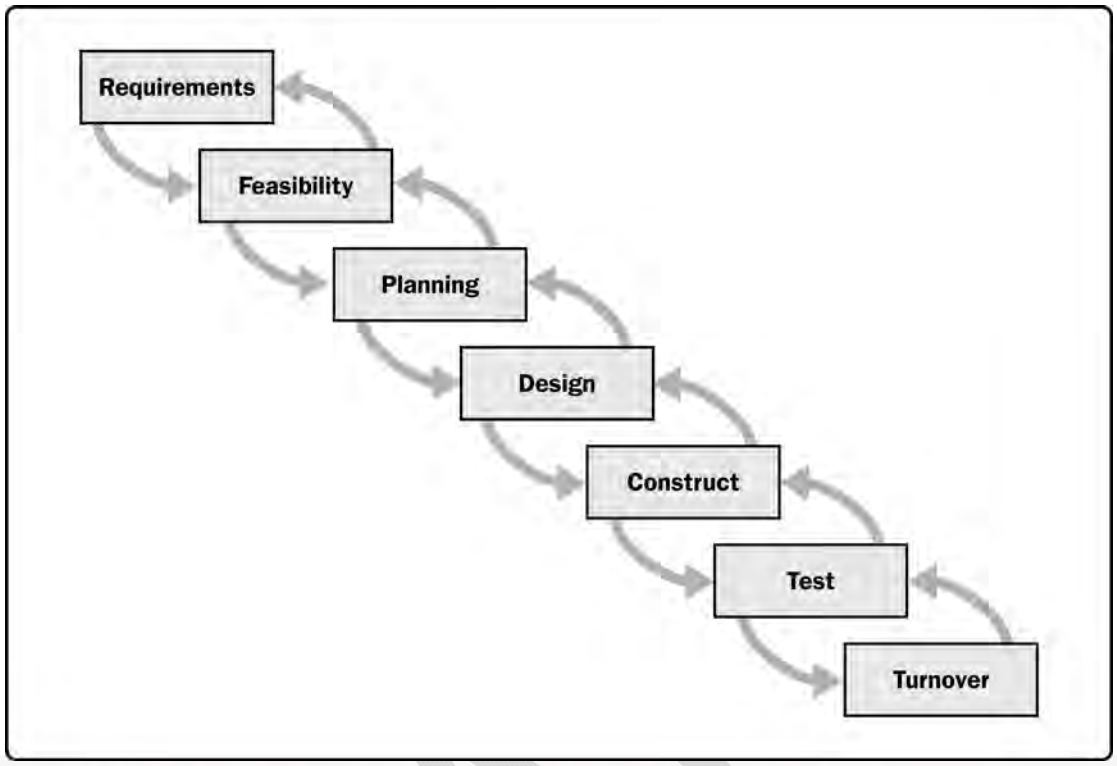

Figure 2-13. Example of Predictive Life Cycle

When the project is initiated, the project team will focus on defining the overall scope for the product and project, develop a plan to deliver the product (and any associated deliverables), and then proceed through phases to execute the plan within that scope. Changes to the project scope are carefully managed and require re-planning and formal acceptance of the new scope.

Predictive life cycles are generally preferred when the product to be delivered is well understood, there is a substantial base of industry practice, or where a product is required to be delivered in full to have value to stakeholder groups.

Even projects with predictive life cycles may use the concept of rolling-wave planning, where a more general, high-level plan is available and more detailed planning is executed for appropriate time windows, as new work activities are approaching and resources are to be assigned.

2.4.2.3 Iterative and Incremental Life Cycles

Iterative and incremental life cycles are ones in which project phases (also called iterations) intentionally repeat one or more project activities as the project team's understanding of the product increases. Iterations develop the product through a series of repeated cycles, while increments successively add to the functionality of the product. These life cycles develop the product both iteratively and incrementally.

Iterative and incremental projects may proceed in phases, and the iterations themselves will be performed in a sequential or overlapping fashion. During an iteration, activities from all Project Management Process Groups will be performed. At the end of each iteration, a deliverable or set of deliverables will be completed. Future iterations may enhance those

deliverables or create new ones. Each iteration incrementally builds the deliverables until the exit criteria for the phase are met, allowing the project team to incorporate feedback.

In most iterative life cycles, a high-level vision will be developed for the overall undertaking, but the detailed scope is elaborated one iteration at a time. Often the planning for the next iteration is carried out as work progresses on the current iteration's scope and deliverables. The work required for a given set of deliverables may vary in duration and effort, and the project team may change between or during iterations. Those deliverables that are not addressed within the scope of the current iteration are typically scoped at a high level only and may be tentatively assigned to a specific future iteration. Changes to the scope of an iteration are carefully managed once work begins.

Iterative and incremental life cycles are generally preferred when an organization needs to manage changing objectives and scope, to reduce the complexity of a project, or when the partial delivery of a product is beneficial and provides value for one or more stakeholder groups without impact to the final deliverable or set of deliverables. Large and complex projects are frequently executed in an iterative fashion to reduce risk by allowing the team to incorporate feedback and lessons learned between iterations.

2.4.2.4 Adaptive Life Cycles

Adaptive life cycles (also known as change-driven or agile methods) are intended to respond to high levels of change and ongoing stakeholder involvement. Adaptive methods are also iterative and incremental, but differ in that iterations are very rapid (usually with a duration of 2 to 4 weeks) and are fixed in time and cost. Adaptive projects generally perform several processes in each iteration, although early iterations may concentrate more on planning activities.

The overall scope of the project will be decomposed into a set of requirements and work to be performed, sometimes referred to as a product backlog. At the beginning of an iteration, the team will work to determine how many of the highest priority items on the backlog list can be delivered within the next iteration. At the end of each iteration, the product should be ready for review by the customer. This does not mean that the customer is required to accept delivery, just that the product should not include unfinished, incomplete, or unusable features. The sponsor and customer representatives should be continuously engaged with the project to provide feedback on deliverables as they are created and to ensure that the product backlog reflects their current needs.

Adaptive methods are generally preferred when dealing with a rapidly changing environment, when requirements and scope are difficult to define in advance, and when it is possible to define small incremental improvements that will deliver value to stakeholders.

3

PROJECT MANAGEMENT PROCESSES

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. This application of knowledge requires the effective management of the project management processes.

A process is a set of interrelated actions and activities performed to create a pre-specified product, service, or result. Each process is characterized by its inputs, the tools and techniques that can be applied, and the resulting outputs. As explained in Section 2, the project manager needs to consider organizational process assets and enterprise environmental factors. These should be taken into account for every process, even if they are not explicitly listed as inputs in the process specification. Organizational process assets provide guidelines and criteria for tailoring the organization's processes to the specific needs of the project. Enterprise environmental factors may constrain the project management options.

In order for a project to be successful, the project team should:

- Select appropriate processes required to meet the project objectives;
- Use a defined approach that can be adapted to meet requirements;
- Establish and maintain appropriate communication and engagement with stakeholders;
- Comply with requirements to meet stakeholder needs and expectations; and
- Balance the competing constraints of scope, schedule, budget, quality, resources, and risk to produce the specified product, service, or result.

The project processes are performed by the project team with stakeholder interaction and generally fall into one of two major categories:

- **Project management processes.** These processes ensure the effective flow of the project throughout its life cycle. These processes encompass the tools and techniques involved in applying the skills and capabilities described in the Knowledge Areas (Sections 4 through 13).
- **Product-oriented processes.** These processes specify and create the project's product. Product-oriented processes are typically defined by the project life cycle (as discussed in Section 2.4) and vary by application area as well as the phase of the product life cycle. The scope of the project cannot be defined without some basic understanding of how to create the specified product. For example, various construction techniques and tools need to be considered when determining the overall complexity of the house to be built.

The *PMBOK® Guide* describes only the project management processes. Although product-oriented processes are outside the scope of this document, they should not be ignored by the project manager and project team. Project management processes and product-oriented processes overlap and interact throughout the life of a project.

Project management processes apply globally and across industry groups. Good practice means there is general agreement that the application of project management processes has been shown to enhance the chances of success over a wide range of projects. Good practice does not mean that the knowledge, skills, and processes described should always be applied uniformly on all projects. For any given project, the project manager, in collaboration with the project team, is always responsible for determining which processes are appropriate, and the appropriate degree of rigor for each process.

Project managers and their teams should carefully address each process and its inputs and outputs and determine which are applicable to the project they are working on. The *PMBOK® Guide* may be used as a resource in managing a project while considering the overall approach and methodology to be followed for the project. This effort is known as tailoring.

Project management is an integrative undertaking that requires each project and product process to be appropriately aligned and connected with the other processes to facilitate coordination. Actions taken during one process typically affect that process and other related processes. For example, a scope change typically affects project cost, but it may not affect the communications management plan or level of risk. These process interactions often require tradeoffs among project requirements and objectives, and the specific performance tradeoffs will vary from project to project and organization to organization. Successful project management includes actively managing these interactions to meet sponsor, customer, and other stakeholder requirements. In some circumstances, a process or set of processes will need to be iterated several times in order to achieve the required outcome.

Projects exist within an organization and do not operate as a closed system. They require input data from the organization and beyond, and deliver capabilities back to the organization. The project processes may generate information to improve the management of future projects and organizational process assets.

The *PMBOK® Guide* describes the nature of project management processes in terms of the integration between the processes, their interactions, and the purposes they serve. Project management processes are grouped into five categories known as Project Management Process Groups (or Process Groups):

- **Initiating Process Group.** Those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.
- **Planning Process Group.** Those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.
- **Executing Process Group.** Those processes performed to complete the work defined in the project management plan to satisfy the project specifications.
- **Monitoring and Controlling Process Group.** Those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.
- **Closing Process Group.** Those processes performed to finalize all activities across all Process Groups to formally close the project or phase.

The remainder of this section provides information for project management of a single project organized as a network of interlinked processes, details the project management processes, and includes the following major sections:

3.1 Common Project Management Process Interactions

3.2 Project Management Process Groups

3.3 Initiating Process Group

3.4 Planning Process Group

3.5 Executing Process Group

3.6 Monitoring and Controlling Process Group

3.7 Closing Process Group

3.8 Project Information

3.9 Role of the Knowledge Areas

3.10 The Standard for Project Management of a Project

3.1 Common Project Management Process Interactions

The project management processes are presented as discrete elements with well-defined interfaces. However, in practice they overlap and interact in ways that are not completely detailed in this document. Most experienced project management practitioners recognize there is more than one way to manage a project. The required Process Groups and their processes are guides for applying appropriate project management knowledge and skills during the project. The application of the project management processes is iterative, and many processes are repeated during the project.

The integrative nature of project management requires the Monitoring and Controlling Process Group to interact with the other Process Groups, as shown in Figure 3-1. Monitoring and Controlling processes occur at the same time as processes contained within other Process Groups. Thus, the Monitoring and Controlling Process is pictured as a “background” Process Group for the other four Process Groups shown in Figure 3-1.

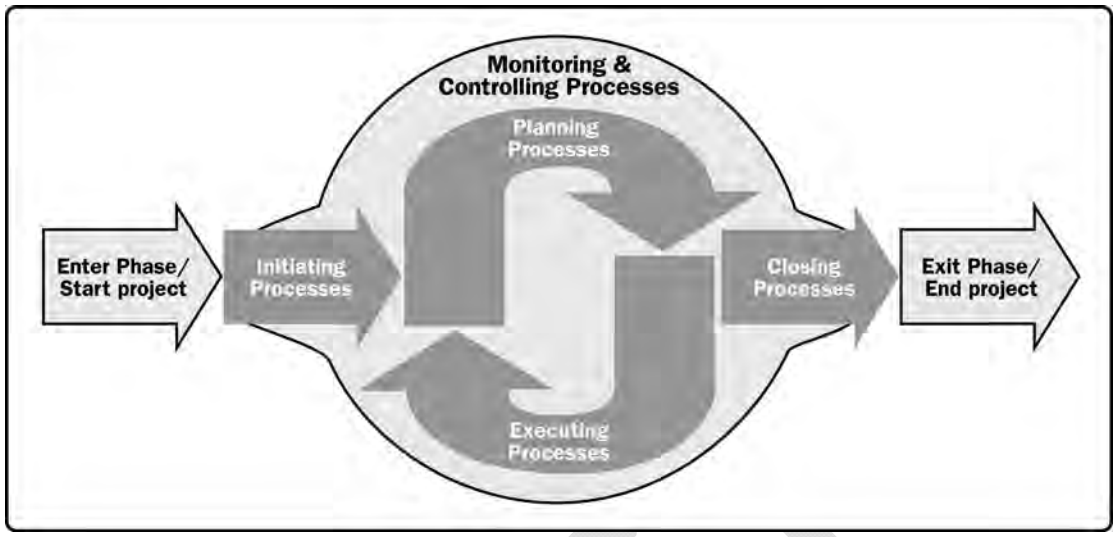

Figure 3-1. Project Management Process Groups

Project Management Process Groups are linked by the outputs which are produced. The Process Groups are seldom either discrete or one-time events; they are overlapping activities that occur throughout the project. The output of one process generally becomes an input to another process or is a deliverable of the project, subproject, or project phase. Deliverables at the subproject or project level may be called incremental deliverables. The Planning Process Group provides the Executing Process Group with the project management plan and project documents, and, as the project progresses, it often creates updates to the project management plan and the project documents. Figure 3-2 illustrates how the Process Groups interact and shows the level of overlap at various times. If the project is divided into phases, the Process Groups interact within each phase.

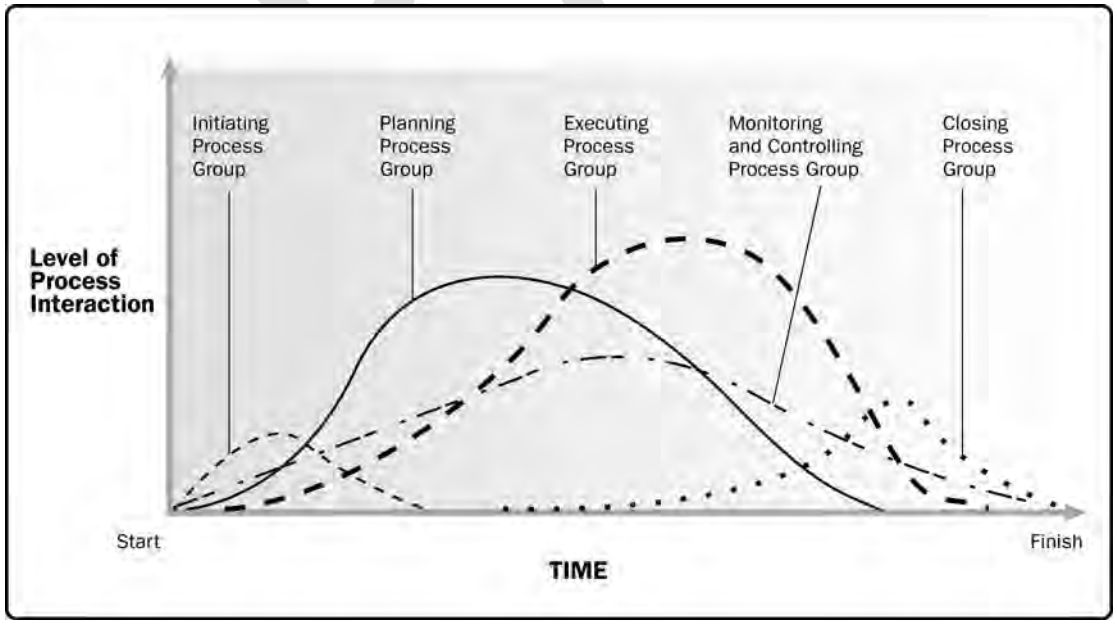

Figure 3-2. Process Groups Interact in a Phase or Project

An example of this interaction is the exit of a design phase, which requires sponsor acceptance of the design document. Once it is available, the design document provides the product description for the Planning and Executing Process Groups in one or more subsequent phases. When a project is divided into phases, the Process Groups are used, as appropriate, to effectively drive the project to completion in a controlled manner. In multiphase projects, processes are repeated within each phase until the criteria for phase completion have been satisfied. Additional information on project organization, life cycles, and project phases is provided in Section 2.

3.2 Project Management Process Groups

The following sections identify and describe the five Project Management Process Groups required for any project. These five Process Groups have clear dependencies and are typically performed in each project and highly interact with one another. These five Process Groups are independent of application areas or industry focus. Individual Process Groups and individual processes are often iterated prior to completing the project and can have interactions within a Process Group and among Process Groups. The nature of these interactions varies from project to project and may or may not be performed in a particular order.

The process flow diagram, Figure 3-3, provides an overall summary of the basic flow and interactions among Process Groups and specific stakeholders. The project management processes are linked by specific inputs and outputs where the result or outcome of one process becomes the input to another process but not necessarily in the same Process Group. **The Process Groups are not project life cycle phases**. In fact, it is possible that all Process Groups could be conducted within a phase. As projects are separated into distinct phases or subcomponents, such as concept development feasibility study, design, prototype, build, or test, etc., all of the Process Groups would normally be repeated for each phase or subcomponent along the lines explained previously and illustrated in Figure 3-2.

