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Foundations of Project Management: Concepts, Tools, and Applications

Michael D. Sherwin, Ph.D., P.E.

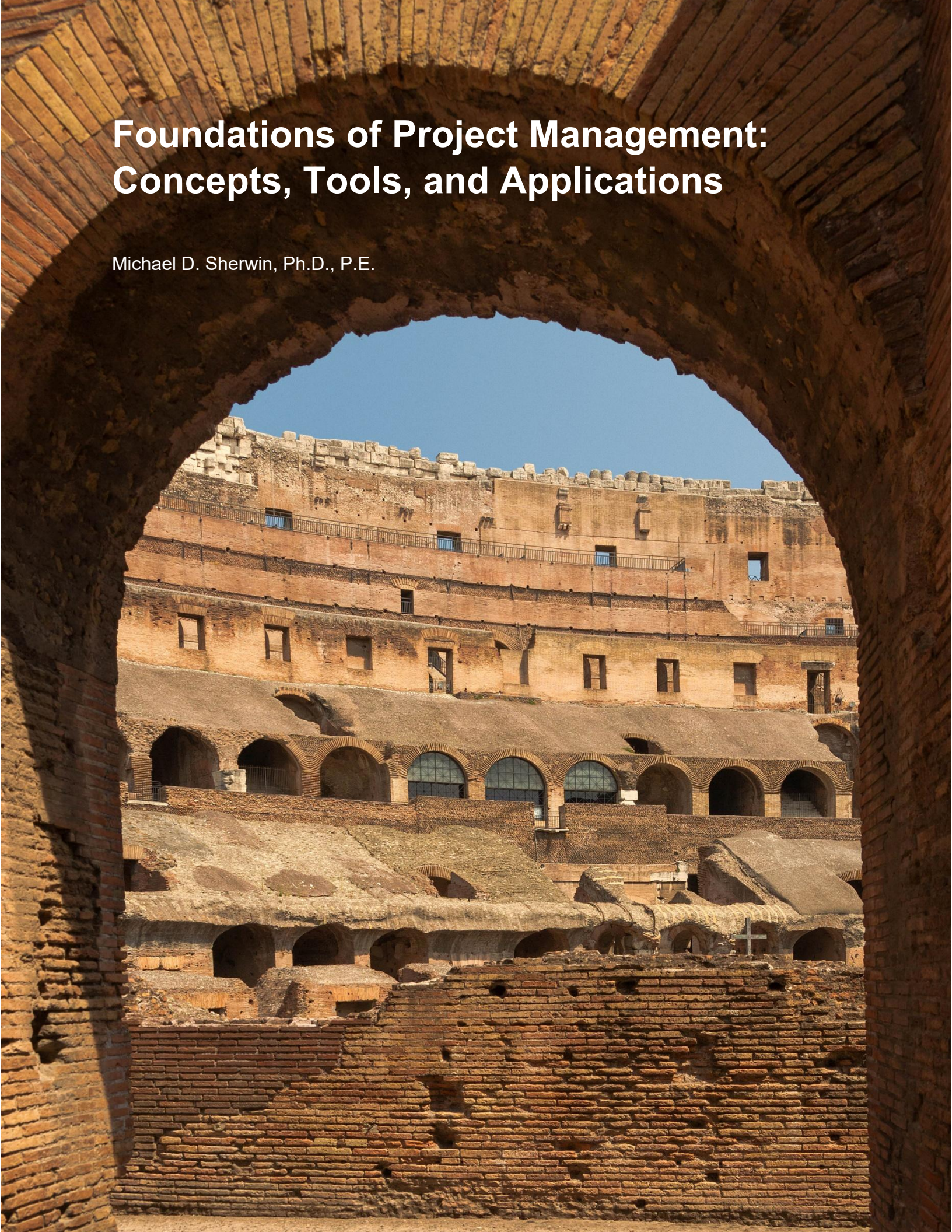


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How to use this book

Throughout this text, you will be introduced to common tools, templates, and techniques used across many industries, projects, and situations to manage projects effectively. You are encouraged to apply the lessons learned in your own workplace and, potentially, in your personal life, whether you are a project manager by title or not.

Whether large or small, long-term or short-term, well-funded or not, global or localized, project management is key to delivering value for organizations and the stakeholders that comprise them. In addition, it applies to operations, supply chain, IT, healthcare, construction, and service industries. The skills learned and developed as a project manager are transferable across industries and roles and can be used as valuable experience for career progression.

This book aims to equip readers with practical tools and strategies for managing people, resources, and tasks effectively. We include examples, case studies, references, and tools and templates. We encourage you to explore references and videos to deepen your understanding of project management. It is designed for everyone, not just those individuals seeking to be project managers. Whether you are supporting or leading projects, this course will provide a foundation for developing the skills needed to drive results within an organization.

The book is organized as follows:

1. Foundations for Project Management
2. Project Planning
3. Project Resource and Stakeholder Management
4. Project Execution, Monitoring, and Control
5. Project Closure and Continuous Improvement

1 Foundations for Project Management

1.1 Introduction to Project Management

Have you ever gone on a trip or vacation, undertaken a home renovation, conducted a job search, completed a degree or certification program, planned a wedding, trained for a marathon, gone on a diet, saved for a large purchase, or done anything similar? If so, you know what a project is, and depending on your involvement, you also have experience managing one. These examples are projects because they include defined start and end dates, clear objectives, well-defined stakeholders, and a certain level of risk and uncertainty. The process of organizing activities within a project is project management.

More formally, the Project Management Institute (PMI) Project Management Body of Knowledge (PMBOK) defines a project, project management, and project manager as follows [1]:

> ***Project:*** *A temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates a beginning and an end to the project work or a phase of the project work. Projects can stand alone or be part of a program or portfolio.*
>
> ***Project Management****: The application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Project management refers to guiding the project work to deliver the intended outcomes. Project teams can achieve the outcomes using a broad range of approaches (e.g., predictive, hybrid, and adaptive).*
>
> ***Project Manager:*** *The individual assigned by the performing organization to lead the team responsible for achieving project objectives.*

1.1.1 What is Project Management?

To understand project management, it is important to differentiate projects from the ordinary activities required to run a business [2]. Projects are typically characterized by relatively short lifetimes, clearly defined start and end dates, defined budgetary constraints, and people temporarily assigned to the project [3]. On the other hand, an operation is described as a set of continuous activities that don't necessarily have defined beginning and ending dates. The budget and associated costs are monitored on regular cycles (e.g., calendar or fiscal periods) in routine operations, with people assigned, typically, on a more permanent basis. Video 1 provides a brief overview of project management.



Video 1. What is project management? (Source: https://youtu.be/Jk-JwtSclIw?si=-KiggpcCWCPHaclj)

Projects and operations can also be defined by their intended purposes. Projects can be used to improve or change existing business processes or to establish new ones. Operations focus on sustaining ongoing business activities and strive to be more repetitive and standardized than for a project, which is more unique and specialized to its intended goal. Most projects are intended to be disruptive and therefore carry greater risk than most operations. In some cases, projects may be embedded or matrixed with ongoing operations to deliver products that require longer durations and operate within a fixed project budget. Table 1 summarizes key differentiators between projects and operations.

Table 1. Key differences between projects and operations.

Dimension	Projects	Operations
Duration	Temporary with defined beginning and end dates	Permanent and ongoing
Purpose	To create change, develop products, construct something, deliver a product	Sustain the organization and run day-to-day processes
Uniqueness	Unique, one-time endeavor	Repetitive and standardized
Risk	Higher uncertainty	Lower uncertainty
Goal	Short-term performance related to project objectives	Long-term performance related to business objectives
Budget	Fixed, often financed by capital expenditures	Continuous, financed by operational expenses

Examples of projects in industry and other domains are vast. According to the PMI [4], projects can involve planning glamorous Fashion Week events, humanitarian aid efforts, video game development, building construction, promotional campaigns, and more. In the context of continuous improvement, Lean or Six Sigma projects can focus on improving the safety, quality, cost, or delivery of products and services within an organization. Firms that offer high-complexity, low-volume, or highly customizable products may implement project-based product realization to manufacture the products they deliver to customers. Examples of such industries that use project management in this way include aerospace, defense, large equipment, and general manufacturing. Many of these types of organizations include a project management office (PMO). The PMO serves as a centralized department that standardizes project governance and establishes project management best practices. Other organizations may hire consultants, such as in the scenario in Video 2.



Video 2. Project management industrial manufacturing (Source: https://youtu.be/e9Dq62UifdY?si=7bjP6nyto-TlQivR)

Project management serves as the strategic link between ideas and tangible business results, organizing teams and resources to deliver projects on time, within budget, and aligned with organizational goals. It ensures efficient execution, mitigates risks, manages costs, and improves communication, which boosts overall organizational success, profitability, and stakeholder confidence. In doing so, effective project management creates value, improves efficiency, and reduces risks across the organization.



Figure 1. The role of project management. (Source: The Author's Own Work)

The success of an individual project and successful project management can be different. Project success focuses on long-term value, business benefits, and stakeholder satisfaction. Project management, however, measures success in terms of efficiency (meeting time, cost, and scope constraints. In other words, a project can be managed successfully, but fail to deliver value. Alternatively, a project can be poorly managed yet still achieve its business objectives despite itself. For additional readings on the topic of project success, explore the following articles:

- Defining project success: a multilevel framework [5]
- Generic project success and project management success criteria and factors: Literature review and survey [6]

1.1.2 Historical Examples of Project Management

Throughout the common era (CE), both formal and informal project management have played a vital role in driving progress. Figure 2 provides an overview of major advances in human history from before 500 CE to the present. In the years preceding 500 CE,

evidence of stone tools, woodworking construction, building complexes, irrigation systems, plumbing, sailboats, the great Pyramids in Egypt, sewage and sanitation systems, and the Great Wall of China were discovered, and most likely utilized early forms of the same project management concepts used today. Starting with the post-classical era (500-1750 CE), the invention of gunpowder, hand-washing machines, the printing press, the steam engine, the Cotton Gin, the locomotive, the automobile, and the Panama Canal were all managed as projects, large and small. In the present technological age, software and computing project management, using concepts that have evolved into Agile project management, is used to keep projects on track, on budget, and to manage updates and upgrades. Without the organizational and operational tools that project management affords, many projects throughout history might not have been completed. If you're interested in learning more details about the history of project management itself, see Video 3.

