined risk. Expertise may be provided by any group or person with specialized education, knowledge, skill, experience, or training in establishing risk responses.

## 11.5.3 Plan Risk Responses: Outputs

### 11.5.3.1 Project Management Plan Updates

Elements of the project management plan that may be updated as a result of carrying out this process include, but are not limited to:

- **Schedule management plan.** The schedule management plan is updated to reflect changes in process and practice driven by the risk responses. This may include changes in tolerance or behavior related to resource loading and leveling, as well as updates to the schedule strategy.
- **Cost management plan.** The cost management plan is updated to reflect changes in process and practice driven by the risk responses. This may include changes in tolerance or behavior related to cost accounting, tracking, and reports, as well as updates to the budget strategy and how contingency reserves are consumed.
- **Quality management plan.** The quality management plan is updated to reflect changes in process and practice driven by the risk responses. This may include changes in tolerance or behavior related to requirements, quality assurance, or quality control, as well as updates to the requirements documentation.
- **Procurement management plan.** The procurement management plan may be updated to reflect changes in strategy, such as alterations in the make-or-buy decision or contract type(s) driven by the risk responses.
- **Human resource management plan.** The staffing management plan, part of the human resource management plan, is updated to reflect changes in project organizational structure and resource applications driven by the risk responses. This may include changes in tolerance or behavior related to staff allocation, as well as updates to the resource loading.
- **Scope baseline.** Because of new, modified or omitted work generated by the risk responses, the scope baseline may be updated to reflect those changes.
- **Schedule baseline.** Because of new work (or omitted work) generated by the risk responses, the schedule baseline may be updated to reflect those changes.
- **Cost baseline.** Because of new work (or omitted work) generated by the risk responses, the cost baseline may be updated to reflect those changes.

### 11.5.3.2 Project Documents Updates

In the Plan Risk Responses process, several project documents are updated as needed. For example, when appropriate risk responses are chosen and agreed upon, they are included in the risk register. The risk register should be written to a level of detail that corresponds with the priority ranking and the planned response. Often, the high and moderate risks are addressed in detail. Risks judged to be of low priority are included in a watch list for periodic monitoring. Updates to the risk register can include, but are not limited to:

- Risk owners and assigned responsibilities;
- Agreed-upon response strategies;
- Specific actions to implement the chosen response strategy;
- Trigger conditions, symptoms, and warning signs of a risk occurrence;
- Budget and schedule activities required to implement the chosen responses;

- Contingency plans and triggers that call for their execution;
- Fallback plans for use as a reaction to a risk that has occurred and the primary response proves to be inadequate;
- Residual risks that are expected to remain after planned responses have been taken, as well as those that have been deliberately accepted;
- Secondary risks that arise as a direct outcome of implementing a risk response; and
- Contingency reserves that are calculated based on the quantitative risk analysis of the project and the organization's risk thresholds.

Other project documents updated could include:

- **Assumptions log updates.** As new information becomes available through the application of risk responses, assumptions could change. The assumptions log needs to be revisited to accommodate this new information.
- **Technical documentation updates.** As new information becomes available through the application of risk responses, technical approaches and physical deliverables may change. Any supporting documentation needs to be revisited to accommodate this new information.
- **Change requests.** Planning for possible risk responses can often result in recommendations for changes to the resources, activities, cost estimates, and other items identified during other planning processes. When such recommendations are identified, change requests are generated and processed through the Perform Integrated Change Control process.



## 11.6 Control Risks

Control Risks is the process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the project. The key benefit of this process is that it improves efficiency of the risk approach throughout the project life cycle to continuously optimize risk responses. The inputs, tools and techniques, and outputs of this process are depicted in Figure 11-20. Figure 11-21 depicts the data flow diagram of the process.