The project management processes are shown in the Process Group in which most of the related activities takes place. For example, a process that normally takes place in the planning phase is put into the Planning Process Group. When this process is updated by an Executing Process Group process or activity, it is not considered a new process within the Executing Process Group but is still a Planning Process Group process or activity. The iterative nature of project management means that processes from any group may be reused throughout the project life cycle. For example, in response to a risk event, executing a risk response may trigger further analysis, which leads to another iteration of the Identify Risks process and the associated Perform Quantitative Risk Analysis and Perform Quantitative Risk Analysis processes to evaluate the impact.

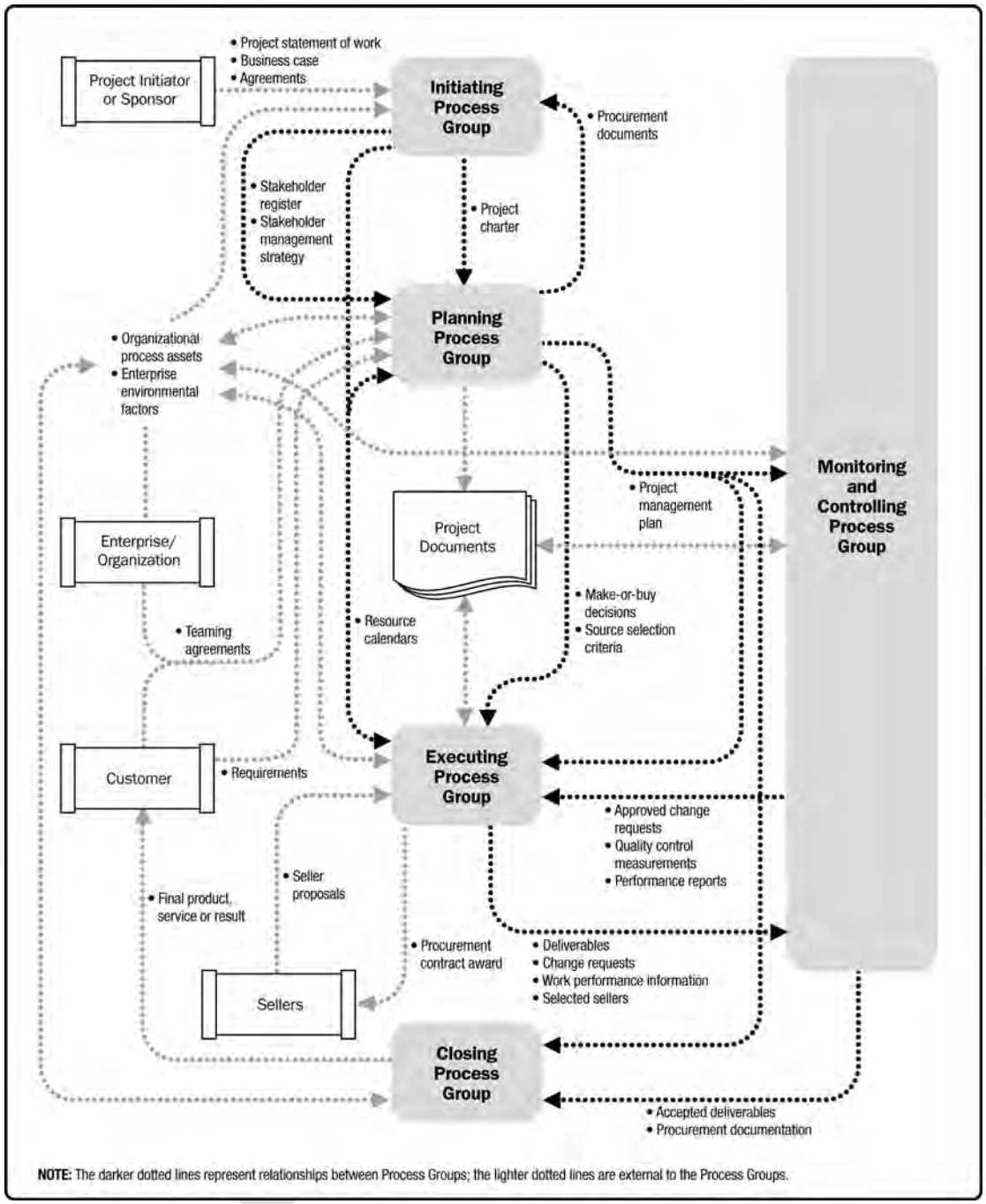

Figure 3-3. Project Management Process Interactions

3.3 Initiating Process Group

The Initiating Process Group consists of those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase. Within the Initiating processes, the initial scope is defined and initial financial resources are committed. Internal and external stakeholders who will interact and influence the overall outcome of the project are identified. If not already assigned, the project manager will be selected. This information is captured in the project charter and stakeholder register. When the

project charter is approved, the project becomes officially authorized. Although the project management team may help write the project charter, this standard assumes that business case assessment, approval, and funding are handled externally to the project boundaries (Figure 3-4). A project boundary is defined as the point in time that a project or project phase is authorized to its completion. The key purpose of this Process Group is to align the stakeholders' expectations with the project's purpose, give them visibility about the scope and objectives, show how their participation in the project and it associated phases can ensure that their expectations are achieved. These processes help set the vision of the project—what is needed to be accomplished.

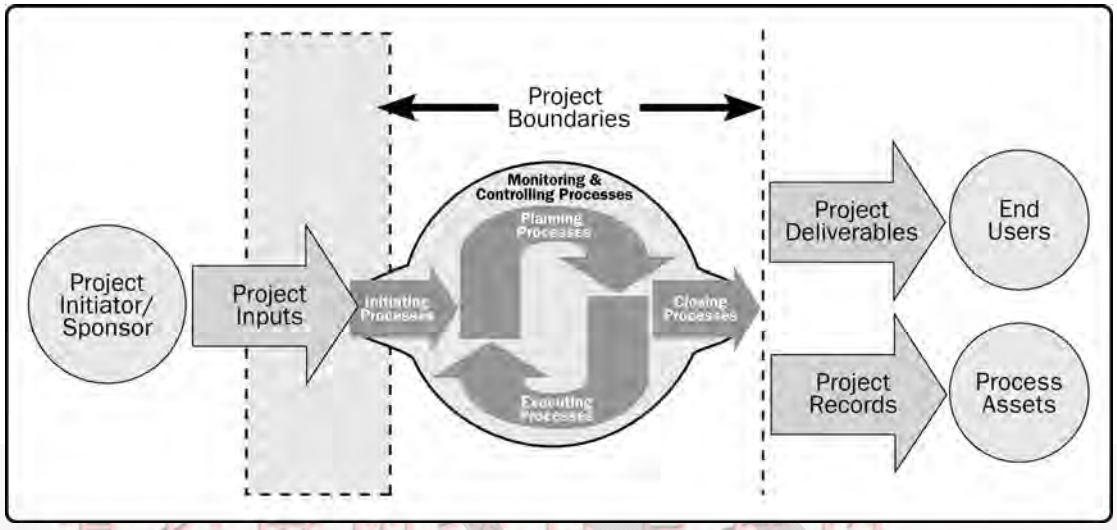

Figure 3-4. Project Boundaries

Large complex projects should be divided into separate phases. In such projects, the Initiating processes are carried out during subsequent phases to validate the decisions made during the original Develop Project Charter and Identify Stakeholders processes. Performing the Initiating processes at the start of each phase helps to keep the project focused on the business need that the project was undertaken to address. The success criteria are verified, and the influence, drivers and objectives of the project stakeholders are reviewed. A decision is then made as to whether the project should be continued, delayed, or discontinued.

Involving the sponsors, customers, and other stakeholders during initiation creates a shared understanding of success criteria, reduces the overhead of involvement, and generally improves deliverable acceptance, customer satisfaction, and other stakeholder satisfaction.

Initiating processes may be performed at the organizational, program, or portfolio level and therefore, would be outside of the project's level of control. For example, prior to commencing a project, the need for high-level requirements may be documented as part of a larger organizational initiative. A process of evaluating alternatives may be utilized to determine the feasibility of the new undertaking. Clear descriptions of the project objectives may be developed, including the reasons why a specific project is the best alternative to satisfy the requirements. The documentation for this decision may also contain the initial project scope statement, deliverables, project duration, and a forecast of the resources for the organization's investment analysis. As part of the Initiating processes, the project manager is given the authority to apply organizational resources to the subsequent project activities.

3.4 Planning Process Group

The Planning Process Group consists of those processes performed to establish the total scope of the effort, define and refine the objectives, and develop the course of action required to attain those objectives. The Planning processes develop the project management plan and the project documents that will be used to carry out the project. The complex nature of project management may require the use of repeated feedback loops for additional analysis. As more project information or characteristics are gathered and understood, additional planning will likely be required. Significant changes occurring throughout the project life cycle trigger a need to revisit one or more of the planning processes and possibly some of the initiating processes. This progressive detailing of the project management plan is called progressive elaboration, indicating that planning and documentation are iterative and ongoing activities. The key benefit of this Process Group is to delineate the strategy and tactics as well as the course of action or path to successfully complete the project or phase. When the Planning Process Group is well managed, it is much easier to get stakeholder buy-in and engagement. These processes express how this will be done, setting the route to the desired objective.

The project management plan and project documents developed as outputs from the Planning Process Group will explore all aspects of the scope, time, cost, quality, communications, human resources, risks, procurements, and stakeholder engagement.

Updates arising from approved changes during the project (generally during Monitoring and Controlling processes and specifically during the Direct and Manage Project Work Process) may significantly impact parts of the project management plan and the project documents. Updates to these documents provide greater precision with respect to schedule, costs, and resource requirements to meet the defined project scope.

The project team seeks input and encourages involvement from all stakeholders when planning the project and developing the project management plan and project documents. While the act of collecting feedback and refining the documents cannot continue indefinitely, procedures set by the organization dictate when the initial planning ends. These procedures will be affected by the nature of the project, the established project boundaries, appropriate monitoring and controlling activities, as well as the environment in which the project will be performed.

Other interactions among the processes within the Planning Process Group are dependent upon the nature of the project. For example, for some projects there will be little or no identifiable risks until after significant amount of planning has been done. At that time, the team might recognize that the cost and schedule targets are overly aggressive, thus involving considerably more risk than previously understood. The results of the iterations are documented as updates to the project management plan or to various project documents.

3.5 Executing Process Group

The Executing Process Group consists of those processes performed to complete the work defined in the project management plan to satisfy the project specifications. This Process Group involves coordinating people and resources, managing stakeholder expectations, as well as integrating and performing the activities of the project in accordance with the project management plan.

During project execution, results may require planning updates and rebaselining. This may include changes to expected activity durations, changes in resource productivity and availability, and unanticipated risks. Such variances may affect the project management plan or project documents and may require detailed analysis and development of appropriate project management responses. The results of the analysis can trigger change requests that, if approved, may modify the project management plan or other project documents and possibly require establishing new baselines. A large portion of the project's budget will be expended in performing the Executing Process Group processes.

3.6 Monitoring and Controlling Process Group

The Monitoring and Controlling Process Group consists of those processes required to track, review, and orchestrate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes. The key benefit of this Process Group is that project performance is measured and analyzed at regular intervals, appropriate events, or exception conditions to identify variances from the project management plan. The Monitoring and Controlling Process Group also involves:

- Controlling changes and recommending corrective or preventive action in anticipation of possible problems,
- Monitoring the ongoing project activities against the project management plan and the project performance measurement baseline, and
- Influencing the factors that could circumvent integrated change control or configuration management so only approved changes are implemented.

This continuous monitoring provides the project team insight into the health of the project and identifies any areas requiring additional attention. The Monitoring and Controlling Process Group not only monitors and controls the work being done within a Process Group, but also monitors and controls the entire project effort. In multiphase projects, the Monitoring and Controlling Process Group coordinates project phases in order to implement corrective or preventive actions to bring the project into compliance with the project management plan. This review can result in recommended and approved updates to the project management plan. For example, a missed activity finish date may require adjustments and trade-offs between budget and schedule objectives. In order to reduce or control overhead, management-by-exception procedures and other techniques can be appropriately considered.

3.7 Closing Process Group

The Closing Process Group consists of those processes performed to conclude all activities across all Project Management Process Groups to formally complete the project, phase, or contractual obligations. This Process Group, when completed, verifies that the defined processes are completed within all of the Process Groups to close the project or a project phase, as appropriate, and formally establishes that the project or project phase is complete.

This Process Group also formally establishes the premature closure of the project. Prematurely closed projects may include, for example: aborted projects, cancelled projects, and projects having a critical situation. In specific cases, when some contracts cannot be formally closed (e.g. claims, termination clauses, etc.) or some activities are to be transferred to other organizational units, specific hand-over procedures may be arranged and finalized.

At project or phase closure, the following may occur:

- Obtain acceptance by the customer or sponsor to formally close the project or phase,
- Conduct post-project or phase-end review,
- Record impacts of tailoring to any process,
- Document lessons learned,
- Apply appropriate updates to organizational process assets,
- Archive all relevant project documents in the project management information system (PMIS) to be used as historical data,
- Close out all procurement activities ensuring termination of all relevant agreements, and
- Perform team members' assessments and release project resources.

3.8 Project Information

Throughout the life cycle of the project, a significant amount of data and information is collected, analyzed, transformed, and distributed in various formats to project team members and other stakeholders. Project data are collected as a result of various Executing processes and are shared within the project team. The collected data are analyzed in context, and aggregated and transformed to become project information during various Controlling processes. The information may then be communicated verbally or stored and distributed as reports in various formats.

The project data are continuously collected and analyzed during the dynamic context of the project execution. As a result, the terms data and information are often used interchangeably in practice. The indiscriminate use of these terms can lead to confusion and misunderstandings by the various project stakeholders. The following guidelines help minimize miscommunication and help the project team use appropriate terminology:

- **Work performance data.** The raw observations and measurements identified during activities performed to carry out the project work. Examples include reported percent of work physically completed, quality and technical performance measures, start and finish dates of schedule activities, number of change requests, number of defects, actual costs, actual durations, etc.
- **Work performance information.** The performance data collected from various controlling processes, analyzed in context and integrated based on relationships across areas. Examples of performance information are status of deliverables, implementation status for change requests, and forecasted estimates to complete.
- **Work performance reports**. The physical or electronic representation of work performance information compiled in project documents, intended to generate decisions or raise issues, actions, or awareness. Examples include status reports, memos, justifications, information notes, electronic dashboards, recommendations, and updates.

Figure 3-5 illustrates the flow of project information across the various processes used to manage the project.

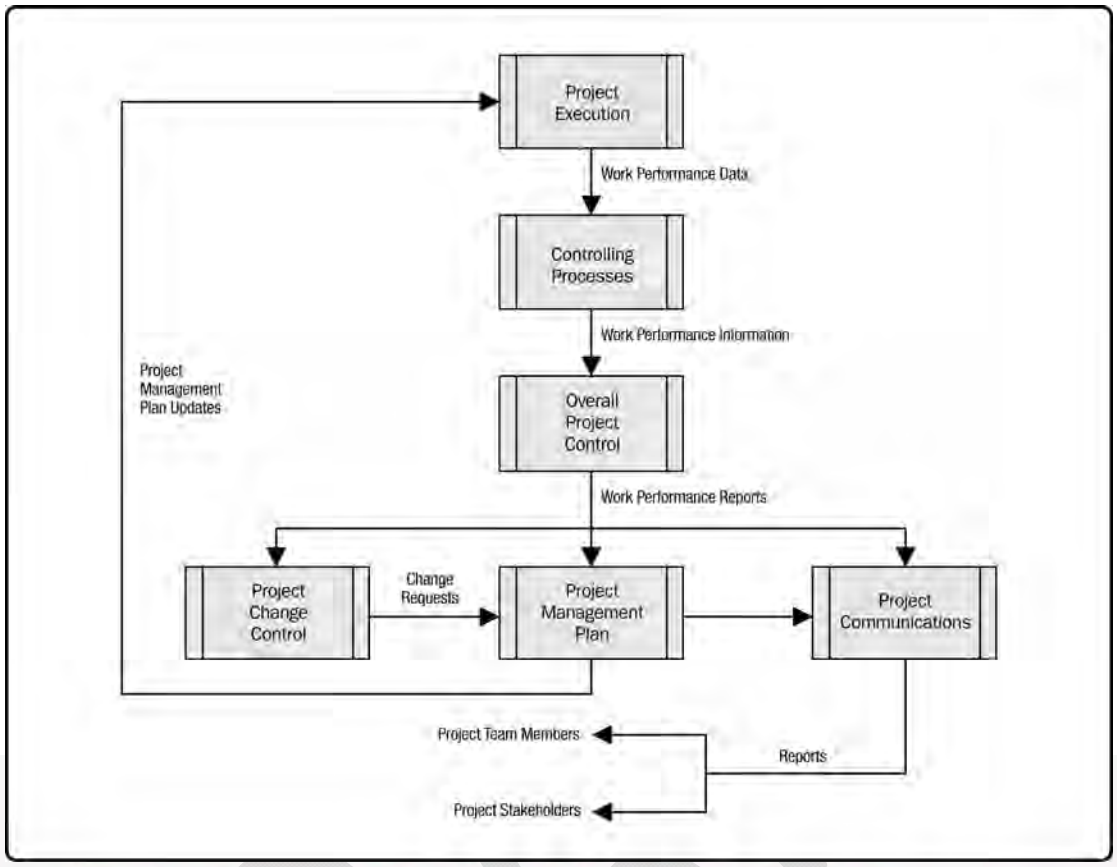

Figure 3-5. Project Data, Information and Report Flow

3.9 Role of the Knowledge Areas

The 47 project management processes identified in the *PMBOK® Guide* are further grouped into ten separate Knowledge Areas. A Knowledge Area represents a complete set of concepts, terms, and activities that make up a professional field, project management field, or area of specialization. These ten Knowledge Areas are used on most projects most of the time. Project teams should utilize these ten Knowledge Areas and other knowledge areas, as appropriate, for their specific project. The Knowledge Areas are: Project Integration Management, Project Scope Management, Project Time Management, Project Quality Management, Project Human Resource Management, Project Communications Management, Project Risk Management, Project Procurement Management and Project Stakeholder Management. Each Knowledge Area within the *PMBOK® Guide* is contained in a separate section.