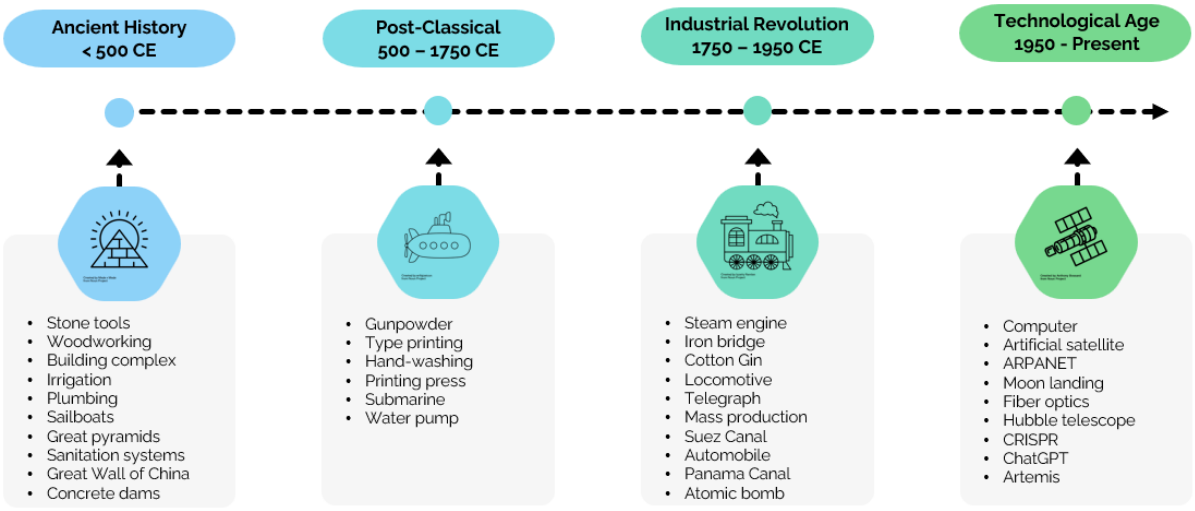


Figure 2. Timeline of major projects throughout history. (Source: The Author's Own Work, Icons from thenounproject.com CC BY 3.0)



Video 3. A short history of project management. (source: https://youtu.be/yybV8WFHyBM?si=OnfkAyiWXnplNWLE)

While project management works to make order out of chaos, several projects throughout history have yielded far less favorable results. Some failures have been attributed to project management-related causes, such as inadequate risk assessments, poor communication, and unrealistic planning. Other projects have failed due to gaps in inputs and prerequisites before launch. Examples of such failures are listed in Table 2. Click on the links below each project description for additional resources and information on the topic.

Table 2. Examples of major project failures.

Project	Leading Causes
Airbus A380 • The Insane Story of the Airbus A380 Failure	Communication Breakdown, Economy, Infrastructure, Market Shifts
Denver International Airport Baggage System • Lessons from the Denver Airport Baggage Handling Fiasco	Unrealistic Planning, Unrealistic Scope
Ford Edsel • The Ford Edsel: 1957's "America's Car"	Consumer Preference Changes, Pricing
Sony Betamax • Sony Goes to Battle for Its Favorite Child	Inadequate Market Research
FBI Virtual Case File • The FBI Virtual Case File: A Case Study	Lack of Oversight, Changing Requirements
New Coke • Project Management Post-Mortems: New Coke	Inadequate Market Research
The French Panama Canal • TR and the Panama Canal	Lack of Quality Risk Mitigation
Apple Lisa • Project Management Post-Mortems: Apple's Lisa	Project Scope, Pricing, Performance

1.1.3 The Project Manager's Role

Project managers are goal-oriented professionals who use innovation, creativity, and collaboration to lead projects [7]. They equip and guide teams using tools to succeed and evolve through the project life cycle. Project managers need to be equipped with a variety of skills and competencies, such as leadership, adaptability, organization, time management, problem-solving, communication, and the ability to motivate and manage the teams that are under their purview. Project manager responsibilities can vary from project to project and organization to organization (see Figure 3).



Figure 3. Common responsibilities of a project manager. (Source: [7], The Author's Own Work.)

Project managers need to serve as both leaders and managers. Leaders focus on the big picture and the "why," whereas managers focus on tasks, processes, and the "how" of getting the project done. In their role as leaders, project managers must focus on the project's overall vision and adapt to changes to ensure alignment with the organizational strategy. This includes inspiring and motivating team members and helping them understand their role in successfully achieving the strategy. Project managers, as leaders, need to embrace risk, make critical decisions, and drive innovation. They earn the role of leader by gaining the trust of the team and stakeholders and using their influence to drive results.

In their role as a manager, a project manager must also focus on executing project tasks, maintaining stability, organizing resources, and implementing processes to achieve project goals on time. Managers are task-oriented and focus on assigning responsibilities and controlling outcomes at minimum risk. When project metrics are trending in an unfavorable direction, the project manager must determine "how" to get tasks done more effectively and get the project back on track.

For more information on the differences between leadership and management in the context of project management, refer to the following articles:

- Project Manager Leadership Role in Improving Project Performance [8]
- Differentiating Leadership from Management: An Empirical Investigation of Leaders and Managers [9]

Adhering to ethical standards is a critical responsibility of a project manager. The PMI outlines the four core values of responsibility, respect, fairness, and honesty in its PMI Code of Ethics and Professional Conduct [10]. Figure 4 describes the PMI core values in greater detail. These standards are essential because of the dilemmas that project

managers regularly face. Due to the complex nature of projects, pressures from tight deadlines and resource constraints, and the diversity of stakeholder incentives, project managers will be tempted to cut corners, engage in unfair practices, and reduce quality [11]. Therefore, it is important for project managers to uphold their integrity and accountability by identifying ethical dilemmas when they arise and holding themselves and those responsible for their actions accountable.

Despite increased discussion and standards for ethical behavior, there is some evidence that unethical behavior is increasing across many professions, including project management. One study conducted found that workplace spirituality influenced positive ethical behaviors to some extent [12]. The authors note that it is particularly linked to responsibility and fairness, two key values outlined in the PMI Code of Ethics and Professional Conduct.

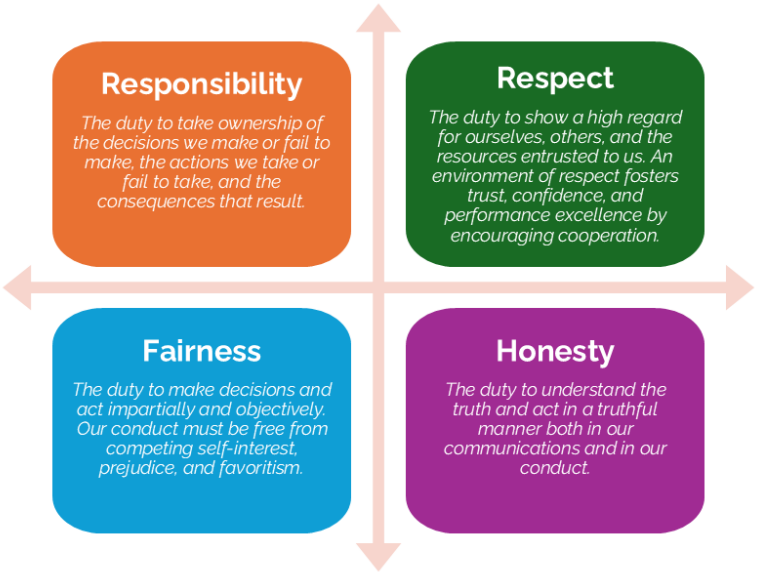


Figure 4. Definitions of the PMI core values for ethical project management. (Source: Adapted from [10], The Author's Own Work)

1.1.4 Project Constraints and Tradeoffs

Project management requires a balance among constraints. Thus, the project manager is tasked with optimizing the project's competing objectives while managing these constraints. Within a given project, constraints are common and can be classified into three broad areas: scope, time, and cost. From a broader perspective, project managers need to balance quality, risk, resources, and stakeholder satisfaction.

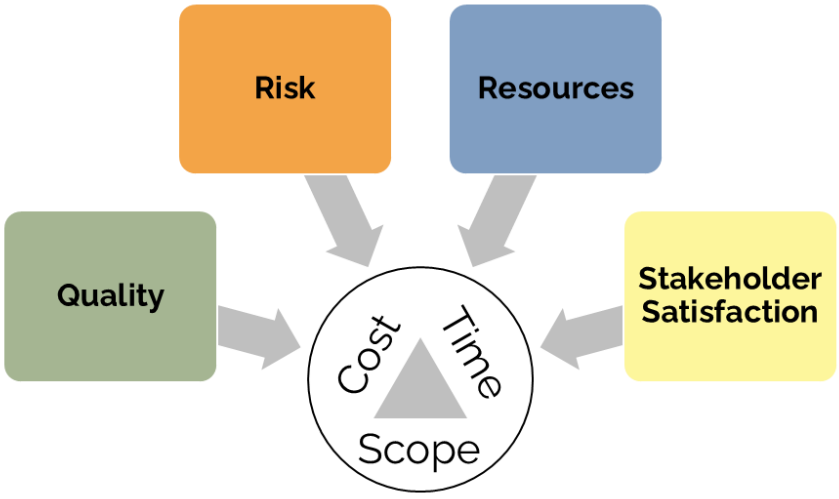


Figure 5. Project constraints and tradeoffs. (Source: The Author's Own Work)

Known as the "triple constraint" or the "iron triangle", scope, time, and cost must be defined and managed across the course of a project [13]. Scope defines the boundaries of the project and includes the tasks to accomplish the objectives. Time includes the project schedule, deadlines, and milestones. Costs include the financial resources available to complete the project. Changing one constraint affects the other. To manage a project, requirements need to be identified, clear objectives established, and specifications, plans, and approaches adapted to stakeholders' concerns. The quality of the project is affected by how well the iron triangle is balanced. Throughout the project, the project manager must meet the project's quality objectives, mitigate risks as they arise, effectively utilize resources, and manage stakeholder expectations.