**Figure 11-20. Control Risks: Inputs, Tools & Techniques, and Outputs**

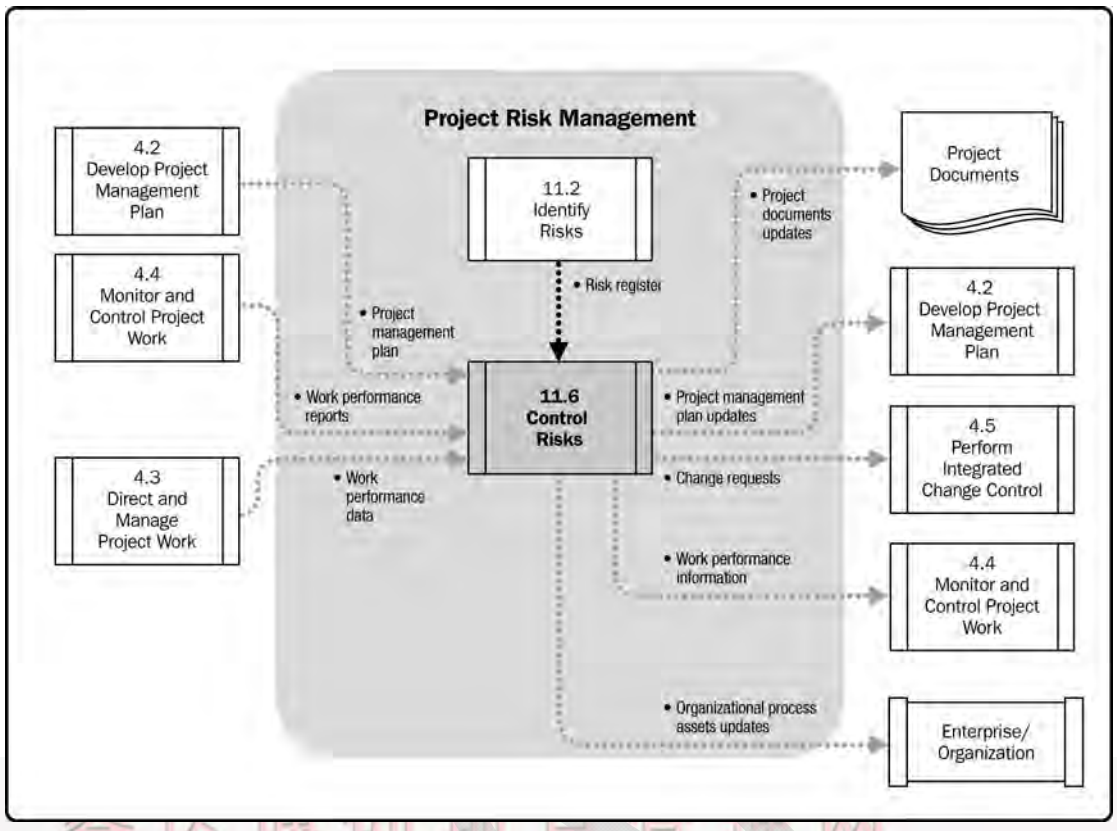



**Figure 11-21. Control Risks Data Flow Diagram**

Planned risk responses that are included in the risk register are executed during the life cycle of the project, but the project work should be continuously monitored for new, changing, and outdated risks.

The Control Risks process applies techniques, such as variance and trend analysis, which require the use of performance information generated during project execution. Other purposes of the Control Risks process are to determine if:

- Project assumptions are still valid,
- Analysis shows an assessed risk has changed or can be retired,
- Risk management policies and procedures are being followed, and
- Contingency reserves for cost or schedule should be modified in alignment with the current risk assessment.

Control Risks can involve choosing alternative strategies, executing a contingency or fallback plan, taking corrective action, and modifying the project management plan. The risk response owner reports periodically to the project manager on the effectiveness of the plan, any unanticipated effects, and any correction needed to handle the risk appropriately. Control Risks also includes updating the organizational process assets, including project lessons learned databases and risk management templates, for the benefit of future projects.