The *PMBOK® Guide* defines the important aspects of each Knowledge Area and how it integrates with the five Process Groups. As supporting elements, the Knowledge Areas provide a detailed description of the process inputs and outputs along with a descriptive explanation of tools and techniques most frequently used within the project management processes to produce each outcome. In addition, a data flow diagram is included for each process and is explained in Appendix X3.

Table 3-1 reflects the mapping of the 47 project management processes within the 5 Project Management Process Groups and the 10 Knowledge Areas.

Table 3-1. Project Management Process Group and Knowledge Area Mapping

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

4

PROJECT INTEGRATION MANAGEMENT

Project Integration Management includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups. In the project management context, integration includes characteristics of unification, consolidation, communication, and integrative actions that are crucial to controlled project execution through completion, successfully managing stakeholder expectations, and meeting requirements. Project Integration Management includes making choices about resource allocation, making trade-offs among competing objectives and alternatives, and managing the interdependencies among the project management Knowledge Areas. The project management processes are usually presented as discrete processes with defined interfaces while, in practice, they overlap and interact in ways that cannot be completely detailed in the *PMBOK® Guide*.

Figure 4-1 provides an overview of the Project Integration Management processes, which are as follows:

4.1 Develop Project Charter—The process of developing a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities.

4.2 Develop Project Management Plan—The process of defining, preparing, and coordinating all subsidiary plans and integrating them into a comprehensive project management plan. The project's integrated baselines and subsidiary plans may be included within the project management plan.

4.3 Direct and Manage Project Work—The process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project's objectives.

4.4 Monitor and Control Project Work—The process of tracking, reviewing, and reporting project progress against the performance objectives defined in the project management plan.

4.5 Perform Integrated Change Control—The process of reviewing all change requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating their disposition.

4.6 Close Project or Phase—The process of finalizing all activities across all of the Project Management Process Groups to formally complete the phase or project.

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

The need for Project Integration Management is necessary in situations where individual processes interact. For example, a cost estimate needed for a contingency plan involves integrating the processes in the Project Cost, Time, and Risk Management Knowledge Areas.

When additional risks associated with various staffing alternatives are identified, then one or more of those processes may be revisited. The project deliverables may also need integrating with ongoing operations of the performing organization, the requesting organization, and with the long-term strategic planning that takes future problems and opportunities into consideration. Project Integration Management also includes the activities needed to manage project documents to ensure consistency with the project management plan and product, service, or capability deliverables.

Most experienced project management practitioners know there is no single way to manage a project. They apply project management knowledge, skills, and required processes in a preferred order and with varying rigor to achieve the desired project performance. However, the determination that a particular process is not required does not mean that it should not be addressed. The project manager and project team need to address every process and the project environment to determine the level of implementation for each process within the project. If a project has more than one phase, the level of rigor applied within each of the project phases should be appropriate for each phase. This determination is also addressed by the project manager and project team.

The integrative nature of projects and project management can be understood by thinking of other types of activities performed while completing a project. Examples of some activities performed by the project management team are:

- Develop, review, analyze, and understand the scope. This includes the project and product requirements, criteria, assumptions, constraints, and other influences related to a project, and how each will be managed or addressed within the project;
- Transform the collected project information into a project management plan using a structured approach as described in the *PMBOK® Guide*;
- Perform activities to produce project deliverables; and
- Measure and monitor the project's progress and take appropriate action to meet project objectives.

The links among the processes in the Project Management Process Groups are often iterative in nature. For example, the Planning Process Group provides the Executing Process Group with a documented project management plan early in the project and then updates the project management plan if changes occur as the project progresses.

Figure 4-1. Project Integration Management Overview

4.1 Develop Project Charter

Develop Project Charter is the process of developing a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities. The key benefit of this process is a well-defined project start and project boundaries, creation of a formal record of the project, and a direct way for senior management to formally accept and commit to the project. The inputs, tools and techniques, and outputs for this process are shown in Figure 4-2. Figure 4-3 depicts the data flow diagram of the process.

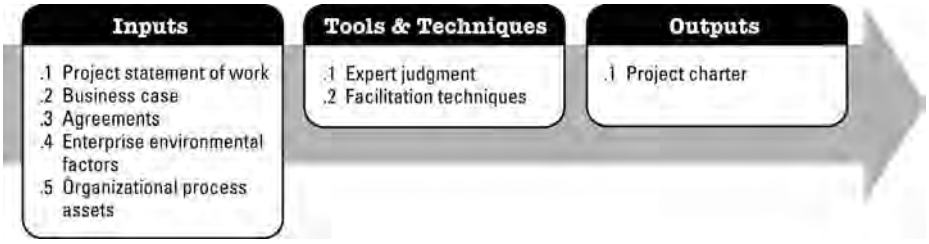

Figure 4-2. Develop Project Charter: Inputs, Tools and Techniques, and Outputs

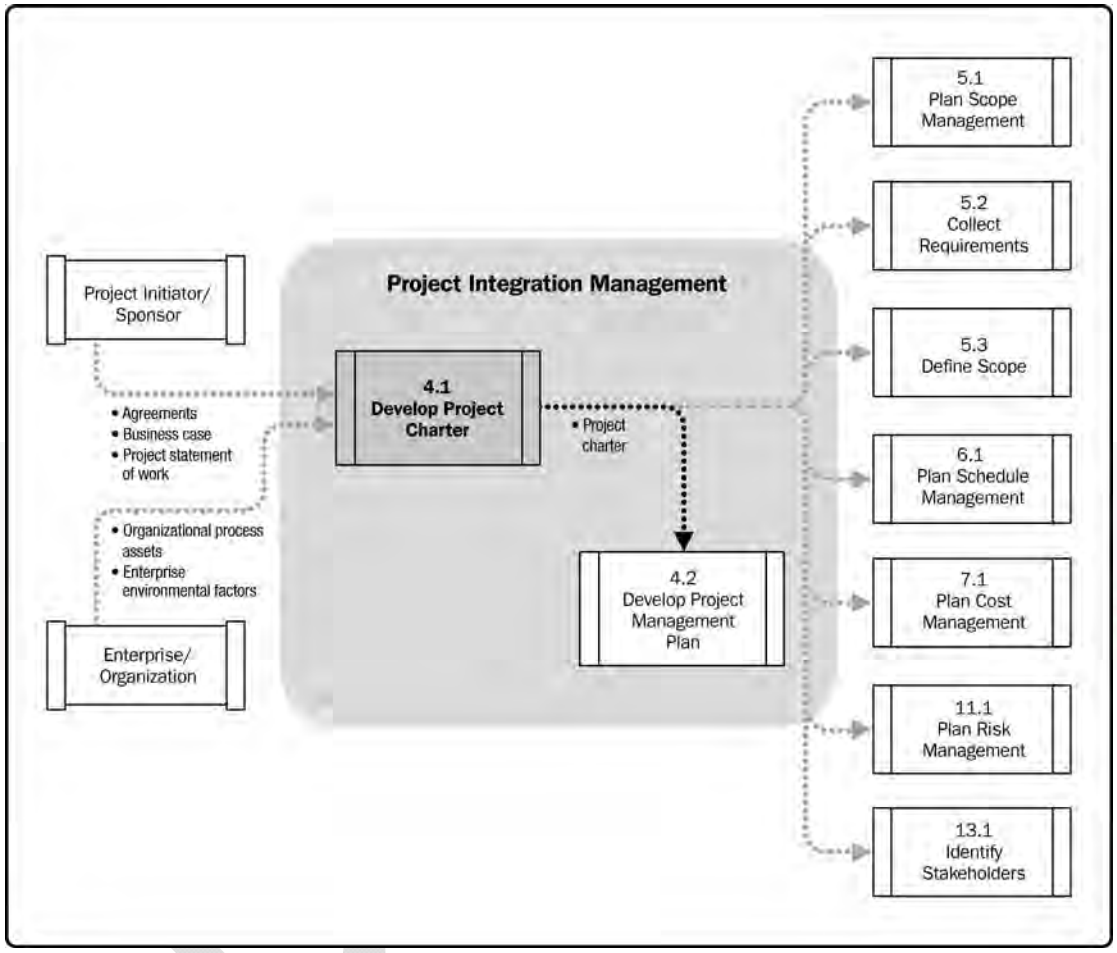

Figure 4-3. Develop Project Charter Data Flow Diagram

The project charter establishes a partnership between the performing and requesting organizations. In the case of external projects, a formal contract is typically the preferred way to establish an agreement. In this case, the project team becomes the seller responding to conditions of an offer to buy from an outside entity. A project charter is still used to establish internal agreements within an organization to assure proper delivery under the contract. The approved project charter formally initiates the project. A project manager is identified and assigned as early in the project as is feasible, preferably while the project charter is being developed and always prior to the start of planning. The project charter should be authored by the sponsoring entity. The project charter provides the project manager with the authority to plan and execute the project. It is recommended that the project manager participate in the development of the

project charter to obtain a foundational understanding of the project requirements. This understanding will better allow for efficient resources allocation to project activities.

Projects are initiated by an entity external to the project such as a sponsor, program or project management office (PMO) staff person, or a portfolio governing body chairperson or authorized representative. The project initiator or sponsor should be at the level that is appropriate to procure funding and commit resources to the project. Projects are initiated due to internal business needs or external influences. These needs or influences often trigger the creation of a needs analysis, feasibility study, business case, or description of the situation that the project will address. Chartering a project validates alignment of the project to the strategy and ongoing work of the organization. A project charter is not considered to be a contract, because there is no consideration or money promised or exchanged in its creation.

4.1.1 Develop Project Charter: Inputs

4.1.1.1 Project Statement of Work

The project statement of work (SOW) is a narrative description of products, services, or results to be delivered by a project. For internal projects, the project initiator or sponsor provides the statement of work based on business needs, product, or service requirements. For external projects, the statement of work can be received from the customer as part of a bid document, (e.g., a request for proposal, request for information, or request for bid) or as part of a contract. The SOW references the following:

- **Business need.** An organization's business need may be based on a market demand, technological advance, legal requirement, government regulation, or environmental consideration. Typically, the business need and the cost-benefit analysis are contained in the business case to justify the project.
- **Product scope description.** The product scope description documents the characteristics of the product, service, or results that the project will be undertaken to create. The description should also document the relationship between the products, services, or results being created and the business need that the project will address.
- **Strategic plan.** The strategic plan documents the organization's strategic vision, goals, and objectives and may contain a high-level mission statement. All projects should be aligned with their organization's strategic plan. Strategic plan alignment assures that each project contributes to the overall objections of the organization.

4.1.1.2 Business Case

The business case or similar document describes the necessary information from a business standpoint to determine whether or not the project is worth the required investment. It is commonly used for decision making by managers or executives above the project level. Typically, the business need and the cost-benefit analysis are contained in the business case to justify and establish boundaries for the project, and such analysis is usually completed by a business analyst using various stakeholder inputs. The sponsor should agree to the scope and limitations of the business case. The business case is created as a result of one or more of the following:

- Market demand (e.g., a car company authorizing a project to build more fuel-efficient cars in response to gasoline shortages),
- Organizational need (e.g., due to high overhead costs a company may combine staff functions and streamline processes to reduce costs.),
- Customer request (e.g., an electric utility authorizing a project to build a new substation to serve a new industrial park),
- Technological advance (e.g., an airline authorizing a new project to develop electronic tickets instead of paper tickets based on technological advances),
- Legal requirement (e.g., a paint manufacturer authorizing a project to establish guidelines for handling toxic materials),
- Ecological impacts (e.g., a company authorizing a project to lessen its environmental impact), or
- Social need (e.g., a nongovernmental organization in a developing country authorizing a project to provide potable water systems, latrines, and sanitation education to communities suffering from high rates of cholera).

Each of the examples in this list may contain elements of risk that should be addressed. In the case of multiphase projects, the business case may be periodically reviewed to ensure that the project is on track to deliver the business benefits. In the early stages of the project life cycle, periodic review of the business case by the sponsoring organization also helps to confirm that the project is still aligned with the business case. The project manager is responsible for ensuring that the project effectively and efficiently meets the goals of the organization and those requirements of a broad set of stakeholders, as defined in the business case.

4.1.1.3 Agreements

Agreements are used to define initial intentions for a project. Agreements may take the form of contracts, memorandums of understanding (MOUs), service level agreements (SLA), letter of agreements, letters of intent, verbal agreements, email, or other written agreements. Typically, a contract is used when a project is being performed for an external customer.

4.1.1.4 Enterprise Environmental Factors

Described in Section 2.1.5. The enterprise environmental factors that can influence the Develop Project Charter process include, but are not limited to:

- Governmental standards, industry standards, or regulations (e.g. codes of conduct, quality standards, or worker protection standards),
- Organizational culture and structure, and
- Marketplace conditions.

4.1.1.5 Organizational Process Assets

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

- Organizational standard processes, policies, and process definitions,
- Templates (e.g., project charter template), and
- Historical information and lessons learned knowledge base (e.g., projects, records, and documents; all project closure information and documentation; information about

both the results of previous project selection decisions and previous project performance information; and information from the risk management activity).

4.1.2 Develop Project Charter: Tools and Techniques

4.1.2.1 Expert Judgment

Expert judgment is often used to assess the inputs used to develop the project charter. Expert judgment is applied to all technical and management details during this process. Such expertise is provided by any group or individual with specialized knowledge or training and is available from many sources, including:

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

4.1.2.2 Facilitation Techniques

Facilitation techniques have broad application within project management processes and guide the development of the project charter. Brainstorming, conflict resolution, problem solving, and meeting management are examples of key techniques used by facilitators to help teams and individuals accomplish project activities.

4.1.3 Develop Project Charter: Outputs

4.1.3.1 Project Charter

The project charter is the document issued by the project initiator or sponsor that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities. It documents the business needs, assumptions, constraints, the understanding of the customer's needs and high-level requirements, and the new product, service, or result that it is intended to satisfy, such as:

- Project purpose or justification,
- Measurable project objectives and related success criteria,
- High-level requirements,
- Assumptions and constraints,
- High-level project description and boundaries,
- High-level risks,
- Summary milestone schedule,
- Summary budget,
- Stakeholder list,
- Project approval requirements (i.e., what constitutes project success, who decides the project is successful, and who signs off on the project),
- Assigned project manager, responsibility, and authority level, and

- Name and authority of the sponsor or other person(s) authorizing the project charter.

4.2 Develop Project Management Plan

Develop Project Management Plan is the process of defining, preparing, and coordinating all subsidiary plans and integrating them into a comprehensive project management plan. The key benefit of this process is a central document that defines the basis of all project work. The inputs, tools and techniques, and outputs for this process are depicted in Figure 4-4. Figure 4-5 depicts the data flow diagram of the process.