For additional reading on triple constraints, please see the following articles:

- The triple constraint [14]
- Manager's challenges: managing constraints [13]

1.1.5 Project Management Approaches

While there are several approaches to managing a project, two primary methods are used. They are traditional (waterfall) project management and iterative methods such as Agile. The two methods can both be used in different applications across the project life cycle or combined to take on a hybrid approach.

The traditional, or waterfall, approach is grounded in structure. Here, projects are completed in a linear fashion in distinct phases where one phase, which includes

several tasks or actions, is completed prior to the next phase beginning. Lean Six Sigma projects are completed using the traditional approach, using the DMAIC (Define-Measure-Analyze-Improve-Control) framework. Upfront planning, documentation, well-defined tasks, specific roles, milestones, and approval are keys to this approach. Because the waterfall approach is quite rigid, it works best in project environments that are stable, have well-defined, predictable requirements, and require compliance with standards. In addition to Lean Six Sigma projects, projects in construction, manufacturing, and defense are typically good candidates for the waterfall approach.

The Agile approach to project management is less rigid than the waterfall approach and focuses on evolving requirements and solutions throughout the project life cycle through collaboration and self-organization among cross-functional project teams. Agile project management is rooted in the Agile Manifesto, which was born in 2001 with software development as its primary focus, and has since been adapted to a variety of other project management applications. Agile encourages frequent review, feedback, and adaptation; a philosophy of teamwork, self-organization, and accountability; the use of best practices to rapidly deliver high-quality results; and the alignment of customer needs with company goals [15]. Table 3 summarizes waterfall and Agile project management.

Table 3. Comparison of waterfall and Agile project management. (Source: [15])

Waterfall Project Management	Agile Project Management
• Detailed, long-term project plans with a single timeline • Definitive and rigid project management and team roles • Changes in deliverables are discouraged and costly • Fully completed product delivered at the end of the timeline • Contract-based approach to scope and requirements • The customer is typically involved only at the beginning and end of a project • Linear-phased approach creates dependencies	• Shorter planning based on iterations and multiple deliveries • Flexible, cross-functional team composition • Changes in deliverables are expected and less impactful • Product delivered in functional stages • Collaborative and interactive approach to requirements • Customer is involved throughout the sprint • Concurrent approach seeks to reduce dependencies

1.2 Project Management Institute (PMI) Framework

The PMI framework is a structured set of principles, standards, domains, and practices developed by PMI to guide the effective management of projects across industries. The framework is communicated through PMI's Project Management Body of Knowledge (PMBOK®) Guide [1]. The PMI framework provides a common language and conceptual model for project management. It does not prescribe any single

methodology but offers guidance for professionals to tailor the concepts to different industries, project types, and organizations. The framework includes three primary project management approaches: traditional (waterfall), adaptive (Agile), and hybrid.

The structure emphasizes what processes to perform and when, and is organized into five process groups and ten knowledge areas. In the 7th Edition of the PMBOK® GUIDE, PMI shifted from a process-based approach to a principles-and-outcomes approach that focuses on 12 principles and 8 project performance domains. Figure 6 includes a diagram that includes both the prior structure (process groups and knowledge areas) and the revised structure (principles and performance domains). Table 4

The PMI framework is not a methodology (e.g., scrum, waterfall) and does not dictate tools or templates, but instead encourages tailoring the approach based on the context of the project. It acts as a meta-framework that helps project managers select and adapt appropriate practices. The framework is a widely recognized global standard that forms the basis for the PMI certifications (e.g., PMP®) with the intent that it can be applied across industries and cultures with an emphasis on delivering value, being adaptable, and providing a basis for professional judgment.

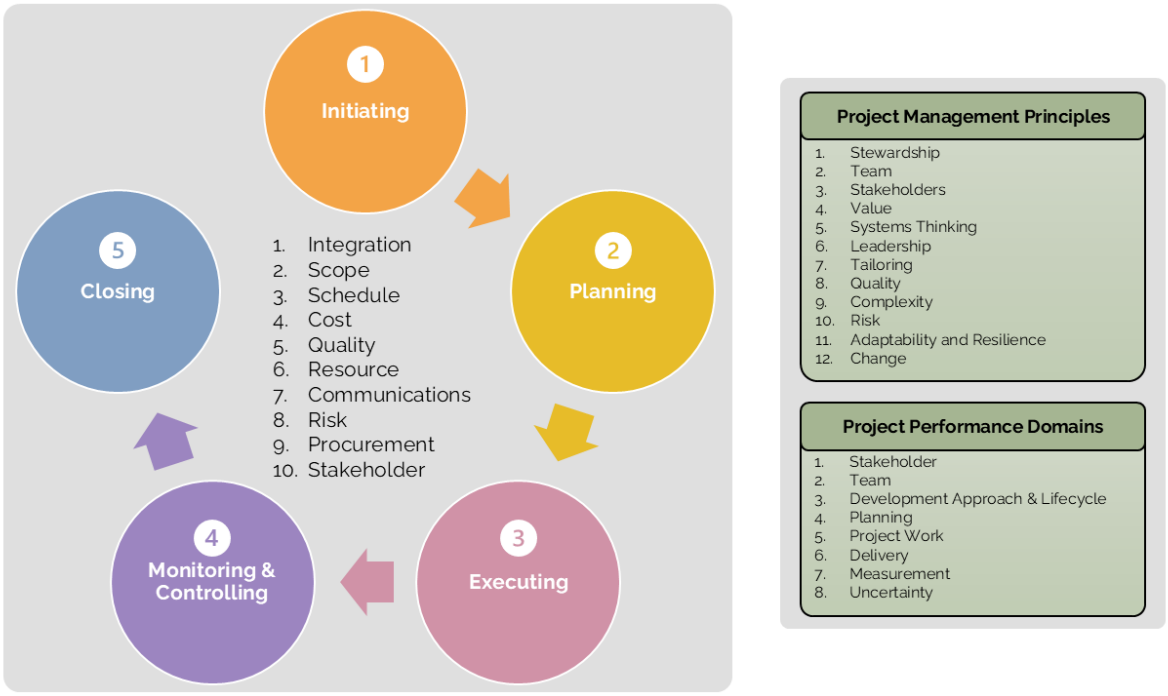


Figure 6. PMI Framework process groups, knowledge areas, principles, and domains. (Source: Adapted from [1], [16], The Author's Own Work)

Table 4. Definition of terms: PMI Framework (PMBOK® GUIDE 6th Edition) process groups and knowledge areas. (Source: Adapted from [16])

PMBOK® Guide – 6th Edition (Process-Based)	
Process Groups	
Term	**Definition**
Initiating	Defines a new project or project phase by obtaining authorization, identifying stakeholders, and establishing the project's objectives and scope.
Planning	Establishes the roadmap for achieving project objectives by defining the work, schedule, budget, resources, risks, communications, and other management plans.
Executing	Carries out the project management plan by coordinating people, resources, and activities to produce the project's deliverables.
Monitoring & Controlling	Tracks project performance, compares actual results to the plan, identifies variances, and implements corrective or preventive actions as needed.
Closing	Formally completes the project or phase by obtaining stakeholder acceptance, documenting lessons learned, releasing resources, and closing contracts.
Knowledge Areas	
Term	**Definition**
Integration	Coordinates all project activities to ensure that the various project components work together effectively throughout the project life cycle.
Scope	Defines and controls the work required to successfully complete the project while preventing unnecessary work (scope creep).
Schedule	Develops, monitors, and controls the project timeline to ensure work is completed on schedule.
Cost	Plans, estimates, budgets, and controls project costs to complete the project within the approved budget.
Quality	Ensures that project deliverables and processes meet agreed-upon quality standards and satisfy stakeholder expectations.
Resource	Plans, acquires, develops, and manages the people, equipment, materials, and facilities needed to complete the project.
Communications	Ensures that project information is generated, distributed, stored, and communicated effectively among stakeholders.
Risk	Identifies, analyzes, plans for, and responds to uncertainties that may positively or negatively affect project objectives.
Procurement	Acquires products, services, or results from external organizations through contracting and supplier management.
Stakeholder	Identifies stakeholders, understands their needs and expectations, and actively engages them throughout the project.

Table 5. Definition of terms: PMI Framework (PMBOK® GUIDE 7th Edition) principles and performance domains. (Source: Adapted from [1])

PMBOK® Guide – 7th Edition (Principle-Based)	
Project Management Principles	
Term	**Definition**
Stewardship	Demonstrating integrity, accountability, ethical behavior, and responsible use of organizational resources.
Team	Building, supporting, and empowering a collaborative team that works effectively toward shared project goals.
Stakeholders	Engaging stakeholders proactively to understand their needs, build relationships, and foster project support.
Value	Continuously focusing on delivering outcomes and benefits that create value for customers, organizations, and stakeholders.
Systems Thinking	Viewing the project as part of a larger organizational and environmental system, recognizing how decisions affect interconnected elements.
Leadership	Inspiring, motivating, and guiding individuals and teams while fostering trust, collaboration, and sound decision-making.
Tailoring	Adapting project management practices, processes, and tools to fit the project's unique characteristics, environment, and objectives.
Quality	Embedding quality into project processes and deliverables to meet stakeholder expectations and achieve fitness for purpose.
Complexity	Recognizing and effectively managing the interconnected factors, uncertainty, and dynamic conditions that influence project outcomes.
Risk	Continuously identifying, assessing, and responding to opportunities and threats that could affect project success.
Adaptability and Resilience	Remaining flexible and responsive to changing conditions while maintaining progress toward project objectives.
Change	Preparing for, managing, and enabling change throughout the project to maximize successful adoption of outcomes.
Project Performance Domains	
Term	**Definition**
Stakeholder	Focuses on building productive relationships with stakeholders to support project success.
Team	Emphasizes developing, empowering, and leading an effective project team that can achieve project objectives.
Development Approach and Lifecycle	Determines the most appropriate project approach (predictive, adaptive, or hybrid) and life cycle based on project characteristics.
Planning	Develops and maintains plans that guide project execution while remaining flexible enough to accommodate change.
Project Work	Manages the day-to-day activities, resources, and processes required to produce project deliverables.
Delivery	Ensures that valuable products, services, or results are delivered efficiently and meet stakeholder expectations.
Measurement	Monitors project performance using meaningful metrics and data to support informed decision-making and continuous improvement.
Uncertainty	Addresses uncertainty by proactively managing risks, ambiguity, complexity, and opportunities throughout the project.