Figure 4-4. Develop Project Management Plan: Inputs, Tools and Techniques, and Outputs

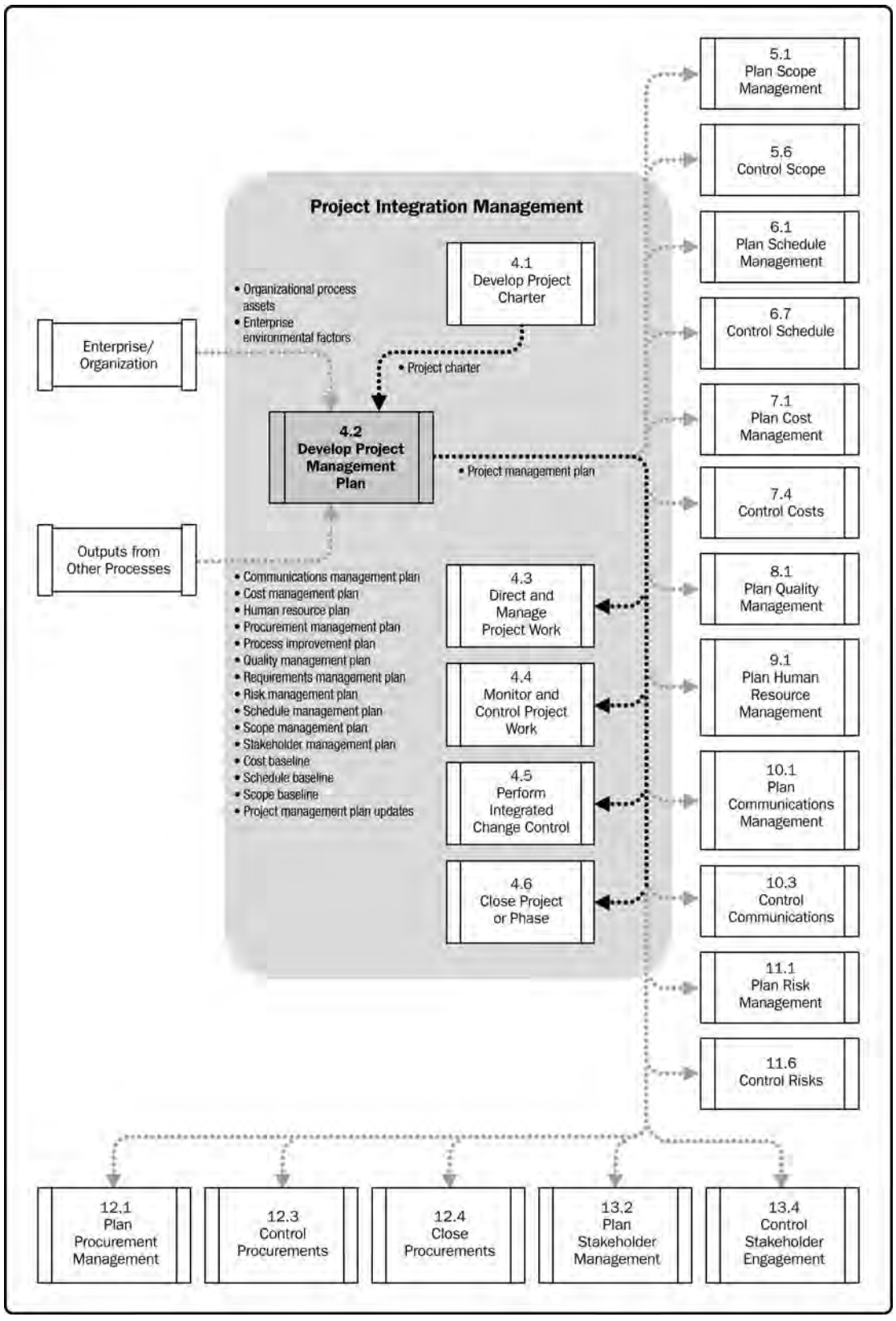

Figure 4-5. Develop Project Management Plan Data Flow Diagram

The project management plan defines how the project is executed, monitored and controlled, and closed. The project management plan's content varies depending upon the application area and complexity of the project. It is developed through a series of integrated processes extending through project closure. This process results in a project management plan that is progressively elaborated by updates, and controlled and approved through the Perform Integrated Change Control (Section 4.5) process. Projects that exist in the context of a program should develop a project management plan that is consistent with the program management plan. For example, if the program management plan indicates all changes exceeding a specified cost need to be reviewed by the change control board (CCB), then this process and cost threshold needs to be defined in the project management plan.

4.2.1 Develop Project Management Plan: Inputs

4.2.1.1 Project Charter

Described in Section 4.1.3.1. The size of the project charter varies depending on the complexity of the project and the information known at the time of its creation. At a minimum, the project charter should define the high-level boundaries of the project. The project manager uses the project charter as the starting point for initial planning throughout the Initiating Process Group.

4.2.1.2 Outputs from Other Processes

Outputs from many of the other processes described in Sections 5 through 13 are integrated to create the project management plan. Any baselines and subsidiary plans that are an output from other planning processes are inputs to this process. In addition, changes to these documents may necessitate updates to the project management plan.

4.2.1.3 Enterprise Environmental Factors

Described in Section 2.1.5. The enterprise environmental factors that can influence the Develop Project Management Plan process include, but are not limited to:

- Governmental or industry standards;
- Project management body of knowledge for vertical market (e.g., construction) and/or focus area (e.g. environmental, safety, risk, or agile software development);
- Project management information system (e.g., an automated tool, such as a scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems);
- Organizational structure, culture, management practices, and sustainability;
- Infrastructure (e.g., existing facilities and capital equipment); and
- Personnel administration (e.g., hiring and termination guidelines, employee performance reviews, and employee development and training records).

4.2.1.4 Organizational Process Assets

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

- Standardized guidelines, work instructions, proposal evaluation criteria, and performance measurement criteria;

- Project management plan template, including:
  - Guidelines and criteria for tailoring the organization's set of standard processes to satisfy the specific needs of the project, and
  - Project closure guidelines or requirements such as the product validation and acceptance criteria;
- Change control procedures, including the steps by which official organization standards, policies, plans, and procedures, or any project documents will be modified and how any changes will be approved and validated;
- Project files from previous projects (e.g., scope, cost, schedule and performance measurement baselines, project calendars, project schedule network diagrams, and risk registers,);
- Historical information and lessons learned knowledge base; and
- Configuration management knowledge base containing the versions and baselines of all official organization standards, policies, procedures, and any project documents.

4.2.2 Develop Project Management Plan: Tools and Techniques

4.2.2.1 Expert Judgment

When developing the project management plan, expert judgment is utilized to:

- Tailor the process to meet the project needs,
- Develop technical and management details to be included in the project management plan,
- Determine resources and skill levels needed to perform project work,
- Define the level of configuration management to apply on the project,
- Determine which project documents will be subject to the formal change control process, and
- Prioritize the work on the project to ensure the project resources are allocated to the appropriate work at the appropriate time.

4.2.2.2 Facilitation Techniques

Described in Section 4.1.2.2. Facilitation techniques have broad application within project management processes and are used to guide the development of the project management plan. Brainstorming, conflict resolution, problem solving, and meeting management are key techniques used by facilitators to help teams and individuals achieve agreement to accomplish project activities.

4.2.3 Develop Project Management Plan: Outputs

4.2.3.1 Project Management Plan

The project management plan is the document that describes how the project will be executed, monitored, and controlled. It integrates and consolidates all of the subsidiary plans and baselines from the planning processes.

Project baselines include, but are not limited to:

- Scope baseline (Section 5.4.3.1),
- Schedule baseline (Section 6.6.3.1), and

- Cost baseline (Section 7.3.3.1).

Subsidiary plans include, but are not limited to:

- Scope management plan (Section 5.1.3.1),
- Requirements management plan (Section 5.1.3.2),
- Schedule management plan (Section 6.1.3.1),
- Cost management plan (Section 7.1.3.1),
- Quality management plan (Section 8.1.3.1),
- Process improvement plan (Section 8.1.3.2),
- Human resource management plan (Section 9.1.3.1),
- Communications management plan (Section 10.1.3.1),
- Risk management plan (Section 11.1.3.1),
- Procurement management plan (Section 12.1.3.1), and
- Stakeholder management plan (Section 13.2.3.1).

Among other things, the project management plan may also include the following:

- Life cycle selected for the project and the processes that will be applied to each phase;
- Details of the tailoring decisions specified by the project management team as follows:
    - Project management processes selected by the project management team,
    - Level of implementation for each selected process,
    - Descriptions of the tools and techniques to be used for accomplishing those processes, and
    - Description of how the selected processes will be used to manage the specific project, including the dependencies and interactions among those processes and the essential inputs and outputs.
- Description of how work will be executed to accomplish the project objectives;
- Change management plan that documents how changes will be monitored and controlled;
- Configuration management plan that documents how configuration management will be performed;
- Description of how the integrity of the project baselines will be maintained;
- Requirements and techniques for communication among stakeholders; and
- Key management reviews for content, the extent of, and timing to address, open issues and pending decisions.

The project management plan may be either summary level or detailed, and may be composed of one or more subsidiary plans. Each of the subsidiary plans is detailed to the extent required by the specific project. Once the project management plan is baselined, it may only be changed when a change request is generated and approved through the Perform Integrated Change Control process.

While the project management plan is one of the primary documents used to manage the project, other project documents are also used. These other documents are not part of the project management plan. Table 4-1 is a representative list of the project management plan components and project documents.

Table 4-1 Differentiation Between the Project Management Plan and Project Documents

Project Management Plan	Project Documents	
Change management plan	Activity attributes	Project staff assignments
Communications management plan	Activity cost estimates	Project statement of work
Configuration management plan	Activity duration estimates	Quality checklists
Cost baseline	Activity list	Quality control measurements
Cost management plan	Activity resource requirements	Quality metrics
Human resource management plan	Agreements	Requirements documentation
Process improvement plan	Basis of estimates	Requirements traceability matrix
Procurement management plan	Change log	Resource breakdown structure
Scope baseline • Project scope statement • WBS • WBS dictionary	Change requests	Resource calendars
Quality management plan	Forecasts • Cost forecast • Schedule forecast	Risk register
Requirements management plan	Issue log	Schedule data
Risk management plan	Milestone list	Seller proposals
Schedule baseline	Procurement documents	Source selection criteria
Schedule management plan	Procurement statement of work	Stakeholder register
Scope management plan	Project calendars	Team performance assessments
Stakeholder management plan	Project charter Project funding requirements Project schedule Project schedule network diagrams	Work performance data Work performance information Work performance reports

4.3 Direct and Manage Project Work

Direct and Manage Project Work is the process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project's objectives. The key benefit of this process is that it provides overall management of the project work. The inputs, tools and techniques, and outputs of this process are depicted in Figure 4-6. Figure 4-7 depicts the data flow diagram of the process.

Figure 4-6. Direct and Manage Project Work: Inputs, Tools and Techniques, and Outputs

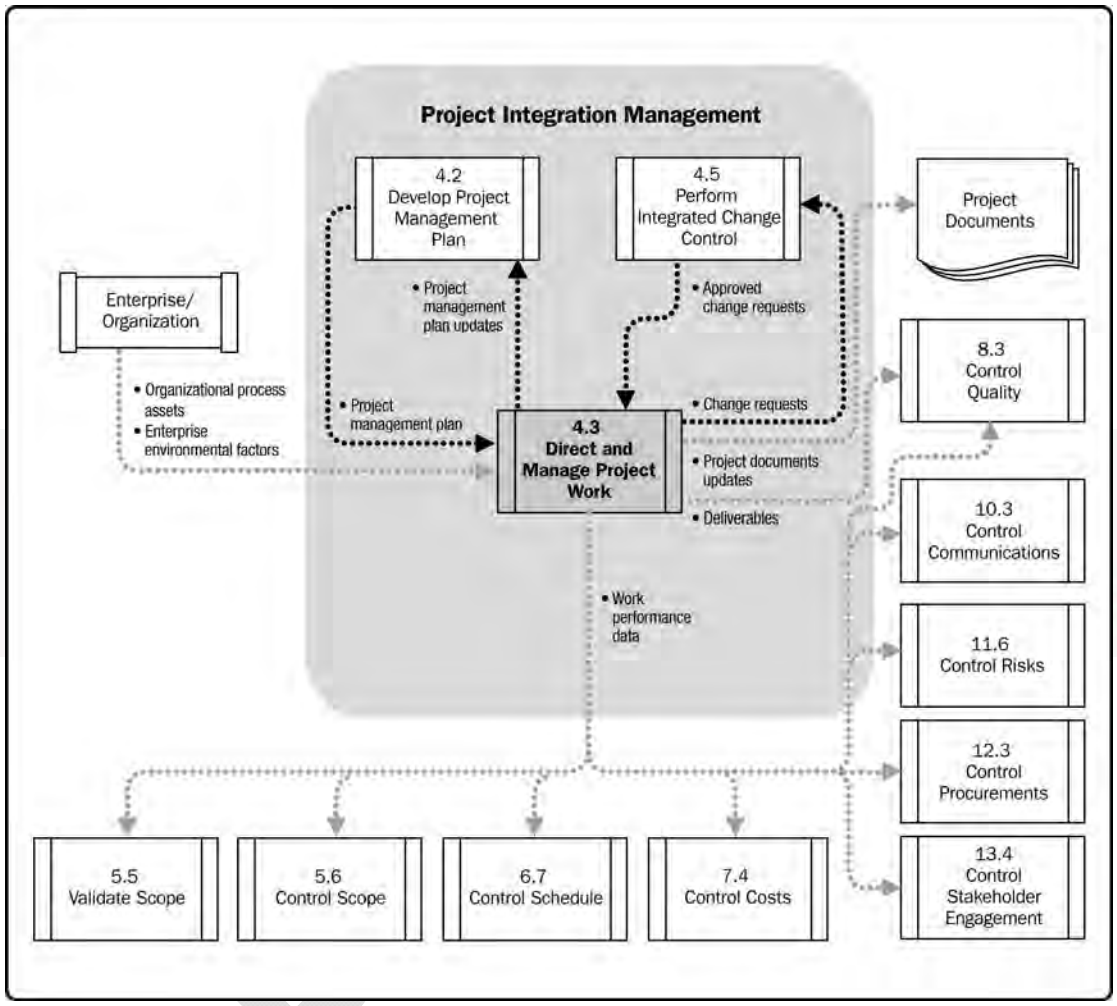

Figure 4-7. Direct and Manage Project Work: Data Flow Diagram

Direct and Manage Project Work activities include, but are not limited to:

- Perform activities to accomplish project objectives;
- Create project deliverables to meet the planned project work;
- Provide, train, and manage the team members assigned to the project;
- Obtain, manage, and use resources including materials, tools, equipment, and facilities;
- Implement the planned methods and standards;
- Establish and manage project communication channels, both external and internal to the project team;
- Generate work performance data, such as cost, schedule, technical and quality progress, and status to facilitate forecasting;
- Issue change requests and implement approved changes into the project's scope, plans, and environment;
- Manage risks and implement risk response activities;
- Manage sellers and suppliers;
- Manage stakeholders and their engagement; and
- Collect and document lessons learned and implement approved process improvement activities.

The project manager, along with the project management team, directs the performance of the planned project activities and manages the various technical and organizational interfaces that exist within the project. The project manager should also manage any unplanned activities and determine the appropriate course of action. The Direct and Manage Project Work process is directly affected by the project application area. Deliverables are produced as outputs from processes performed to accomplish the project work as planned and scheduled in the project management plan.

During project execution, the work performance data is collected and appropriately actioned and communicated. Work performance data includes information about the completion status of deliverables and other relevant details about project performance. The work performance data will also be used as an input to the Monitoring and Controlling Process Group.

Direct and Manage Project Work also requires review of the impact of all project changes and the implementation of approved changes:

- **Corrective action**—An intentional activity that realigns the performance of the project work with the project management plan;
- **Preventive action**—An intentional activity that ensures the future performance of the project work is aligned with the project management plan; and/or
- **Defect repair**—An intentional activity to modify a nonconforming product or product component.

4.3.1 Direct and Manage Project Work: Inputs

4.3.1.1 Project Management Plan

Described in Section 4.2.3.1. The project management plan contains subsidiary plans concerning all aspects of the project. Those subsidiary plans related to project work include, but are not limited to:

- Scope management plan (Section 5.1.3.1),
- Requirements management plan (Section 5.1.3.2),
- Schedule management plan (Section 6.1.3.1),
- Cost management plan (Section 7.1.3.1), and
- Stakeholder management plan (13.2.3.1).

4.3.1.2 Approved Change Requests

Approved change requests are an output of the Perform Integrated Change Control process, and include those requests reviewed and approved for implementation by the change control board (CCB). The approved change request may be a corrective action, a preventative action, or a defect repair. Approved change requests are scheduled and implemented by the project team, and can impact any area of the project or project management plan. The approved change requests can also modify the policies, project management plan, procedures, costs, or budgets or revise the schedules. Approved change requests may require implementation of preventive or corrective actions.

4.3.1.3 Enterprise Environmental Factors

Described in Section 2.1.5. The Direct and Manage Project Work process is influenced by enterprise environmental factors that include, but are not limited to:

- Organizational, company, or customer culture and structure of the performing or sponsor organizations;
- Infrastructure (e.g., existing facilities and capital equipment);
- Personnel administration (e.g., hiring and firing guidelines, employee performance reviews, and training records);
- Stakeholder risk tolerances, for example allowable cost overrun percentage; and
- Project management information system (e.g., an automated tool suite, such as a scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems).

4.3.1.4 Organizational Process Assets

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

- Standardized guidelines and work instructions;
- Communication requirements defining allowed communication media, record retention, and security requirements;
- Issue and defect management procedures defining issue and defect controls, issue and defect identification and resolution, and action item tracking;

- Process measurement database used to collect and make available measurement data on processes and products;
- Project files from previous projects (e.g., scope, cost, schedule, performance measurement baselines, project calendars, project schedule, network diagrams, risk registers, planned response actions, defined risk impact, and documented lessons learned); and
- Issue and defect management database(s) containing historical issue and defect status, control information, issue and defect resolution, and action item results.