Organizations oriented to project management often have a project management office (PMO), a centralized organizational function that establishes standards, provides governance, and supports the successful execution of projects across the company. Project managers are focused on individual projects, whereas the PMO focuses on how projects are managed with the organization’s strategy in mind.

A PMO can be thought of as a department or team within a company that develops and maintains project management standards, methods, tools, and governance to improve project performance and consistency. While the PMO structure varies, it typically falls into one of three broad categories: supportive, controlling, or directive. In supportive PMOs, guidance is provided as needed, along with tools, templates, and training. Along with the elements of a supportive PMO, a controlling PMO serves as an enforcing and auditing body that holds projects to the standards and maintains stricter governance. In a directive PMO, the office directly manages projects and project managers, while also serving as a supportive and controlling PMO. In each case, the PMO serves as the company's governing body for implementing the project management framework at varying levels of oversight (e.g., supportive, controlling, directive).

For additional information on PMOs, please refer to the following references:

- PMO frameworks [17]
- The PMO: your key to strategy execution and results delivery [18]

1.3 Project Life Cycle

A project's life cycle consists of the sequential phases that guide a project from its beginning to its conclusion. As the definition implies, the traditional (waterfall) project management approach aligns most directly with the standard project life cycle. However, projects that implement the Agile approach also incorporate phases into their life cycles. In general, every project has a beginning, middle, and end, and identifying the phases of the life cycle helps determine structure, direction, control, and decision-making points. Simply put, the life cycle is the roadmap for delivering the project.

Firms incorporate project life cycles to reduce uncertainty, improve planning, manage risk, allocate resources efficiently and effectively, improve communication, measure progress, ensure stakeholder alignment, and ultimately increase the likelihood of project success. Think about it this way: if you were building a house, would you start without a plan organized into phases, so you know, at a high level, whether the project is progressing as intended? Without a plan, the project would likely result in delays, cost overruns, and rework. The starting point for the plan is the project life cycle.

Whether the waterfall or Agile methodology is employed, standard phases of a project's life cycle can be defined. In the waterfall approach, the project progresses through five general phases during its life cycle: initiation, planning, execution, monitoring and controlling (simultaneously with execution), and closing. These phases are synonymous with the PMBOK® GUIDE process groups illustrated in Figure 6. Figure 7 summarizes the phases of the life cycle for a project managed using the waterfall approach, including each phase's purpose, elements, and deliverables.

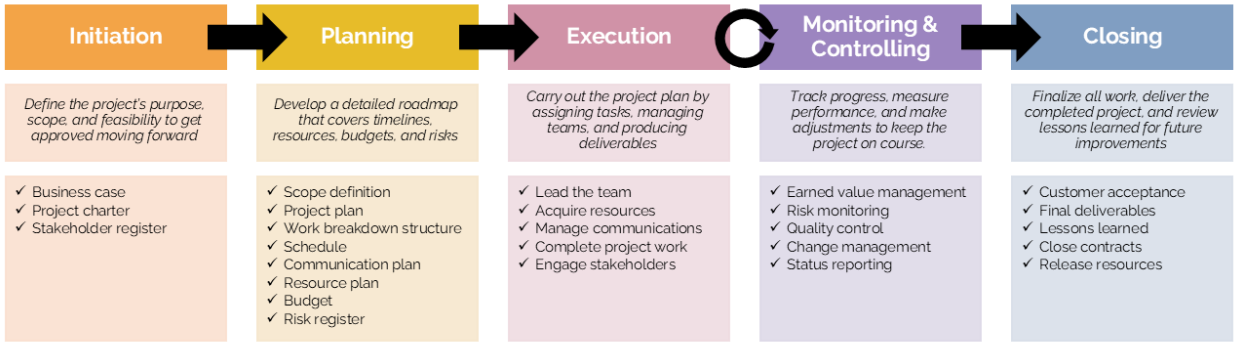


Figure 7. Phases of a project's life cycle using the traditional (waterfall) approach (Source: [19], The Author's Own Work).

Agile project management also follows a series of phases from project initiation to completion. While frameworks may vary, a project managed using Agile still generally follows phases similar to those of a waterfall project throughout its life cycle, though the specifics may differ depending on the project. Agile is commonly used in software and product development, but the concepts may be applied to other types of projects as well. In general, an Agile project life cycle incorporates the following phases: vision, initiation, inception, iteration, release, maintenance, and retirement. During the iteration stage, the Agile method incorporates sprints, in which small, cross-functional, self-managed teams work on a prioritized set of deliverables during a fixed time frame. During each sprint, the team collaborates to plan, develop, test, and improve the product/process while gathering and incorporating stakeholder feedback. At the end of each sprint, a portion of the product/process is completed. Multiple sprints may occur simultaneously and are ongoing, building on the results of the previous sprint. Figure 8 summarizes the general life cycle phases of a project using the Agile methodology.

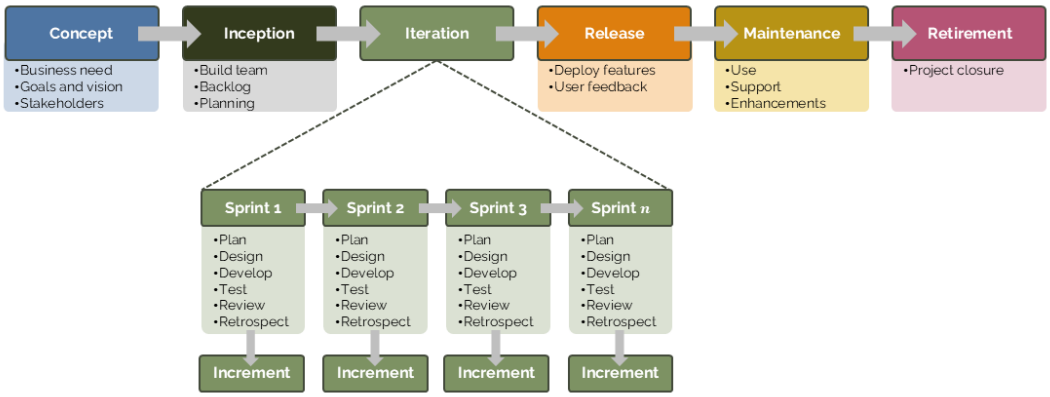


Figure 8. Phases of a project's life cycle using the Agile approach (Source: [20], [21], The Author's Own Work).

1.4 Organizational Influences

Organizational influences are the internal structures, processes, culture, governance, and resources that affect how projects are initiated, managed, and delivered within an organization. Organizational influences can have a significant impact on a project's success, even when the tactical elements are well managed.

1.4.1 Organizational Strategy

Aligning project selection and intended outcomes with the organization's strategy is an important first step [1]. First, doing so will significantly impact whether the project is funded and will make it a priority, leading to support as the project progresses from initiation to closure. In addition, the organizational strategy provides and guides the project objectives as well as the success criteria.

1.4.2 Organizational Structure

The way the organization is structured defines authority and reporting relationships both within the project and in support of it. Reporting structures within companies typically take one of three primary forms: a functional organization, a matrix organization, or a project-based organization. Although hybrid forms of these structures may also occur, each may have a dedicated PMO. In a functional organization, employees report to functional managers and projects are typically managed within departments. In a functionally based organizational structure, project managers have the lowest level of authority of the three types. Figure 9 illustrates a representative functional organizational structure for a manufacturing firm.

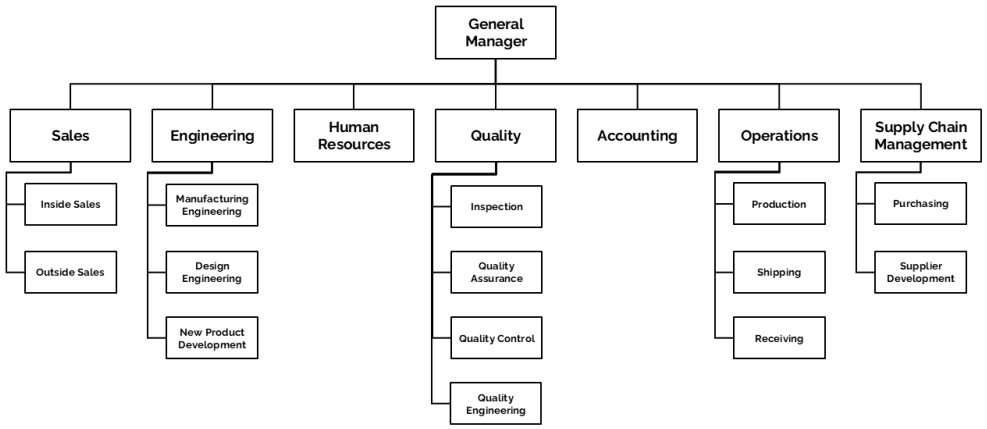


Figure 9. Example functional organizational structure for a manufacturing firm. (Source: The Author's Own Work)

In a matrix organization, employees report to both the project manager and their functional or department manager. Project managers have greater authority in matrix organizations than in functional organizational structures, but less than in project-based organizations. The degree of authority of the project manager can vary across matrix organizational structures. In a weak matrix structure, decision-making authority primarily resides with the functional manager, whereas in a strong matrix structure, the project manager holds most of the decision-making power and controls the project budget. A high degree of collaboration is required across all matrix structures and is most prevalent and important in balanced matrix organizations where the functional manager and project manager share authority and decision-making responsibilities equally. Figure 10 shows an example of the structure of a matrix organization.