4.3.2 Direct and Manage Project Work: Tools and Techniques

4.3.2.1 Expert Judgment

Expert judgment is used to assess the inputs needed to direct and manage execution of the project management plan. Such judgment and expertise are applied to all technical and management details during this process. This expertise is provided by the project manager and the project management team using specialized knowledge or training. Additional expertise is available from many sources, including:

- Other units within the organization;
- Consultants and other subject matter experts (internal and external);
- Stakeholders, including customers, suppliers, or sponsors; and
- Professional and technical associations.

4.3.2.2 Project Management Information System

The project management information system, which is part of the environmental factors, provides access to tools, such as a scheduling tool, a work authorization system, a configuration management system, an information collection and distribution system, or interfaces to other online automated systems. Automated gathering and reporting on key performance indicators (KPI) can be part of this system.

4.3.2.3 Meetings

Meetings are used to discuss and address pertinent topics of the project when directing and managing project work. Attendees at the meetings may include the project manager, the project team and appropriate stakeholders involved or affected by the topics addressed. Each attendee should have a defined role to ensure appropriate participation. Meetings tend to be one of three types:

- Information exchange;
- Brainstorming, option evaluation, or design; or
- Decision making.

Meeting types should not be mixed as a best practice. Meetings should be prepared with a well-defined agenda, purpose, objective, and time frame and should be appropriately documented with meeting minutes and action items. Meeting minutes should be stored as defined in the project management plan. Meetings are most effective when all participants can be face-to-face in the same location. Virtual meetings can be held using audio and/or video conferencing tools, but generally require additional preparation and organization to achieve the same effectiveness of a face-to-face meeting.

4.3.3 Direct and Manage Project Work: Outputs

4.3.3.1 Deliverables

A deliverable is any unique and verifiable product, result or capability to perform a service that is required to be produced to complete a process, phase, or project. Deliverables are typically tangible components completed to meet the project objectives and can include elements of the project management plan.

4.3.3.2 Work Performance Data

Work performance data are the raw observations and measurements identified during activities being performed to carry out the project work. Data are often viewed as the lowest level of detail from which information is derived by other processes. Data is gathered through work execution and passed to the controlling processes of each process area for further analysis.

Examples of work performance data include work completed, key performance indicators, technical performance measures, start and finish dates of schedule activities, number of change requests, number of defects, actual costs, and actual durations, etc.

4.3.3.3 Change Requests

A change request is a formal proposal to modify any document, deliverable, or baseline. An approved change request will replace the associated document, deliverable, or baseline and may result in an update to other parts of the project management plan. When issues are found while project work is being performed, change requests are submitted, which may modify project policies or procedures, project scope, project cost or budget, project schedule, or project quality. Other change requests cover the needed preventive or corrective actions to forestall negative impact later in the project. Requests for a change can be direct or indirect, externally or internally initiated, and can be optional or legally/contractually mandated, and may include:

- **Corrective action**—An intentional activity that realigns the performance of the project work with the project management plan;
- **Preventive action**—An intentional activity that ensures the future performance of the project work is aligned with the project management plan;
- **Defect repair**—An intentional activity to modify a nonconforming product or product component; and/or
- **Updates**—Changes to formally controlled project documents, plans, etc., to reflect modified or additional ideas or content.

4.3.3.4 Project Management Plan Updates

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

- Scope management plan,
- Requirements management plan,
- Schedule management plan,
- Cost management plan,
- Quality management plan,
- Process improvement plan,

- Human resource management plan,
- Communications management plan,
- Risk management plan,
- Procurement management plan,
- Stakeholder management plan, and
- Project baselines.

4.3.3.5 Project Documents Updates

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

- Requirements documentation,
- Project logs (issues, assumptions, etc.),
- Risk register, and
- Stakeholder register.

4.4 Monitor and Control Project Work

Monitor and Control Project Work is the process of tracking, reviewing, and reporting the progress to meet the performance objectives defined in the project management plan. The key benefit of this process is that it allows stakeholders to understand the current state of the project, the steps taken, and budget, schedule, and scope forecasts. The inputs, tools and techniques, and outputs for this process are depicted in Figure 4-8. Figure 4-9 depicts the data flow diagram of the process.

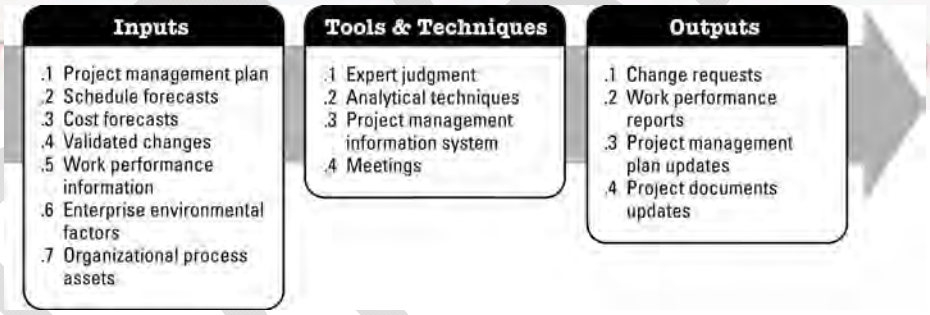

Figure 4-8. Monitor and Control Project Work: Inputs, Tools & Techniques, and Outputs

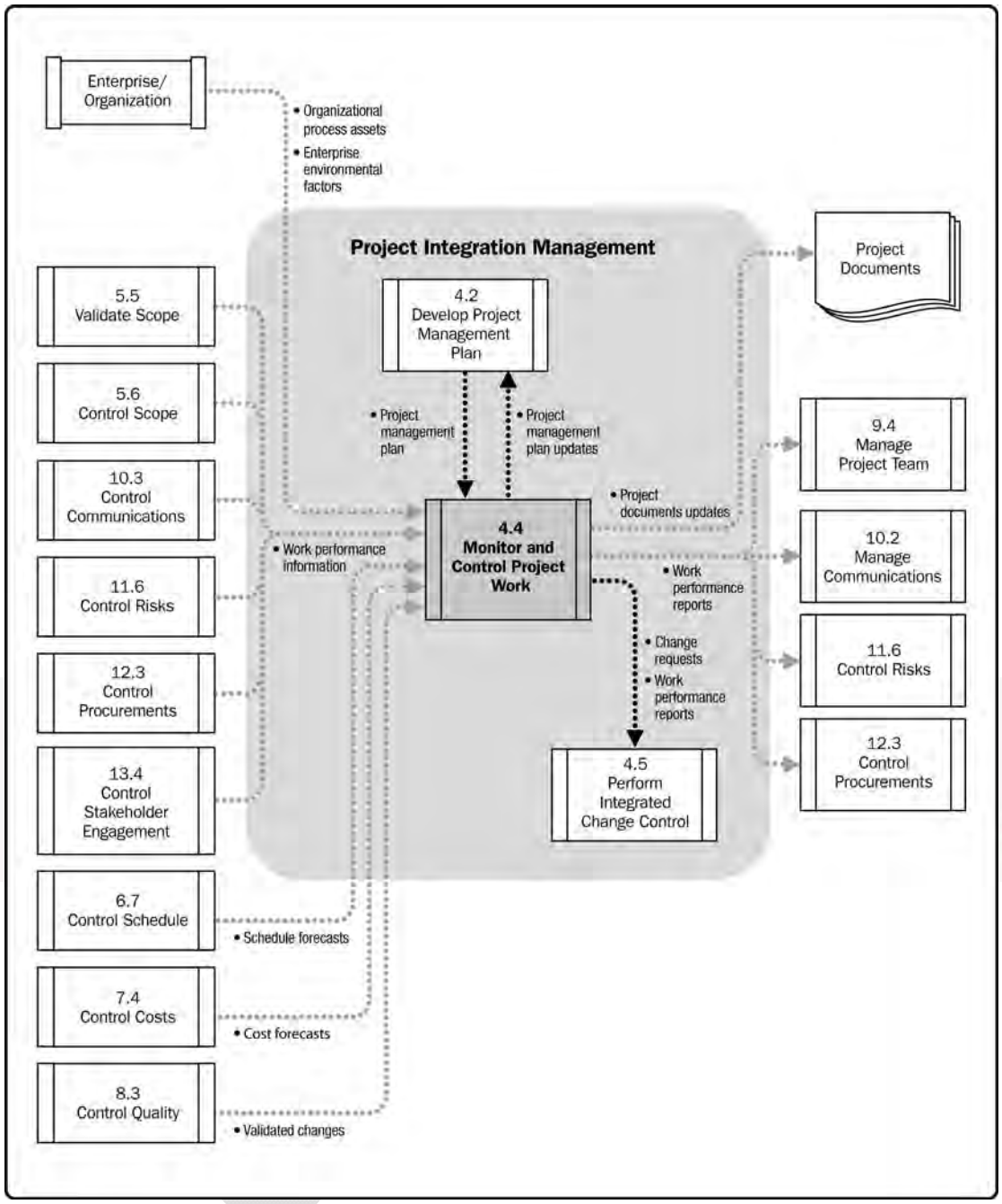

Figure 4-9. Monitor and Control Project Work Data Flow Diagram

Monitoring is an aspect of project management performed throughout the project. Monitoring includes collecting, measuring, and distributing performance information, and assessing measurements and trends to effect process improvements. Continuous monitoring gives the project management team insight into the health of the project and identifies any areas that may require special attention. Control includes determining corrective or preventive actions or replanning and following up on action plans to determine whether the actions taken resolved the performance issue. The Monitor and Control Project Work process is concerned with:

- Comparing actual project performance against the project management plan;
- Assessing performance to determine whether any corrective or preventive actions are indicated, and then recommending those actions as necessary;
- Identifying new risks and analyzing, tracking, and monitoring existing project risks to make sure the risks are identified, their status is reported, and that appropriate risk response plans are being executed;
- Maintaining an accurate, timely information base concerning the project's product(s) and their associated documentation through project completion;
- Providing information to support status reporting, progress measurement, and forecasting;
- Providing forecasts to update current cost and current schedule information;
- Monitoring implementation of approved changes as they occur; and
- Providing appropriate reporting on project progress and status to program management when the project is part of an overall program.

4.4.1 Monitor and Control Project Work: Inputs

4.4.1.1 Project Management Plan

Described in Section 4.2.3.1. Monitoring and controlling project work involves looking at all aspects of the project. Subsidiary plans within the project management plan form the basis for controlling the project. Subsidiary plans and baselines include, but are not limited to:

- Scope management plan (Section 5.1.3.1),
- Requirements management plan (Section 5.1.3.2),
- Schedule management plan (Section 6.1.3.1),
- Cost management plan (Section 7.1.3.1),
- Quality management plan (Section 8.1.3.1),
- Process improvement plan (Section 8.1.3.2),
- Human resource management plan (Section 9.1.3.1),
- Communications management plan (Section 10.1.3.1),
- Risk management plan (Section 11.1.3.1),
- Procurement management plan (Section 12.1.3.1),
- Stakeholder management plan (Section 13.2.3.1),
- Scope baseline (Section 5.4.3.1),
- Schedule baseline (Section 6.6.3.1), and
- Cost baseline (Section 7.3.3.1).

4.4.1.2 Schedule Forecasts

Described in Section 6.7.3.2. The schedule forecasts are derived from progress against the schedule baseline and computed time estimate to complete (ETC_t). This is typically expressed in terms of schedule variance (SV) and schedule performance index (SPI). For projects not using earned value management, variances against the planned finish dates and forecasted finish dates are provided.

The forecast may be used to determine if the project is still within defined tolerance ranges and identify any necessary change requests.

4.4.1.3 Cost Forecasts

Described in Section 7.4.3.2. The cost forecasts are derived from progress against the cost baseline and computed estimates to complete (ETC). This is typically expressed in terms of cost variance (CV) and cost performance index (CPI). An estimate at completion (EAC) can be compared to the budget at completion (BAC) to see if the project is still within tolerance ranges or if a change request is required. For projects not using earned value management, variances against the planned versus actual expenditures and forecasted final costs are provided.

4.4.1.4 Validated Changes

Described in Section 8.3.3.2. Approved changes that result from the Perform Integrated Change Control process require validation to ensure that the change was appropriately implemented. A validated change provides the necessary data to confirm that the change was appropriately executed.

4.4.1.5 Work Performance Information

Work performance information is the performance data collected from various controlling processes, analyzed in context, and integrated based on relationships across areas. Thus work performance data has been transformed into work performance information. Data in itself cannot be used in the decision-making process as it has only out-of-context meaning. Work performance information, however, is correlated and contextualized, and provides a sound foundation for project decisions.

Work performance information is circulated through communication processes. Examples of performance information are status of deliverables, implementation status for change requests, and forecasted estimates to complete.

4.4.1.6 Enterprise Environmental Factors

Described in Section 2.1.5. The enterprise environmental factors that can influence the Monitor and Control Project Work process include, but are not limited to:

- Governmental or industry standards (e.g., regulatory agency regulations, codes of conduct, product standards, quality standards, and workmanship standards),
- Organization work authorization systems,
- Stakeholder risk tolerances, and
- Project management information system (e.g., an automated tool suite, such as a scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems).

4.4.1.7 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that can influence the Monitor and Control Project Work process include, but are not limited to:

- Organizational communication requirements;
- Financial controls procedures (e.g., time reporting, required expenditure and disbursement reviews, accounting codes and standard contract provisions);

- Issue and defect management procedures defining issue and defect controls, issue and defect identification, and resolution and action item tracking;
- Change control procedures, including those for scope, schedule, cost, and quality variances;
- Risk control procedures including risk categories, probability definition and impact, and probability and impact matrix;
- Process measurement database used to make available measurement data on processes and products; and
- Lessons learned database.

4.4.2 Monitor and Control Project Work: Tools and Techniques

4.4.2.1 Expert Judgment

Expert judgment is used by the project management team to interpret the information provided by the monitor and control processes. The project manager, in collaboration with the team, determines the actions required to ensure project performance matches expectations.

4.4.2.2 Analytical Techniques

Analytical techniques are applied in project management to forecast potential outcomes based on possible variations of project or environmental variables and their relationships with other variables. Examples of analytical techniques used in projects are:

- Regression analysis,
- Grouping methods,
- Causal analysis,
- Root cause analysis,
- Forecasting methods (e.g., time series, scenario building, simulation, etc.),
- Failure mode and effect analysis (FMEA),
- Fault tree analysis (FTA),
- Reserve analysis,
- Trend analysis,
- Earned value management,
- Variance analysis, and
- Forecasting methods.

4.4.2.3 Project Management Information System

The project management information system, which is part of enterprise environmental factors, provides access to automated tools, such as scheduling, cost, and resourcing tools, performance indicators, databases, project records, and financials used during the Monitor and Control Project Work process.

4.4.2.4 Meetings

Described in Section 4.3.2.3. Meetings may be face-to-face, virtual, formal, or informal. They may include project team members, stakeholders, and others involved in or affected by the project. Types of meetings include, but are not limited to, user groups and review meetings.

4.4.3 Monitor and Control Project Work: Outputs

4.4.3.1 Change Requests

As a result of comparing planned results to actual results, change requests may be issued to expand, adjust, or reduce project scope, product scope, or quality requirements and schedule or cost baselines. Change requests may necessitate the collection and documentation of new requirements. Changes can impact the project management plan, project documents, or product deliverables. Changes that meet the project's change control criteria should go through the integrated change control process established for the project. Changes may include, but are not limited to, the following:

- **Corrective action—**An intentional activity that realigns the performance of the project work with the project management plan;
- **Preventive action**—An intentional activity that ensures the future performance of the project work is aligned with the project management plan; and
- **Defect repair**—An intentional activity to modify a nonconforming product or product component.

4.4.3.2 Work Performance Reports

Work performance reports are the physical or electronic representation of work performance information compiled in project documents, intended to generate decisions, actions, or awareness. Project information may be communicated verbally from person to person. However, in order to record, store, and sometimes distribute work performance information, a physical or electronic representation in the form of project documents is required. Work performance reports are a subset of project documents, which are intended to create awareness and generate decisions or actions. Specific work performance metrics may be defined at the start of the project and included in the normal work performance reports provided to key stakeholders.

Examples of work performance reports include status reports, memos, justifications, information notes, recommendations, and updates.

4.4.3.3 Project Management Plan Updates

Changes identified during the Monitor and Control Project Work process may affect the overall project management plan. These changes, after being processed through the appropriate change control process can lead to project management plan updates. Project management plan elements that may be updated include, but are not limited to:

- Scope management plan (Section 5.1.3.1),
- Requirements management plan (Section 5.1.3.2),
- Schedule management plan (Section 6.1.3.1),
- Cost management plan (Section 7.1.3.1),
- Quality management plan (Section 8.1.3.1),
- Scope baseline (Section 5.4.3.1),
- Schedule baseline (Section 6.6.3.1), and
- Cost baseline (Section 7.3.3.1).

4.4.3.4 Project Documents Updates

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

- Schedule and cost forecasts,
- Work performance reports, and
- Issue log.

4.5 Perform Integrated Change Control

Perform Integrated Change Control is the process of reviewing all change requests; approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan; and communicating their disposition. It reviews all requests for changes or modifications to project documents, deliverables, baselines, or the project management plan and approves or rejects the changes. The key benefit of this process is that it allows for documented changes within the project to be considered in an integrated fashion while reducing project risk, which often arises from changes made without consideration to the overall project objectives or plans. The inputs, tools and techniques, and outputs of this process are depicted in Figure 4-10. Figure 4-11 depicts the data flow diagram of the process.

Figure 4-10. Perform Integrated Change Control: Inputs, Tools & Techniques, and Outputs

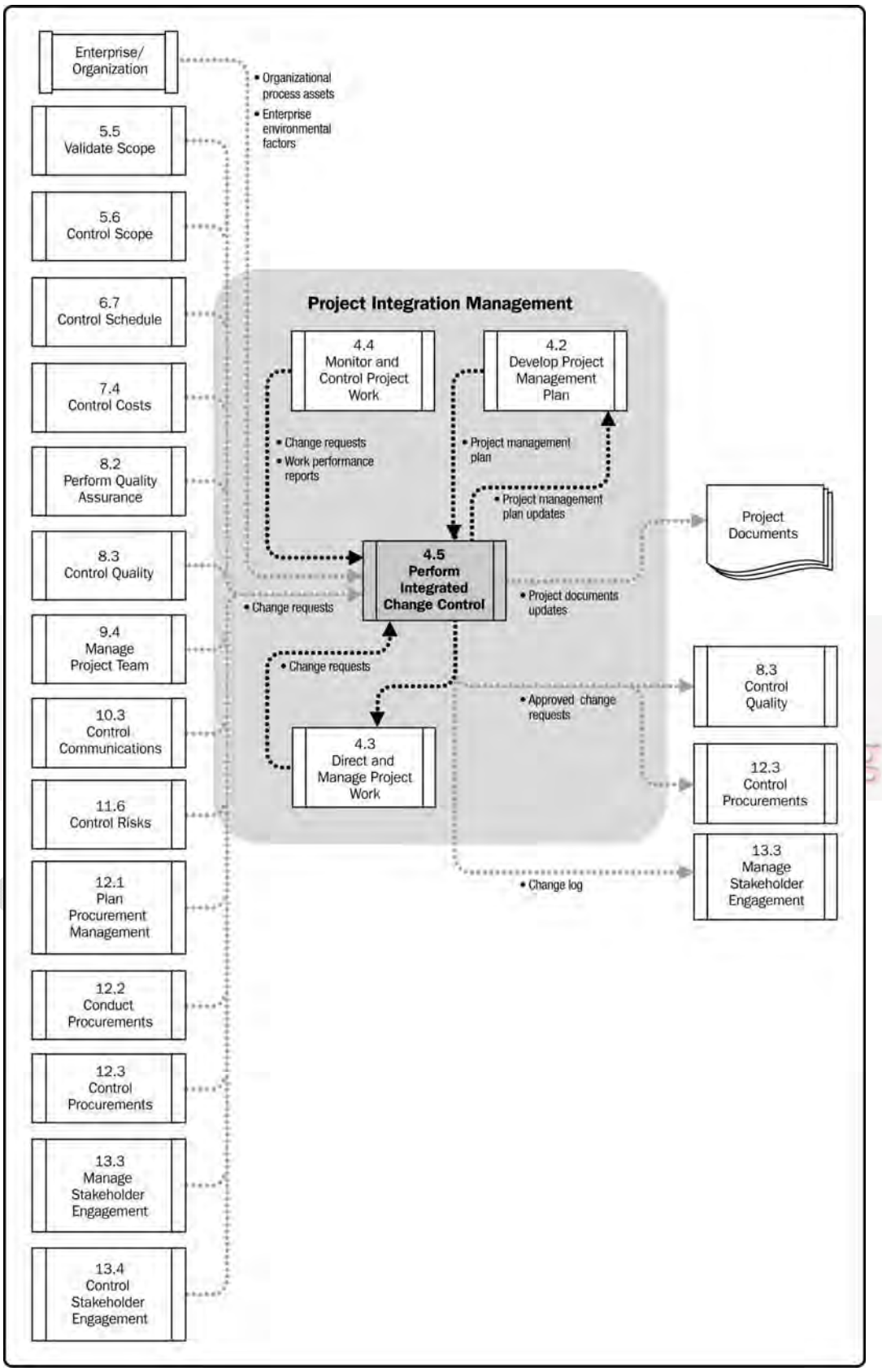

Figure 4-11. Perform Integrated Change Control Data Flow Diagram

The Perform Integrated Change Control process is conducted from project inception through completion and is the ultimate responsibility of the project manager. The project management plan, the project scope statement, and other deliverables are maintained by carefully and continuously managing changes, either by rejecting changes or by approving changes, thereby assuring that only approved changes are incorporated into a revised baseline.

Changes may be requested by any stakeholder involved with the project. Although changes may be initiated verbally, they should be recorded in written form and entered into the change management and/or configuration management system. Change requests are subject to the process specified in the change control and configuration control systems. Those change request processes may require information on estimated time impacts and estimated cost impacts.

Every documented change request needs to be either approved or rejected by a responsible individual, usually the project sponsor or project manager. The responsible individual will be identified in the project management plan or by organizational procedures. When required, the Perform Integrated Change Control process includes a change control board (CCB), which is a formally chartered group responsible for reviewing, evaluating, approving, delaying, or rejecting changes to the project, and for recording and communicating such decisions. Approved change requests can require new or revised cost estimates, activity sequences, schedule dates, resource requirements, and analysis of risk response alternatives. These changes can require adjustments to the project management plan and other project documents. The applied level of change control is dependent upon the application area, complexity of the specific project, contract requirements, and the context and environment in which the project is performed. Customer or sponsor approval may be required for certain change requests after CCB approval, unless they are part of the CCB.

Configuration control is focused on the specification of both the deliverables and the processes; while change control is focused on identifying, documenting, and approving or rejecting changes to the project documents, deliverables, or baselines.

Some of the configuration management activities included in the Perform Integrated Change Control process are as follows:

- **Configuration identification.** Identification and selection of a configuration item to provide the basis for which the product configuration is defined and verified, products and documents are labeled, changes are managed, and accountability is maintained.
- **Configuration status accounting.** Information is recorded and reported as to when appropriate data about the configuration item should be provided. This information includes a listing of approved configuration identification, status of proposed changes to the configuration, and the implementation status of approved changes.
- **Configuration verification and audit.** Configuration verification and configuration audits ensure the composition of a project's configuration items is correct and that corresponding changes are registered, assessed, approved, tracked, and correctly implemented. This ensures the functional requirements defined in the configuration documentation have been met.

4.5.1 Perform Integrated Change Control: Inputs

4.5.1.1 Project Management Plan

Described in Section 4.2.3.1. Elements of the project management plan that may be used include, but are not limited to:

- Scope management plan, which contains the procedures for scope changes;
- Scope baseline, which provides product definition; and
- Change management plan, which provides the direction for managing the change control process and documents the formal change control board (CCB).

Changes are documented and updated within the project management plan as part of the change and configuration management processes.

4.5.1.2 Work Performance Reports

Described in Section 4.4.3.2. Work performance reports of particular interest to the Perform Integrated Change Control process include resource availability, schedule and cost data, and earned value management (EVM) reports, burnup or burndown charts.

4.5.1.3 Change Requests

All of the Monitoring and Controlling processes and many of the Executing processes produce change requests as an output. Change requests may include corrective action, preventive action, and defect repairs. However, corrective and preventive actions do not normally affect the project baselines—only the performance against the baselines.

4.5.1.4 Enterprise Environmental Factors

Described in Section 2.1.5. The following enterprise environmental factor can influence the Perform Integrated Change Control process: project management information system. The project management information system may include the scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems.

4.5.1.5 Organizational Process Assets

Described in Section 2.1.4. The organizational process assets that can influence the Perform Integrated Change Control process include, but are not limited to:

- Change control procedures, including the steps by which official organization standards, policies, plans, and other project documents will be modified, and how any changes will be approved, validated, and implemented;
- Procedures for approving and issuing change authorizations;
- Process measurement database used to collect and make available measurement data on processes and products;
- Project documents (e.g., scope, cost, and schedule baselines, project calendars, project schedule network diagrams, risk registers, planned response actions, and defined risk impact); and
- Configuration management knowledge base containing the versions and baselines of all official organization standards, policies, procedures, and any project documents.

4.5.2 Perform Integrated Change Control: Tools and Techniques

4.5.2.1 Expert Judgment

In addition to the project management team's expert judgment, stakeholders may be asked to provide their expertise and may be asked to sit on the change control board (CCB). Such judgment and expertise are applied to any technical and management details during this process and may be provided by various sources, for example:

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

4.5.2.2 Meetings

In this case, these meetings are usually referred to as change control meetings. When needed for the project, a change control board (CCB) is responsible for meeting and reviewing the change requests and approving, rejecting, or other disposition of those changes. The CCB may also review configuration management activities. The roles and responsibilities of these boards are clearly defined and agreed upon by appropriate stakeholders and documented in the change management plan. CCB decisions are documented and communicated to the stakeholders for information and follow-up actions.

4.5.2.3 Change Control Tools

In order to facilitate configuration and change management, manual or automated tools may be used. Tool selection should be based on the needs of the project stakeholders including organizational and environmental considerations and/or constraints.

Tools are used to manage the change requests and the resulting decisions. Additional considerations should be made for communication to assist the CCB members in their duties as well as distribute the decisions to the appropriate stakeholders.

4.5.3 Perform Integrated Change Control: Outputs

4.5.3.1 Approved Change Requests

Change requests are processed according to the change control system by the project manager, CCB, or by an assigned team member. Approved change requests will be implemented through the Direct and Manage Project Work process. The disposition of all change requests, approved or not, will be updated in the change log as part of updates to the project documents.

4.5.3.2 Change Log

A change log is used to document changes that occur during a project. These changes and their impact to the project in terms of time, cost, and risk, are communicated to the appropriate stakeholders. Rejected change requests are also captured in the change log.

4.5.3.3 Project Management Plan Updates

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

- Any subsidiary plans, and
- Baselines that are subject to the formal change control process.

Changes to baselines should only show the changes from the current time forward. Past performance may not be changed. This protects the integrity of the baselines and the historical data of past performance.

4.5.3.4 Project Documents Updates

Project documents that may be updated as a result of the Perform Integrated Change Control process include all documents specified as being subject to the project's formal change control process.

4.6 Close Project or Phase

Close Project or Phase is the process of finalizing all activities across all of the Project Management Process Groups to formally complete the project or phase. The key benefit of this process is that it provides lessons learned, the formal ending of project work, and the release of organization resources to pursue new endeavors. The inputs, tools and techniques, and outputs of this process are depicted in Figure 4-12. Figure 4-13 depicts the data flow diagram of the process.

Figure 4-12. Close Project or Phase: Inputs, Tools & Techniques, and Outputs

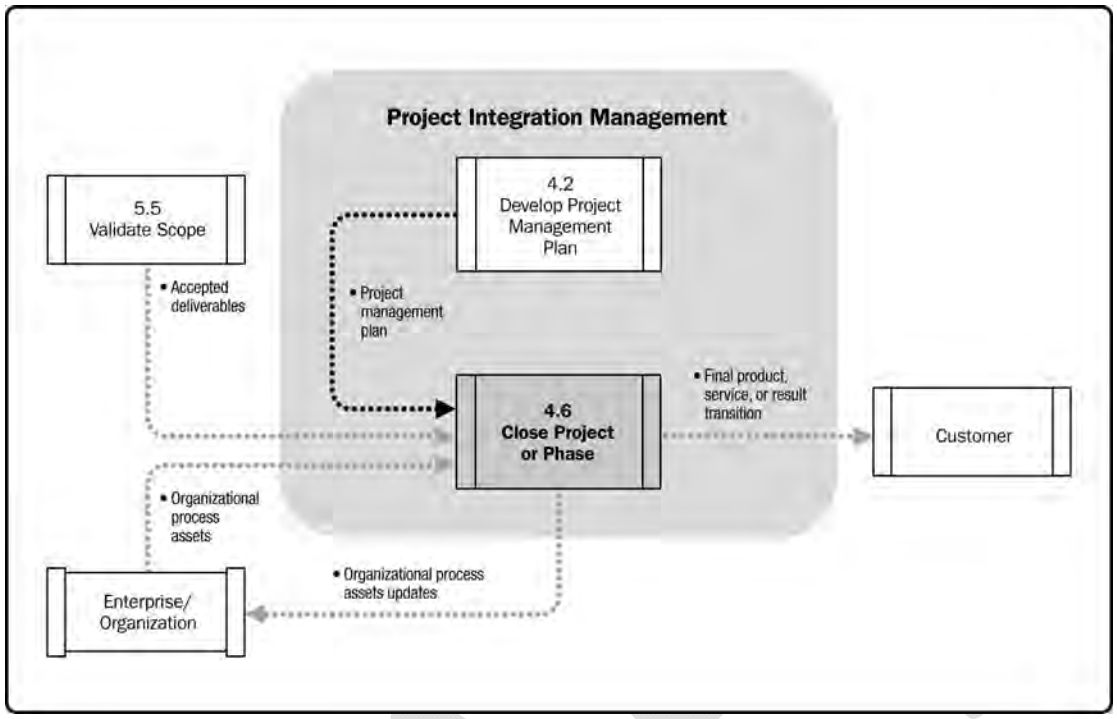

Figure 4-13. Close Project or Phase Data Flow Diagram

When closing the project, the project manager reviews all prior information from the previous phase closures to ensure that all project work is completed and that the project has met its objectives. Since project scope is measured against the project management plan, the project manager reviews the scope baseline to ensure completion before considering the project closed. The Close Project or Phase process also establishes the procedures to investigate and document the reasons for actions taken if a project is terminated before completion. In order to successfully achieve this, the project manager needs to engage all the proper stakeholders in the process.

This includes all planned activities necessary for administrative closure of the project or phase, including step-by-step methodologies that address:

- Actions and activities necessary to satisfy completion or exit criteria for the phase or project;
- Actions and activities necessary to transfer the project's products, services, or results to the next phase or to production and/or operations; and
- Activities needed to collect project or phase records, audit project success or failure, gather lessons learned and archive project information for future use by the organization.

4.6.1 Close Project or Phase: Inputs

4.6.1.1 Project Management Plan

Described in Section 4.2.3.1. The project management plan becomes the agreement between the project manager and project sponsor, defining what constitutes project completion.

4.6.1.2 Accepted Deliverables

Described in Section 5.5. Accepted deliverables may include approved product specifications, delivery receipts, and work performance documents. Partial or interim deliverables may also be included for phased or cancelled projects.

4.6.1.3 Organizational Process Assets

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

- Project or phase closure guidelines or requirements (e.g., administrative procedures, project audits, project evaluations, and transition criteria); and
- Historical information and lessons learned knowledge base (e.g., project records and documents, all project closure information and documentation, information about both the results of previous project selection decisions and previous project performance information, and information from risk management activities).

4.6.2 Close Project or Phase: Tools and Techniques

4.6.2.1 Expert Judgment

Expert judgment is applied when performing administrative closure activities. These experts ensure the project or phase closure is performed to the appropriate standards. Expertise is available from many sources, including but not limited to

- Other project managers within the organization,
- Project management office (PMO), and
- Professional and technical associations.

4.6.2.2 Analytical Techniques

Described in Section 4.4.2.2. Examples of analytical techniques used in project closeout are:

- Regression analysis, and
- Trend analysis.

4.6.2.3 Meetings

Described in Section 4.3.2.3. Meetings may be face-to-face, virtual, formal, or informal. This may include project team members and other stakeholders, involved in or affected by the project. Types of meetings include, but are not limited to lessons learned, closeout, user group, and review meetings.

4.6.3 Close Project or Phase: Outputs

4.6.3.1 Final Product, Service, or Result Transition

This output refers to the transition of the final product, service, or result that the project was authorized to produce (or in the case of phase closure, the intermediate product, service, or result of that phase).

4.6.3.2 Organizational Process Assets Updates

The organizational process assets that are updated as a result of the Close Project or Phase process include, but are not limited to:

- **Project files**—Documentation resulting from the project's activities, for example, project management plan; scope, cost, schedule, and project calendars; risk registers and other registers; change management documentation; planned risk response actions; and risk impact.
- **Project or phase closure documents**—Project or phase closure documents, consisting of formal documentation that indicates completion of the project or phase and the transfer of the completed project or phase deliverables to others, such as an operations group or to the next phase. During project closure, the project manager reviews prior phase documentation, customer acceptance documentation from the Validate Scope process (Section 5.4), and the contract (if applicable), to ensure that all project requirements are completed prior to finalizing the closure of the project. If the project was terminated prior to completion, the formal documentation indicates why the project was terminated and formalizes the procedures for the transfer of the finished and unfinished deliverables of the cancelled project to others.
- **Historical information**—Historical information and lessons learned information are transferred to the lessons learned knowledge base for use by future projects or phases. This can include information on issues and risks as well as techniques that worked well that can be applied to future projects.

5

PROJECT SCOPE MANAGEMENT

Project Scope Management includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. Managing the project scope is primarily concerned with defining and controlling what is and is not included in the project.

Figure 5-1 provides an overview of the Project Scope Management processes, which include the following:

5.1 Plan Scope Management—The process of creating a scope management plan that documents how the project scope will be defined, validated, and controlled.