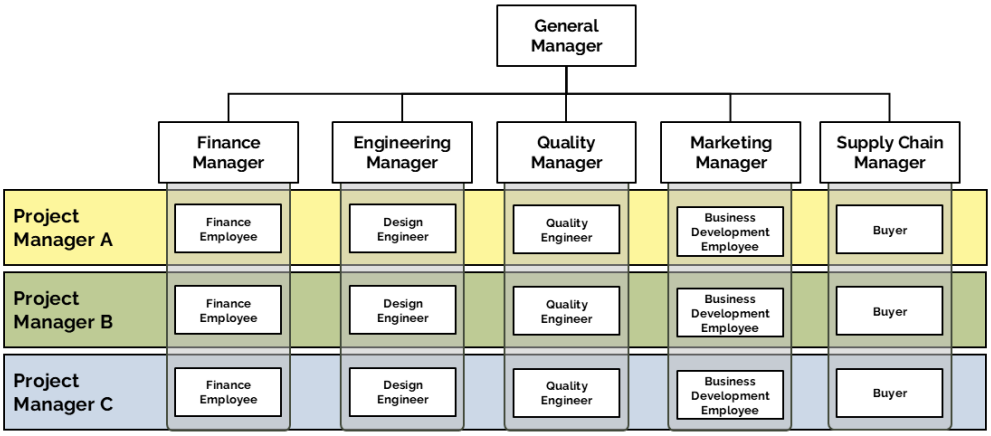


Figure 10. Example matrix organizational structure. (Source: The Author's Own Work)

Construction firms, engineering consulting firms, and similar companies are typically organized around a project-based organizational structure due to the nature of their work. In such situations, most employees work directly on projects and charge their time accordingly. Project managers have a high-level of decision-making authority in these organizations. Figure 11 provides a simple example of a project-oriented organizational structure.

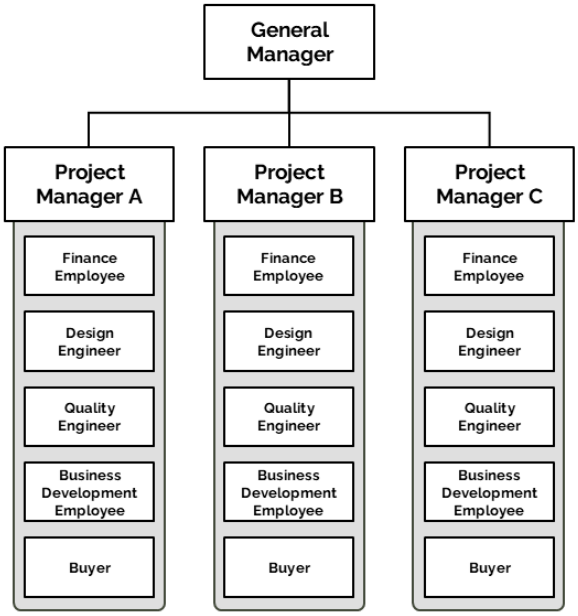


Figure 11. Example project-based organizational structure. (Source: The Author's Own Work)

1.4.3 Organizational Culture

Beyond the organizational structure, the organization's culture directly impacts project success. Culture influences how teams communicate, tolerate risk, adapt to change, and approach authority. Schein et al. [22] describe culture as “a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore to be taught to new members as the correct way to perceive, think, and feel in relation to those problems” and include observable events and underlying forces (see Table 6).

Table 6. Observable events and underlying forces of an organization’s culture. (Source:[22], The Author’s Own Work)

• Observed behavioral regularities when people interact • Group norms • Espoused values • Formal philosophy • Rules of the game • Climate • Embedded skills • Habits of thinking, mental models, and linguistic paradigms • Shared meanings • Root metaphors or integrated symbols • Formal rituals and celebrations

The organization’s culture drives how its members behave [23]. Both internal and external forces shape the company's culture and dictate how projects are managed and their ultimate success. Internal forces include the vision, mission, and strategy; organizational structure; leadership actions and behaviors; human resource practices; and performance measures. External forces may include religion, science, political ideologies, and environmental concerns. Project managers need to understand the organization’s culture as well as the factors that influence their project team members. Within the team, differences may arise, and the project manager must take these differences into account. Without acknowledging and adapting to differences, barriers and conflicts may develop that thwart project success. Thus, the project manager has an opportunity to create and shape a project subculture that drives toward success. Suda [23] recommends that project managers should incorporate the following to increase the probability of success:

- Start with the premise that organizations are living systems
- Assess, identify, work with, and align with the organization’s core values
- Design on the front end a system focused perspective and implement in a manner congruent with that design
- Tie directly to the organization’s strategy

- Align with culture and leadership initiatives
- Understand that all organizations have a core culture and subcultures and the key is that the project culture must function in service of the organization's core or lead culture

A common model for project managers to use to identify and make sense of the environments they are working in was developed by William Schneider [24]. The model is based on two dimensions that describe "what the organization pays attention to" (vertical axis) and "how an organization makes decisions" (horizonal axis). The four quadrants form four core cultures: control, competence, cultivation, and collaboration.

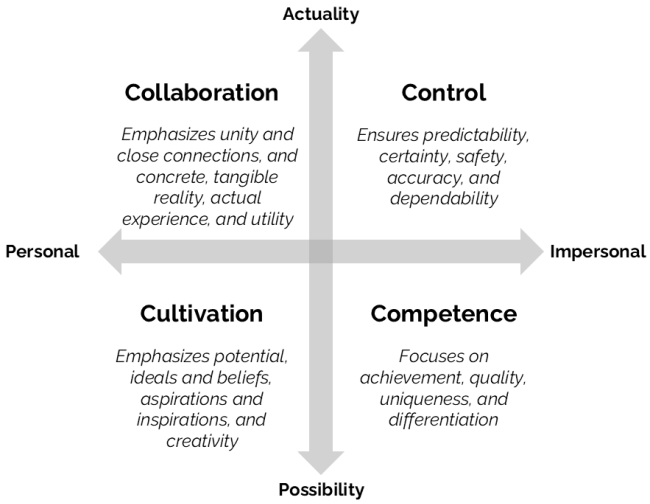


Figure 12. Cultural identification model. (Source: Adapted from [23], [24] and The Author's Own Work)

For additional information on organizational culture and its relation to project success, please refer to the following references:

- The meaning and importance of culture for project success [23]
- The reengineering alternative: A plan for making your current culture work [24]
- Organizational culture and leadership [23]

1.4.4 Governance

Project governance establishes the rules for managing projects. It includes the organization's policies and procedures, stage-gate approvals, level of financial controls, risk oversight, and ethical standards. Governance helps ensure accountability, compliance, and strategic alignment throughout the project lifecycle and can be implemented with or without a formal PMO. However, a mature PMO can increase

project consistency and success rates. The extent to which organizations apply project governance is influenced by the organizational structure and culture.

1.4.5 Resources

Projects require resources that include personnel, budgets, equipment, technology, facilities, physical resources, and information, to name a few. The availability, quality, and allocation of these resources directly influence project planning, execution, and overall performance. In organizations where multiple projects are run simultaneously, project managers compete for resources. Therefore, they must carefully plan resource requirements and, depending on the organizational structure and culture, negotiate with functional managers and stakeholders to ensure resource utilization and access throughout the project life cycle. Constrained resources require project managers to prioritize and negotiate for those resources as well as make trade-offs among scope, schedule, quality, cost, and risk.

Although time is often viewed as a constraint, it is also a resource, given that employee availability is finite. Resource time is reflected in the availability and support of team members, support staff, executives, subject matter experts, contractors, and consultants.

Knowledge repositories and standard project management tools and templates help to avoid repeating mistakes and ensure standardization and compliance. Examples of these resources include lessons-learned databases, historical project records, standard operating procedures, checklists, best practices, documentation, and risk registers. These resources enable project teams to make better-informed decisions, work more efficiently, and reduce uncertainty.

1.4.6 Enterprise Environmental Factors

Conditions internal and external to the company (or project) influence projects but are often outside the team’s direct control. Examples of internal factors, some of which have been discussed previously, include organizational culture, infrastructure, information systems, available technology, and employee capabilities. External factors include, but are not limited to, government regulations, economic conditions, market forces, industry standards, and the political environment.

Enterprise environmental factors support several key principles and performance domains of the PMI PMBOK® [1] (see Figure 13). In addition, these factors influence several of the project performance domains: stakeholder, team, planning, project work, delivery, and uncertainty.

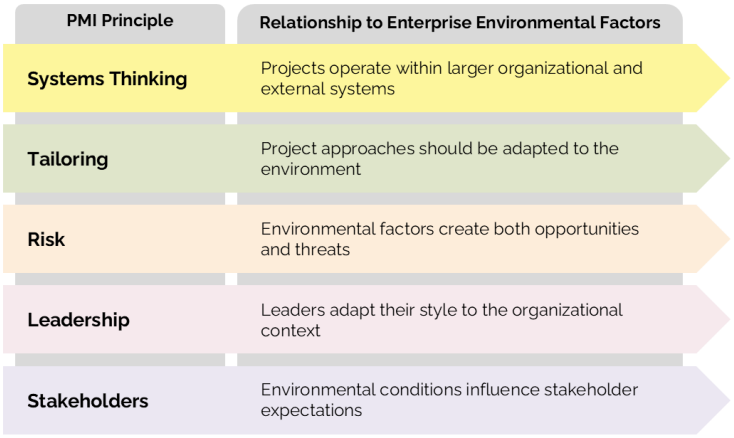


Figure 13. Relationship between PMI PMBOK® Guide principles and enterprise environmental factors. (Source: [1], The Author's Own Work)

1.4.7 Organizational Process Assets

Organizational process assets include the resources available for project managers and their teams to improve project performance. By capturing knowledge from previous projects and establishing best practices from lessons learned, organizational process assets help project managers by reducing the planning effort, improving consistency, supporting better decision-making, and promoting organizational learning. Firms that invest in, develop, and maintain repositories for this information are better equipped to execute projects and adapt to changing conditions. Examples of common organizational process assets are summarized in Figure 14.

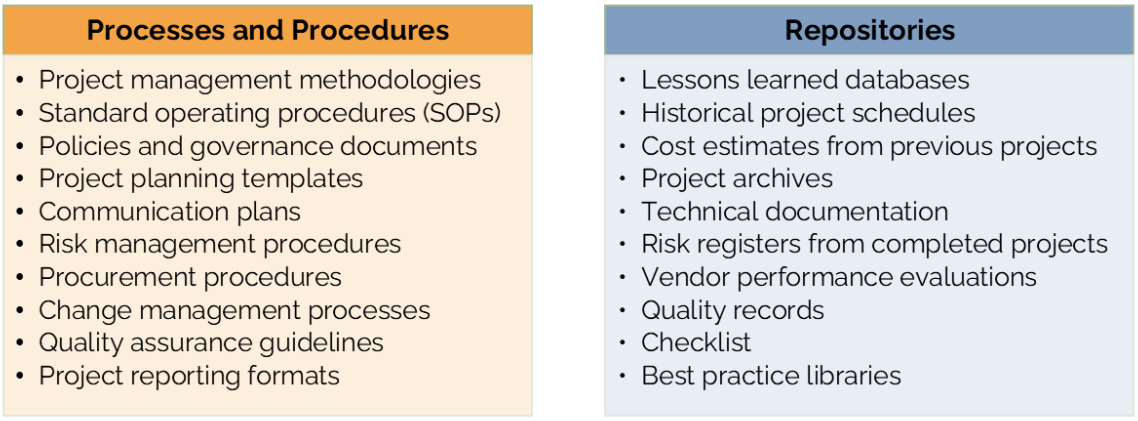


Figure 14. Examples of organizational process assets. (Source: The Author's Own Work)

Processes and procedures provide standardized methods for performing work within a project. Standardized methods are important because they ensure that projects are managed consistently across departments, business units, and geographic locations, and from one project to the next. In addition, standard processes and procedures reduce unnecessary variation and provide guidance for project managers and team members, so they do not have to reinvent practices for each project and can focus on adding value to the project's progress and solving problems as they arise.

Knowledge repositories, or libraries, contain information gathered from completed prior projects. This information can be used to learn from prior mistakes and to apply best practices developed, thus saving time on subsequent projects.

1.4.8 Leadership

Support and project sponsorship from the organization’s leaders are strong predictors of project success. Leaders play an important role by influencing funding decisions, removing organizational barriers and constraints, resolving conflicts, communicating and aligning the organization around the importance of the project, and supporting project managers in change management. Project leaders must actively communicate with leaders to ensure their projects are being supported and that leaders are engaged in important decision-making.

1.4.9 Stakeholders

A stakeholder is any individual, group, or organization that can affect, be affected by, or perceive themselves to be affected by a project’s activities or outcomes [25]. The PMI PMBOK® Guide [1] identifies stakeholders as one of the project performance domains. Successful projects depend on building productive relationships with individuals and organizations that influence project outcomes. Internal stakeholders may include project sponsors, project managers, the project team, company executives, and management. In addition, individuals and parties outside the organization, external stakeholders, may also be affected by the project. External stakeholders may include customers, end users, suppliers, regulatory bodies, government entities, or the public.

Stakeholder analysis is a technique that helps identify and understand stakeholders' needs and expectations. The successful execution of a project requires the project manager to be politically astute and to identify those who are advocates and those who oppose the project [26]. For instructions on how to complete stakeholder analysis as well as examples, the reader is referred to the following references:

- Stakeholder analysis: a pivotal practice of successful projects [26]
- Stakeholder Analysis Process: What is It? [27]
- Project stakeholder management-past and present [28]
- Stakeholder analysis and engagement in projects: From stakeholder relational perspective to stakeholder relational ontology [29]
- Who really matters?: A stakeholder analysis tool [30]

- Information systems project abandonment: a stakeholder analysis [31]

2 Project Planning

Project planning is the process of translating a project's vision into a structured roadmap for execution. More specifically, the PMI PMBOK® Guide defines project planning as "the process of establishing the scope of the project, refining the objectives, and defining the course of action required to attain the objectives and scope" [1]. It focuses on detailing every aspect of the project to guide execution. Without a good project plan, the project's success is at risk. In this chapter, we will explore the various tools and techniques used during the project planning phase.

The project manager plays a key role in anticipating and determining these elements before the project is executed. It's also important to note that the plan that is developed may change, but without a plan, coordinating and communicating those changes becomes more difficult. Planning is not simply about producing documentation. It is about creating a shared understanding of how the value will be delivered and establishing a framework for informed decision-making throughout the project [1]. For more information and general perspectives on the project planning process, please refer to Video 4 and the following references:

- Project Planning Processes that Shape a Successful Project [32]
- Case Study: Keeping it simple? A case study into the advantages and disadvantages of reducing complexity in mega project planning [33]



Video 4. Importance of project planning. (Source: https://youtu.be/FoQxs-0CRxc?si=gXUSj002Xq3S3pAB)

2.1 Project Integration Management

Projects consist of many interconnected activities that must be coordinated to achieve the project's objectives. Planning the project schedule without considering resource availability, managing project risks without evaluating their impact on cost, or implementing changes without understanding their effects on scope can lead to conflicting priorities and unintended consequences. Project integration management provides the framework for coordinating these interdependent activities and ensuring that individual project elements function together as a whole. The Sixth Edition of the PMI PMBOK® Guide defines project integration management as follows:

> ***Project Integration Management****: the set of processes and activities used to identify, define, combine, unify, coordinate, and integrate the various project management activities throughout the project life cycle [16].*

One of the greatest challenges facing project managers is that projects rarely proceed as planned. Requirements evolve, stakeholders request changes, risks emerge, resources become constrained, and priorities shift. These changes often affect multiple aspects of the project simultaneously. For example, a customer may request an additional product feature midway through the development phase. Although the

change appears to affect only the project scope, it may also require additional engineering effort, increase the project costs, extend the timeline, introduce new requirements, require additional procurement activities, and alter expectations. Effective integration management ensures that these interdependencies and the cascading effects of the changes are evaluated systematically before decisions are made.

When such changes are presented, the project manager needs to focus on answering the following questions before agreeing to the change, or at a minimum, make leadership aware of the consequences of the change:

- ☐ How do changes in one area affect the rest of the project?
- ☐ Are the changes and resulting decisions aligned with the organization’s strategy?
- ☐ Do competing priorities require new tradeoffs between scope, schedule, cost, quality, or risk?
- ☐ Are project resources impacted and coordinated effectively to implement the change?
- ☐ Will the project continue to deliver value to the organization if the change is made?

Project integration management is a key responsibility of the project manager. They serve as the key integrator of people, processes, and information. To successfully serve in this role, the project manager must continuously balance competing interests, priorities, requirements, and constraints to maximize the project's value. The larger and more diverse (e.g., international projects) a project is, the more valuable and important it is for the project manager to have skills and competencies associated with being a good integrator.

The Seventh Edition of the PMI PMBOK® Guide no longer includes project integration management activities as prescriptive processes. However, the underlying importance and responsibilities remain essential to good project management. The Sixth Edition of the PMI PMBOK® Guide organized project integration management into seven interrelated processes (see Figure 15).

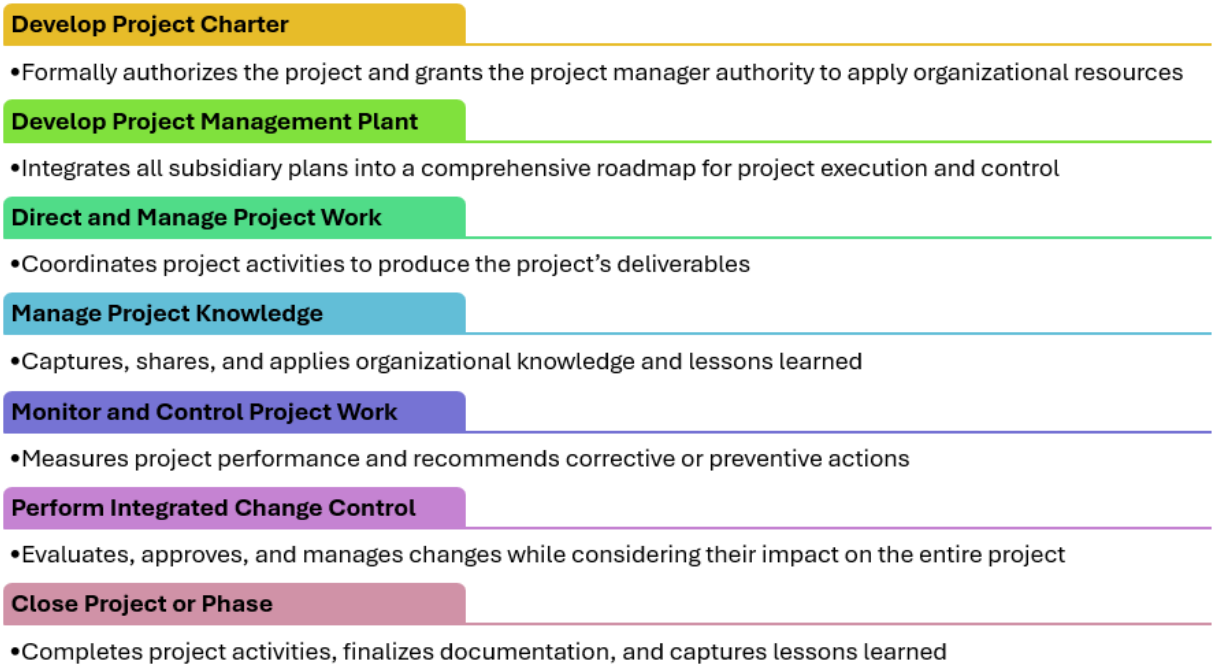


Figure 15. Project integration management processes and their purpose. (Source: [16])

2.2 Project Charter

The project charter is the foundational document for any project. It provides a clear understanding of why the project exists, what it is intended to accomplish, who has the authority to lead it, and leadership's commitment to authorizing the project. The Sixth Edition of the PMI PMBOK® Guide defines a project charter as follows:

> ***Project Charter**: A document issued by the project sponsor that formally authorizes the existence of a project and grants the project manager the authority to apply organizational resources to project activities [16].*

While organizations will include various levels of detail in project charters, the purpose remains the same. It ensures that everyone involved understands the project's strategic purpose and that it is aligned with the organization's strategy before time, resources, and money are expended. The project charter defines the project's high-level objectives and key stakeholders and establishes the project manager's authority. Without a formally approved charter, project teams may lack clear direction, expectations may vary, and project managers may not possess the authority and resources needed to make decisions. It provides answers to the following fundamental questions:

- ☐ Why is the project being undertaken?
- ☐ What organizational need or opportunity does it address?