5.2 Collect Requirements—The process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives.

5.3 Define Scope—The process of developing a detailed description of the project and product.

5.4 Create WBS—The process of subdividing project deliverables and project work into smaller, more manageable components.

5.5 Validate Scope—The process of formalizing acceptance of the completed project deliverables.

5.6 Control Scope—The process of monitoring the status of the project and product scope and managing changes to the scope baseline.

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

In the project context, the term scope can refer to:

- **Product scope.** The features and functions that characterize a product, service, or result; and/or
- **Project scope.** The work performed to deliver a product, service, or result with the specified features and functions. The term project scope is sometimes viewed as including product scope.

The processes used to manage project scope, as well as the supporting tools and techniques, can vary by project. The scope baseline for the project is the approved version of the project scope statement, work breakdown structure (WBS), and its associated WBS dictionary. A baseline can be changed only through formal change control procedures and is used as a basis for comparison while performing Validate Scope and Control Scope processes as well as other controlling processes.

Completion of the project scope is measured against the project management plan (Section 4.2.3.1). Completion of the product scope is measured against the product requirements (Section 5.2). The Project Scope Management processes need to be well integrated with the other

Knowledge Area processes, so that the work of the project will result in delivery of the specified product scope.

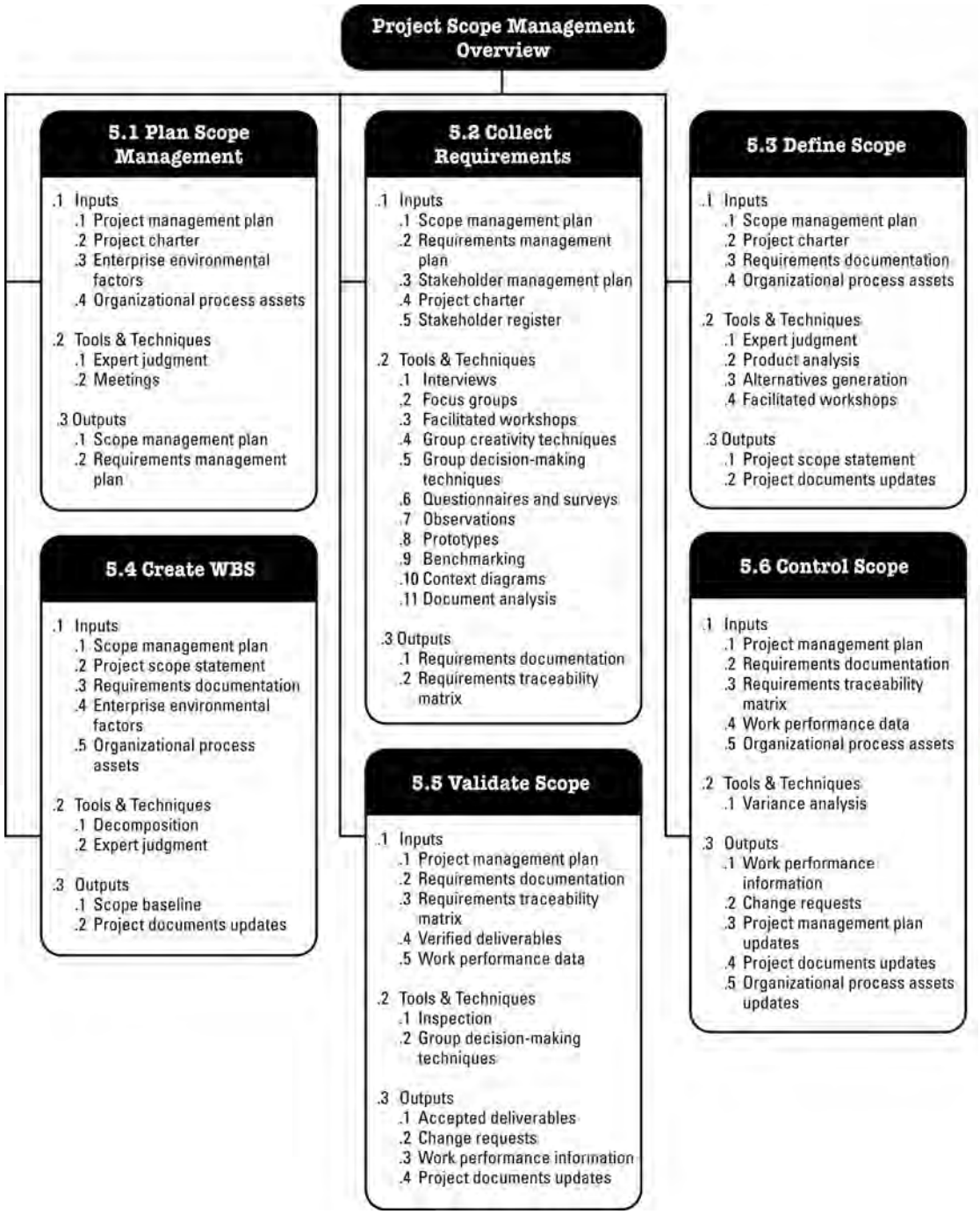

Figure 5-1. Project Scope Management Overview

5.1 Plan Scope Management

Plan Scope Management is the process of creating a scope management plan that documents how the project scope will be defined, validated, and controlled. The key benefit of this process is that it provides guidance and direction on how scope will be managed throughout

the project. The inputs, tools and techniques, and outputs of this process are depicted in Figure 5-2. Figure 5-3 depicts the data flow diagram of the process.

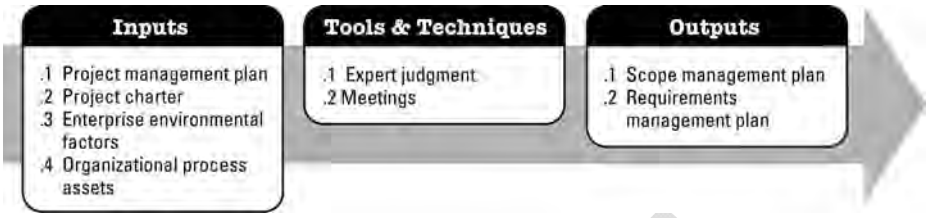

Figure 5-2. Plan Scope Management: Inputs, Tools & Techniques, and Outputs

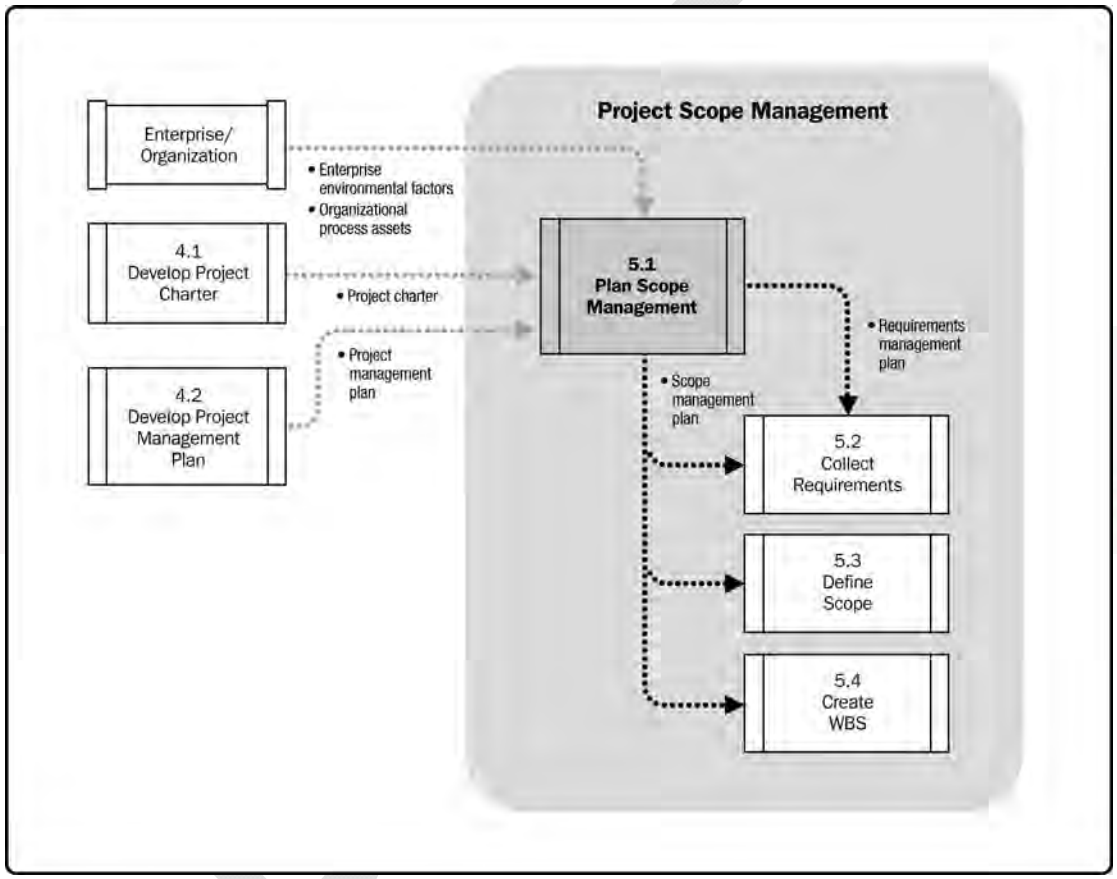

Figure 5-3. Plan Scope Management Data Flow Diagram

The scope management plan is a component of the project or program management plan that describes how the scope will be defined, developed, monitored, controlled, and verified. The development of the scope management plan and the detailing of the project scope begin with the analysis of information contained in the project charter (Section 4.1.3.1), the latest approved subsidiary plans of the project management plan (Section 4.2.3.1), historical information contained in the organizational process assets (Section 2.1.4), and any other relevant enterprise environmental factors (Section 2.1.5). This plan helps reduce the risk of project scope creep.

5.1.1 Plan Scope Management: Inputs

5.1.1.1 Project Management Plan

Described in Section 4.2.3.1. Approved subsidiary plans of the project management plan are used to create the scope management plan and influence the approach taken for planning scope and managing project scope.

5.1.1.2 Project Charter

Described in Section 4.1.3.1. The project charter is used to provide the project context needed to plan the scope management processes. It provides the high-level project description and product characteristics from the project statement of work.

5.1.1.3 Enterprise Environmental Factors

Described in Section 2.1.5. The enterprise environmental factors that can influence the Plan Scope Management process include, but are not limited to:

- Organization's culture,
- Infrastructure,
- Personnel administration, and
- Marketplace conditions.

5.1.1.4 Organizational Process Assets

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

- Policies and procedures, and
- Historical information and lessons learned knowledge base.

5.1.2 Plan Scope Management: Tools and Techniques

5.1.2.1 Expert Judgment

Expert judgment refers to input received from knowledgeable and experienced parties. Expertise may be provided by any group or person with specialized education, knowledge, skill, experience, or training in developing scope management plans.

5.1.2.2 Meetings

Project teams may attend project meetings to develop the scope management plan. Attendees at these meetings may include the project manager, the project sponsor, selected project team members, selected stakeholders, anyone with responsibility for any of the scope management processes, and others as needed.

5.1.3 Plan Scope Management: Outputs

5.1.3.1 Scope Management Plan

The scope management plan is a component of the project or program management plan that describes how the scope will be defined, developed, monitored, controlled, and verified. The scope management plan is a major input into the Develop Project Management Plan process, and the other scope management processes. The components of a scope management plan include:

- Process for preparing a detailed project scope statement;

- Process that enables the creation of the WBS from the detailed project scope statement;
- Process that establishes how the WBS will be maintained and approved;
- Process that specifies how formal acceptance of the completed project deliverables will be obtained; and
- Process to control how requests for changes to the detailed project scope statement will be processed. This process is directly linked to the Perform Integrated Change Control process (Section 4.5).

The scope management plan can be formal or informal, broadly framed or highly detailed, based on the needs of the project.

5.1.3.2 Requirements Management Plan

The requirements management plan is a component of the project management plan that describes how requirements will be analyzed, documented, and managed. The phase-to-phase relationship, described in Section 2.4.2.1, strongly influences how requirements are managed. The project manager chooses the most effective relationship for the project and documents this approach in the requirements management plan. Many of the requirements management plan components are based on that relationship.

Components of the requirements management plan can include, but are not limited to:

- How requirements activities will be planned, tracked, and reported;
- Configuration management activities such as: how changes to the product will be initiated, how impacts will be analyzed, how they will be traced, tracked, and reported, as well as the authorization levels required to approve these changes;
- Requirements prioritization process;
- Product metrics that will be used and the rationale for using them; and
- Traceability structure to reflect which requirement attributes will be captured on the traceability matrix.

5.2 Collect Requirements

Collect Requirements is the process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives. The key benefit of this process is that it provides the basis for defining and managing the project scope including product scope. The inputs, tools and techniques, and outputs of this process are depicted in Figure 5-4. Figure 5-5 depicts the data flow diagram of the process.

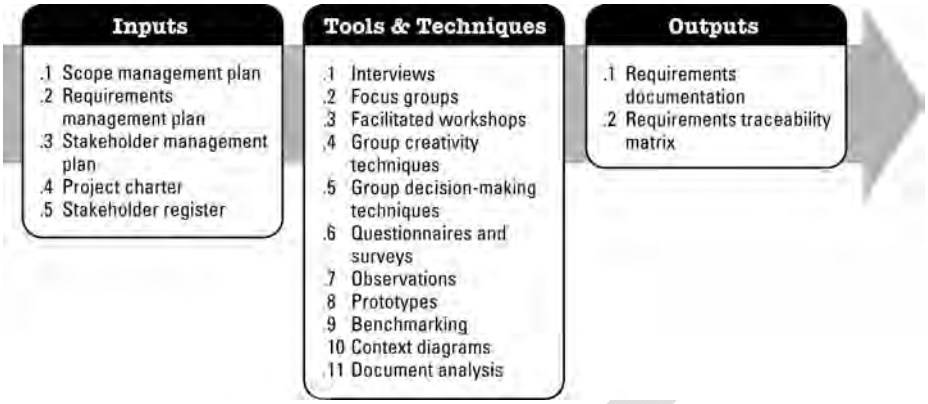

Figure 5-4. Collect Requirements: Inputs, Tools & Techniques, and Outputs

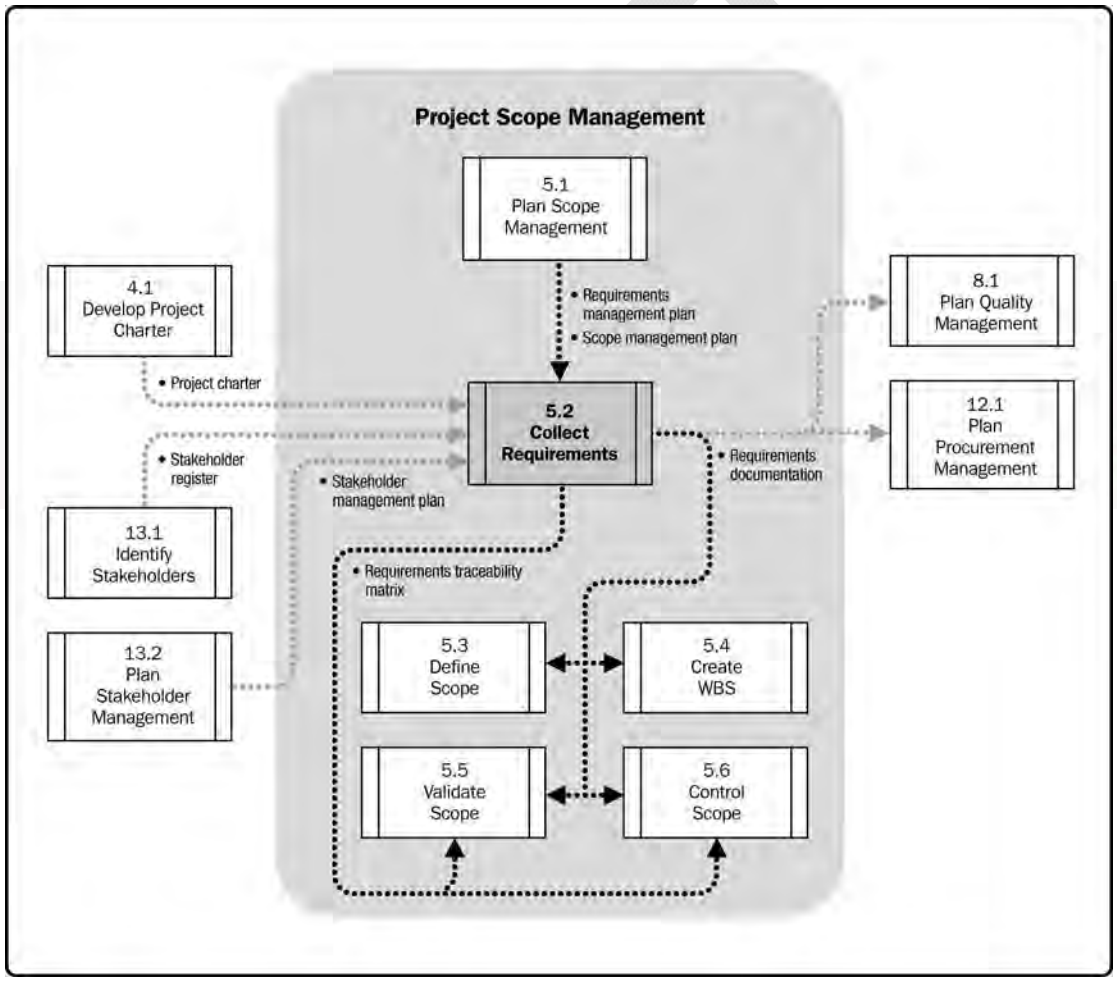

Figure 5-5. Collect Requirements Data Flow Diagram

The project's success is directly influenced by active stakeholder involvement in the discovery and decomposition of needs into requirements and by the care taken in determining, documenting, and managing the requirements of the product, service, or result of the project. Requirements include conditions or capabilities that are to be met by the project or present in the product, service, or result to satisfy an agreement or other formally imposed specification.

Requirements include the quantified and documented needs and expectations of the sponsor, customer, and other stakeholders. These requirements need to be elicited, analyzed, and recorded in enough detail to be included in the scope baseline and to be measured once project execution begins. Requirements become the foundation of the WBS. Cost, schedule, quality planning, and sometimes procurement are all based upon these requirements. The development of requirements begins with an analysis of the information contained in the project charter (Section 4.1.3.1), the stakeholder register (Section 13.1.3.1) and the stakeholder management plan (Section 13.2.3.1).

Many organizations categorize requirements into different types, such as business and technical solutions, the former referring to stakeholder needs and the latter as to how those needs will be implemented. Requirements can be grouped into classifications allowing for further refinement and detail as the requirements are elaborated. These classifications include:

- Business requirements, which describe the higher-level needs of the organization as a whole, such as the business issues or opportunities, and reasons why a project has been undertaken.
- Stakeholder requirements, which describe needs of a stakeholder or stakeholder group.
- Solution requirements, which describe features, functions, and characteristics of the product, service, or result that will meet the business and stakeholder requirements. Solution requirements are further grouped into functional and nonfunctional requirements:
  - Functional requirements describe the behaviors of the product. Examples include processes, data, and interactions with the product.
  - Nonfunctional requirements supplement functional requirements and describe the environmental conditions or qualities required for the product to be effective. Examples include: reliability, security, performance, safety, level of service, supportability, retention/purge, etc.
- Transition requirements describe temporary capabilities, such as data conversion and training requirements, needed to transition from the current “as-is” state to the future “to-be” state.
- Project requirements, which describe the actions, processes, or other conditions the project needs to meet.
- Quality requirements, which capture any condition or criteria needed to validate the successful completion of a project deliverable or fulfillment of other project requirements.

5.2.1 Collect Requirements: Inputs

5.2.1.1 Scope Management Plan

Described in Section 5.1.3.1. The scope management plan provides clarity as to how project teams will determine which type of requirements need to be collected for the project.

5.2.1.2 Requirements Management Plan

Described in Section 5.1.3.2. The requirements management plan provides the processes that will be used throughout the Collect Requirements process to define and document the stakeholder needs.

5.2.1.3 Stakeholder Management Plan

Described in Section 13.2.3.1. The stakeholder management plan is used to understand stakeholder communication requirements and the level of stakeholder engagement in order to assess and adapt to the level of stakeholder participation in requirements activities.

5.2.1.4 Project Charter

Described in Section 4.1.3.1. The project charter is used to provide the high-level description of the product, service, or result of the project so that detailed requirements can be developed.

5.2.1.5 Stakeholder Register

Described in Section 13.1.3.1. The stakeholder register is used to identify stakeholders who can provide information on the requirements. The stakeholder register also captures major requirements and main expectations stakeholders may have for the project.

5.2.2 Collect Requirements: Tools and Techniques

5.2.2.1 Interviews

An interview is a formal or informal approach to elicit information from stakeholders by talking to them directly. It is typically performed by asking prepared and spontaneous questions and recording the responses. Interviews are often conducted on an individual basis between an interviewer and an interviewee, but may involve multiple interviewers and/or multiple interviewees. Interviewing experienced project participants, sponsors and other executives, and subject matter experts can aid in identifying and defining the features and functions of the desired product deliverables. Interviews are also useful for obtaining confidential information.

5.2.2.2 Focus groups

Focus groups bring together prequalified stakeholders and subject matter experts to learn about their expectations and attitudes about a proposed product, service, or result. A trained moderator guides the group through an interactive discussion, designed to be more conversational than a one-on-one interview.

5.2.2.3 Facilitated Workshops

Facilitated workshops are focused sessions that bring key stakeholders together to define product requirements. Workshops are considered a primary technique for quickly defining cross-functional requirements and reconciling stakeholder differences. Because of their interactive group nature, well-facilitated sessions can build trust, foster relationships, and improve communication among the participants, which can lead to increased stakeholder consensus. In addition, issues can be discovered earlier and resolved more quickly than in individual sessions.

For example, facilitated workshops called joint application design/development (JAD) sessions are used in the software development industry. These facilitated sessions focus on bringing business subject matter experts and the development team together to improve the software development process. In the manufacturing industry, quality function deployment (QFD) is another example of a facilitated workshop technique that helps determine critical characteristics for new product development. QFD starts by collecting customer needs, also known as voice of the customer (VOC). These needs are then objectively sorted and prioritized, and goals are set for achieving them. User stories, which are short, textual descriptions of required functionality, are often developed during a requirements workshop. User stories

describe the stakeholder who benefits from the feature (role), what the stakeholder needs to accomplish (goal), and the benefit to the stakeholder (motivation). User stories are widely used with agile methods.

5.2.2.4 Group Creativity Techniques

Several group activities can be organized to identify project and product requirements. Some of the group creativity techniques that can be used are:

- **Brainstorming.** A technique used to generate and collect multiple ideas related to project and product requirements. Although brainstorming by itself does not include voting or prioritization, it is often used with other group creativity techniques that do.
- **Nominal group technique.** A technique that enhances brainstorming with a voting process used to rank the most useful ideas for further brainstorming or for prioritization.
- **Idea/mind mapping.** A technique in which ideas created through individual brainstorming sessions are consolidated into a single map to reflect commonality and differences in understanding, and generate new ideas.
- **Affinity diagram.** A technique that allows large numbers of ideas to be classified into groups for review and analysis.
- **Multicriteria decision analysis.** A technique that utilizes a decision matrix to provide a systematic analytical approach for establishing criteria, such as risk levels, uncertainty, and valuation, to evaluate and rank many ideas.

5.2.2.5 Group Decision-Making Techniques

A group decision-making technique is an assessment process having multiple alternatives with an expected outcome in the form of future actions. These techniques can be used to generate, classify, and prioritize product requirements.

There are various methods of reaching a group decision, such as:

- **Unanimity.** A decision that is reached whereby everyone agrees on a single course of action. One way to reach unanimity is the Delphi technique, in which a selected group of experts answers questionnaires and provides feedback regarding the responses from each round of requirements gathering. The responses are only available to the facilitator to maintain anonymity.
- **Majority.** A decision that is reached with support obtained from more than 50 % of the members of the group. Having a group size with an uneven number of participants can ensure that a decision will be reached, rather than resulting in a tie.
- **Plurality.** A decision that is reached whereby the largest block in a group decides, even if a majority is not achieved. This method is generally used when the number of options nominated is more than two.
- **Dictatorship.** In this method, one individual makes the decision for the group.

All of these group decision-making techniques can be applied to the group creativity techniques used in the Collect Requirements process.

5.2.2.6 Questionnaires and Surveys

Questionnaires and surveys are written sets of questions designed to quickly accumulate information from a large number of respondents. Questionnaires and/or surveys are most appropriate with varied audiences, when a quick turnaround is needed, when respondents are geographically dispersed, and where statistical analysis is appropriate.

5.2.2.7 Observations

Observations provide a direct way of viewing individuals in their environment and how they perform their jobs or tasks and carry out processes. It is particularly helpful for detailed processes when the people that use the product have difficulty or are reluctant to articulate their requirements. Observation is also known as "job shadowing." It is usually done externally by an observer viewing a business expert performing a job. It can also be done by a "participant observer" who actually performs a process or procedure to experience how it is done to uncover hidden requirements.

5.2.2.8 Prototypes

Prototyping is a method of obtaining early feedback on requirements by providing a working model of the expected product before actually building it. Since a prototype is tangible, it allows stakeholders to experiment with a model of the final product rather than being limited to discussing abstract representations of their requirements. Prototypes support the concept of progressive elaboration in iterative cycles of mock-up creation, user experimentation, feedback generation, and prototype revision. When enough feedback cycles have been performed, the requirements obtained from the prototype are sufficiently complete to move to a design or build phase. Storyboarding is a prototyping technique showing sequence or navigation through a series of images or illustrations. Storyboards are used on a variety of projects in a variety of industries, such as film, advertising, instructional design, and on agile and other software development projects. In software development, storyboards use mock-ups to show navigation paths through webpages, screens, or other user interfaces.

5.2.2.9 Benchmarking

Benchmarking involves comparing actual or planned practices, such as processes and operations, to those of comparable organizations to identify best practices, generate ideas for improvement, and provide a basis for measuring performance. The organizations compared during benchmarking can be internal or external.

5.2.2.10 Context Diagrams

The context diagram is an example of a scope model. Context diagrams visually depict the product scope by showing a business system (process, equipment, computer system, etc.), and how people and other systems (actors) interact with it. Context diagrams show inputs to the business system, the actor(s) providing the input, the outputs from the business system, and the actor(s) receiving the output.

5.2.2.11 Document Analysis

Document analysis is used to elicit requirements by analyzing existing documentation and identifying information relevant to the requirements. There are a wide range of documents that may be analyzed to help elicit relevant requirements. Examples of documents that may be analyzed include, but are not limited to: business plans, marketing literature, agreements, requests for proposal, current process flows, logical data models, business rules repositories,

application software documentation, business process or interface documentation, use cases, other requirements documentation, problem/issue logs, policies, procedures, and regulatory documentation such as laws, codes, or ordinances, etc.

5.2.3 Collect Requirements: Outputs

5.2.3.1 Requirements Documentation

Requirements documentation describes how individual requirements meet the business need for the project. Requirements may start out at a high level and become progressively more detailed as more about the requirements is known. Before being baselined, requirements need to be unambiguous (measurable and testable), traceable, complete, consistent, and acceptable to key stakeholders. The format of a requirements document may range from a simple document listing all the requirements categorized by stakeholder and priority, to more elaborate forms containing an executive summary, detailed descriptions, and attachments.

Components of requirements documentation can include, but, are not limited to:

- Business requirements, including:
  - Business and project objectives for traceability;
  - Business rules for the performing organization; and
  - Guiding principles of the organization.
- Stakeholder requirements, including:
  - Impacts to other organizational areas;
  - Impacts to other entities inside or outside the performing organization; and
  - Stakeholder communication and reporting requirements.
- Solution requirements, including:
  - Functional and nonfunctional requirements;
  - Technology and standard compliance requirements;
  - Support and training requirements;
  - Quality requirements; and
  - Reporting requirements, etc. (solution requirements can be documented textually, in models, or both).
- Project requirements, such as:
  - Levels of service, performance, safety, compliance, etc.; and
  - Acceptance criteria.
- Transition requirements.
- Requirements assumptions, dependencies, and constraints.

5.2.3.2 Requirements Traceability Matrix

The requirements traceability matrix is a grid that links product requirements from their origin to the deliverables that satisfy them. The implementation of a requirements traceability matrix helps ensure that each requirement adds business value by linking it to the business and project objectives. It provides a means to track requirements throughout the project life cycle, helping to ensure that requirements approved in the requirements documentation are delivered at the end of the project. Finally, it provides a structure for managing changes to the product scope.

Tracing includes, but is not limited to, tracing requirements for the following:

- Business needs, opportunities, goals, and objectives;
- Project objectives;
- Project scope/WBS deliverables;
- Product design;
- Product development;
- Test strategy and test scenarios; and
- High-level requirements to more detailed requirements.

Attributes associated with each requirement can be recorded in the requirements traceability matrix. These attributes help to define key information about the requirement. Typical attributes used in the requirements traceability matrix may include: a unique identifier, a textual description of the requirement, the rationale for inclusion, owner, source, priority, version, current status (such as active, cancelled, deferred, added, approved, assigned, completed), and status date. Additional attributes to ensure that the requirement has met stakeholders' satisfaction may include stability, complexity, and acceptance criteria. Figure 5-6 provides an example of a requirements traceability matrix with its associated attributes.

Requirements Traceability Matrix

Project Name:	
Cost Center:	
Project Description:	

ID	Associate ID	Requirements Description	Business Needs, Opportunities, Goals, Objectives	Project Objectives	WBS Deliverables	Product Design	Product Development	Test Cases
001	1.0							
	1.1							
	1.2							
	1.2.1							
002	2.0							
	2.1							
	2.1.1							
003	3.0							
	3.1							
	3.2							
004	4.0							
005	5.0							

Figure 5-6. Example of a Requirements Traceability Matrix

5.3 Define Scope

Define Scope is the process of developing a detailed description of the project and product. The key benefit of this process is that it describes the project, service, or result boundaries by defining which of the requirements collected will be included in and excluded from the project scope. The inputs, tools and techniques, and outputs of this process are depicted in Figure 5-7. Figure 5-8 depicts the data flow diagram of the process.

Figure 5-7. Define Scope: Inputs, Tools & Techniques, and Outputs

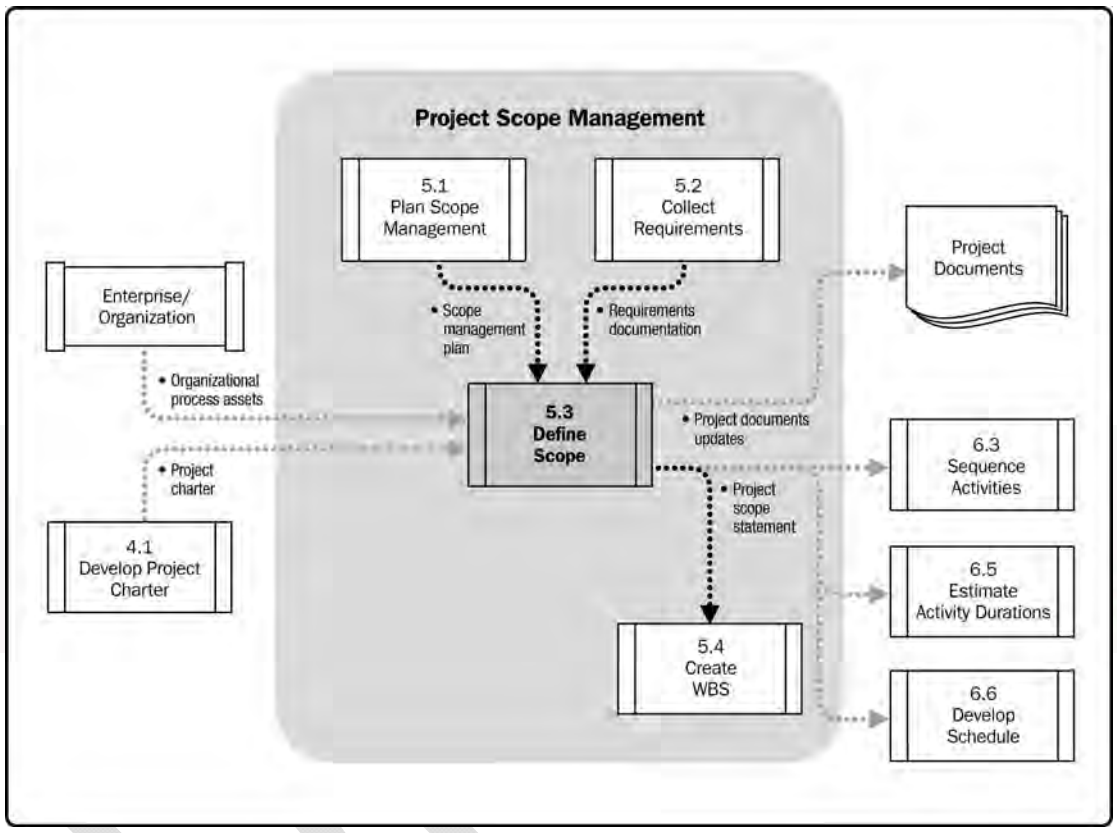

Figure 5-8. Define Scope Data Flow Diagram

Since all of the requirements identified in Collect Requirements may not be included in the project, the Define Scope process selects the final project requirements from the requirements documentation delivered during the Collect Requirements process. It then develops a detailed description of the project and product, service, or result.

The preparation of a detailed project scope statement is critical to project success and builds upon the major deliverables, assumptions, and constraints that are documented during project initiation. During project planning, the project scope is defined and described with greater specificity as more information about the project is known. Existing risks, assumptions, and constraints are analyzed for completeness and added or updated as necessary. The Define Scope process can be highly iterative. In iterative life cycle projects, a high-level vision will be developed for the overall project, but the detailed scope is determined one iteration at a time and the detailed planning for the next iteration is carried out as work progresses on the current project scope and deliverables.