- ☐ What outcomes are expected?
- ☐ Who is responsible for leading the project?
- ☐ Who are the major stakeholders?
- ☐ What constraints or assumptions should be recognized at the outset?

The charter also serves as an important foundation for project governance. Larger and smaller organizations may need to evaluate numerous project proposals under limited budgets, resources, and time. Therefore, it can assist in providing the necessary information for leadership to approve projects and in documenting approval. For additional information on project charters, please reference the following resources:

- The Charter: Selling Your Project [34]
- The Power of a Project Charter: Purpose, Creation, and Best Practice [35]
- What is a Project Charter? Complete Guide and Examples [36]

Project charter templates come in various formats (e.g., MS Excel, MS Word) and are available from various software providers, some of which are free and others are not. Figure 16 illustrates a simple project charter example for implementing automated warehouse management software. The template shown in the example is provided in the templates included in the Toolkit that accompanies this text. A simple internet search will yield many free templates you can use. An abbreviated list of example template resources is provided below. The reader is encouraged to develop and modify the project charter template to fit their respective organization's and project requirements and needs.

- Project Management Toolkit.zip
- Center for Project Innovation [37]
- Process Management International [38]

Regardless of the template or software being used, project charters include key elements. Table 7 describes the key elements of a project charter and aligns with the example provided in Figure 16.

Table 7. Key elements of a project charter.

Element	Description
Project Purpose and Business Need	Explains why the project is being undertaken and identifies the problem, opportunity, or strategic objective that the project addresses.
Project Objectives	Define the high-level outcomes that the project is expected to achieve. Well-written objectives are specific, measurable, achievable, relevant, and time-bound (SMART) whenever possible. The objectives establish the measurable criteria for evaluating success.
High-Level Scope	Provide a broad description of the work to be performed without defining the detailed requirements. It is often helpful to outline the elements that are within and outside the project's scope to establish project boundaries and reduce confusion among stakeholders.
Major Deliverables and Budget	Major deliverables describe the primary outputs that the project will produce and may include milestones, which are the major categories, significant events, major phases of the project, or checkpoints. The duration of each deliverable includes the expected time to complete it. The budget provides a high-level overview of project costs, including the total cost and contingencies for overruns.
Key Stakeholders	Individuals and groups who have significant influence over or interest in the project.
Project Manager Authority	Identifies the authority granted to the project manager and introduces uncertainty regarding the governance within the project manager's control. Any exceptions to authority should also be stated.
Assumptions and Constraints	Every project begins with assumptions about future conditions that may arise. Similarly, limitations (constraints) may affect the project's performance. Stating assumptions and constraints provides transparency so that all are aware prior to the start of the project.
High-Level Risks	Identifies major risks that may influence project success before detailed risk management begins, including activities to mitigate both high-level and more detailed risks. These preliminary risks provide an initial understanding of project uncertainty and inform subsequent planning activities to address them.
Authorization	Formal authorization provides an official mandate to launch the project. Authorization is typically granted by an executive and authorizes the project manager to allocate resources to project activities.

Project Charter

Project Name	Implementation of Automated Warehouse Management System
Project Manager	Terry Norris
Project Sponsor	Sally Jones

Project Purpose and Business Need

The organization seeks to reduce order fulfillment time by implementing an automated warehouse management system to improve inventory accuracy and reduce shipping delays.

Project Objectives

1. Reduce order fulfillment time by 25% within six months of implementation
2. Increase inventory accuracy to 99.5%
3. Complete system implementation before the holiday sales season

High-Level Scope

Included	Excluded
• Software implementation • Employee training • Data migration	• Replacement of warehouse automation equipment • Facility expansion

Major Deliverables and Budget

Milestone and Duration	Budgetary Items and Estimated Cost
• Selection of Software Vendor: 60 days • Approved System Design: 60 days • Software Installation and Integration: 90 days • Employee Training Program: 14 days • User Documentation: 30 days • **Total Estimated Duration: 254 days**	• Software Subscription (3 years): $180,000 • Implementation Consulting: $220,000 • ERP Integration: $110,000 • Data Migration: $45,000 • Employee Training: $30,000 • Contingency (10%): $58,500 • **Total Estimated Project Cost: $643,000**

Key Stakeholders

Role	Name	Title
Project Sponsor	Sally Jones	CTO
Project Manager	Terry Norris	Senior Project Manager
Functional Manager	Carrie Knapp	Warehouse Manager
Executive Leadership	Sam MacIntosh	VP, Supply Chain Management

Project Manager Authority (place an "X" next to all that apply)

x	Resource allocation	x	Budget management	x	Schedule decisions
x	Vendor coordination	x	Team leadership	x	Change approval

Notes on Project Manager Authority

Changes that exceed the 10% contingency require approval by Executive Leadership and the Project Sponsor.

Assumptions and Constraints

Assumptions	Constraints
• Approval of required funding • Key personnel are available • Technology is compatible with the existing ERP	• Fixed budget • Required completion date • Limited staffing

High-Level Risks

- Supply chain disruptions
- Delays associated with integration and data migration
- Resource shortages
- Resistance to change

Authorization

Name	Title	Signature	Date
Sam MacIntosh	VP, Supply Chain Management	Samuel D. MacIntosh	07/17/26

Figure 16. Project charter example. (Source: The Author's Own Work)

2.3 Project Scope Management

One of the primary responsibilities of a project manager is to ensure that the project delivers all the work required to achieve its objectives. This also means that *only* the work required shall be done. In general, every project is initiated to produce products, deliver services, or make improvements. However, if the project's boundaries aren't clear, the team may misunderstand expectations, duplicate efforts, overlook critical items, or perform work that may not add value. Often, it is as important, if not more important, to clearly identify what's *not* within the scope of the project as it is to identify what *is* in scope (see High-Level Scope in Figure 16). The Sixth Edition of the PMI PMBOK® Guide defines project scope management as follows:

> ***Project Scope Management****: The processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully [16].*

Scope management is one of the most critical areas in project management. It established the foundation for nearly every other planning activity: project schedule, budget, resource requirements, procurement activities, standards, requirements, and risk management. Having a poorly defined scope often leads to project delays, budget overruns, project failure, and a host of other negative consequences. To manage the scope effectively, project managers must go beyond merely limiting work within the project's scope to ensure the project team is keenly aware of the project's objectives, deliverables, assumptions, constraints, and measures of success, all of which are defined in the project charter.

Product scope and project scope are often confused. The product refers to the project's deliverable and thus could also refer to the service, process, or final deliverable of the project. For simplicity, we will refer to a product, but any deliverable could be substituted for the term product. The product scope refers to the characteristics, features, and functions of the project deliverable. In other words, it describes what the internal or external customer expects at the end of the project. Alternatively, the project scope describes the work required to deliver the product at the project's focus. It focuses on how the project team will achieve the project's desired outcome.

By clearly defining the project scope, a project manager can establish a shared understanding among stakeholders regarding what the project will and will not deliver. Doing so reduces ambiguity, improves communication, and provides the baseline for planning and controlling the work within the project.

One of the most common issues within projects is scope creep. Scope creep is the uncontrolled growth of project work without allowances for the schedule, budget, or resources. It can result from informal requests from executives or stakeholders, poorly defined customer requirements, poor change control processes, and an ill-defined

scope. This isn't to say that changes won't or shouldn't occur during project execution. Sometimes they are necessary and can create additional value. Instead, it is the lack of control and the inability to manage changes appropriately that can create problems or, worse, chaos within the project team.

When defining the project scope, collaboration is required. The project sponsor, project manager, project team, executive management, and other key stakeholders will need to be on the same page. Thinking of scope development and definition as a process with inputs and outputs can help to facilitate collaboration (see Figure 17).

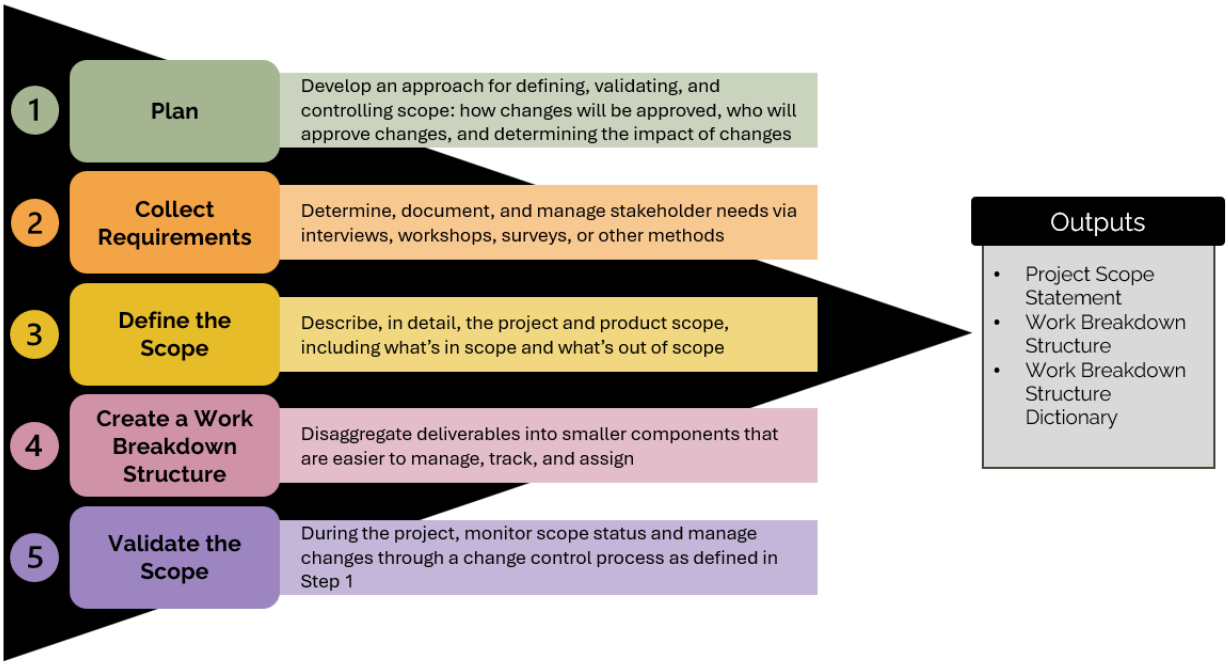


Figure 17. Scope development and definition process. (Source: [39], [16], The Author's Own Work)

Once the project scope has been defined and approved, it becomes part of the scope baseline, which serves as a reference point for evaluating the project's ongoing performance and managing changes that may occur. The Sixth Edition of the PMI PMBOK® Guide identifies three components of the scope baseline [16]:

- **Project Scope Statement**: A detailed description of the project's objectives, deliverables, assumptions, constraints, and boundaries
- **Work Breakdown Structure**: A hierarchical decomposition of the total project scope into smaller, manageable work packages
- **Work Breakdown Structure Dictionary**: Supporting documentation that describes each work package, including responsibilities, deliverables, assumptions, and acceptance criteria

The primary goal of a successful project is to deliver value to the stakeholders. At times, this can get lost in the details of the project activities. Effectively managing the scope of the project helps deliver that value by ensuring the project work focuses on the meaningful outcomes stakeholders expect, not just completing tasks. Think of it this way: the customer at the end of the project doesn't usually care about the action items; they simply want the outcomes they expect. There are certainly some exceptions to this rule (e.g., milestone completion payments, incentives to adhere to requirements), but for the most part, customers and stakeholders just want the project to deliver what was expected on time and on budget.

Adding features or expanding project work does not necessarily increase value. In many cases, additional work increases costs, delays project completion, and complicates implementation without improving stakeholder satisfaction. As a result, it is important for project managers to evaluate whether proposed changes contribute to the project's objectives or not and control the project accordingly.

For additional reading on project scope management and scope creep, please reference the following resources:

- Analysis of project scope change management as a tool for project success: Case study of Akazi Kanoze projects (2011–2014) [40]
- Managing project scope definition to improve stakeholders' participation and enhance project outcome [41]
- Managing project scope creep in the construction industry [42]
- Factors affecting scope creep in project management: Identify the key factors contributing to scope creep and explore strategies to prevent it [43]
- A triangular perception of scope creep influencing the project success [44]
- Effect of Scope Creep in Software Projects–Its Bearing on Critical Success Factors [45]

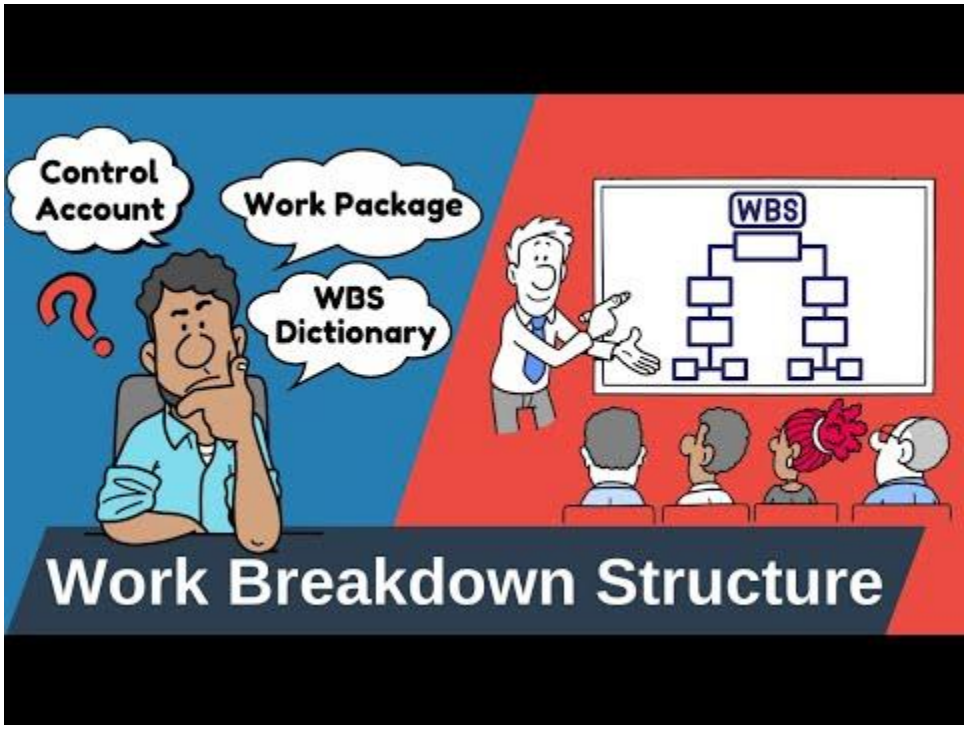
2.4 Work Breakdown Structure (WBS)

Once the project scope has been defined, the project team next needs to determine how all of the activities will be organized and managed. Projects can include hundreds to thousands of individual actions and activities. Without an organized approach to managing them, the project is doomed to fail. A work breakdown structure (WBS) provides the organizational framework for disaggregating the project scope into smaller, more manageable activities. The Sixth Edition of the PMI PMBOK® Guide defines WBS as follows:

> ***Work Breakdown Structure (WBS)****: A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables [16].*

The WBS organizes the project into smaller levels of detail, beginning with the overall project and continuing through major deliverables. Unlike a project schedule, which is helpful in developing it, the WBS provides a breakdown of what must be delivered and establishes a foundation for estimating costs and timelines, assigning responsibilities, identifying risks, and monitoring project performance.

The purpose of the WBS is to organize and define the complete scope of the project and divide broader work into smaller, more manageable components. By doing so, the project manager and team at-large can better understand what it will take to complete the project. Video 5 provides an overview of WBS, the WBS dictionary, its components, and an example of a real WBS.



Video 5. Work breakdown structure explained. (Source: https://www.youtube.com/watch?v=fFluTGvKWMA)

The first step in developing a WBS is to define the scope of the project by determining deliverables and requirements [46]. Next, those deliverables are decomposed into the individual work packages. The final step before designing the WBS is to select the appropriate way to construct it for your project, including different WBS types. There are five primary types of WBS, each based on whether the focus of the project is on deliverables or the project schedule. The deliverable-oriented WBS and phased-based

WBS are the most common. There are more types of WBS approaches than those listed in Figure 18, and ultimately, they should be customized to best serve the project.

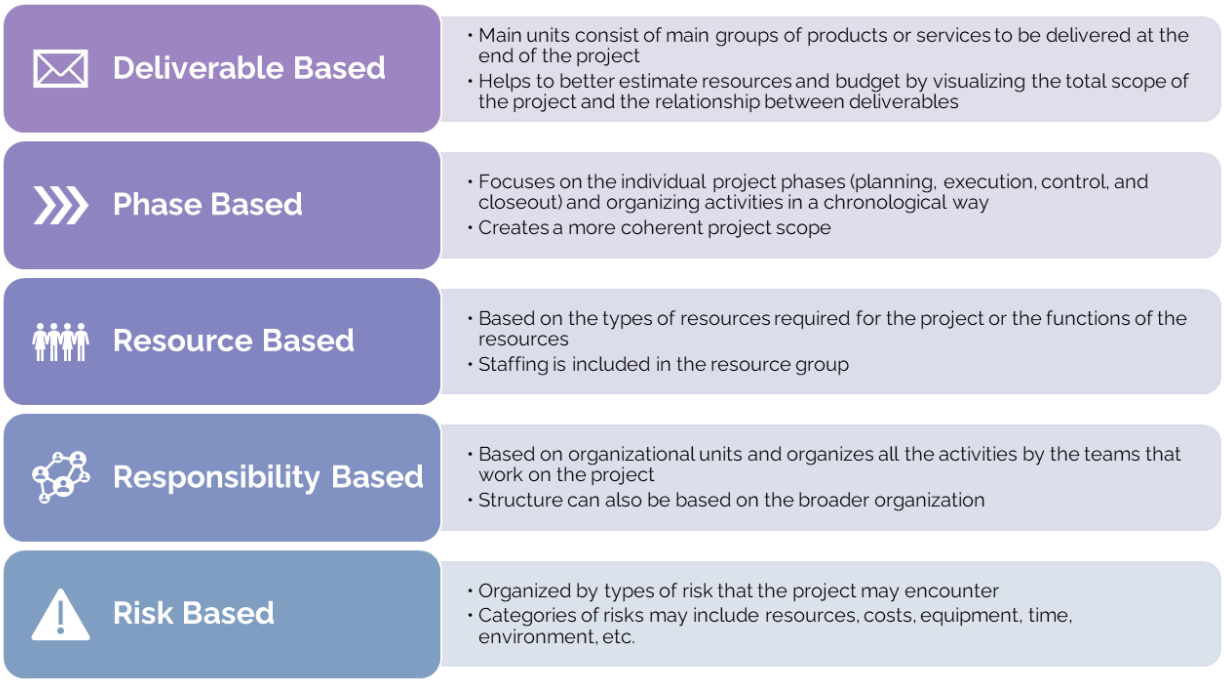


Figure 18. Types of work breakdown structures. (Source: [46], The Author's Own Work)

WBS structures can be quite extensive, if done correctly, and can take on different formats. Often, a WBS is shown in a tree format with the broadest categories at the top, and most detailed at the bottom. Alternatively, a WBS can be developed in an indented form. Figure 19 illustrates the top and second levels (left) of a deliverable-oriented, indented work breakdown structure for implementing the warehouse management system described in the project charter in Figure 16. Additional details of one of the second-level deliverables, the systems integration deliverable (1.8), is broken down into its third and fourth levels of deliverables.

The WBS is one of the best tools for project managers to organize and manage project work. By decomposing the project scope into manageable, deliverable-oriented work packages, the WBS provides the structure needed to estimate costs, develop schedules, assign responsibilities, monitor progress, and control project performance. Rather than being simply a list of tasks, the WBS represents a comprehensive view of the project's approved scope and serves as the foundation for nearly every subsequent project management activity.

For more information on WBS, please refer to the following:

- The WBS [47]
- Work Breakdown Structures Overview [48]
- Work Breakdown Structure (WBS): A Comprehensive Guide [46]

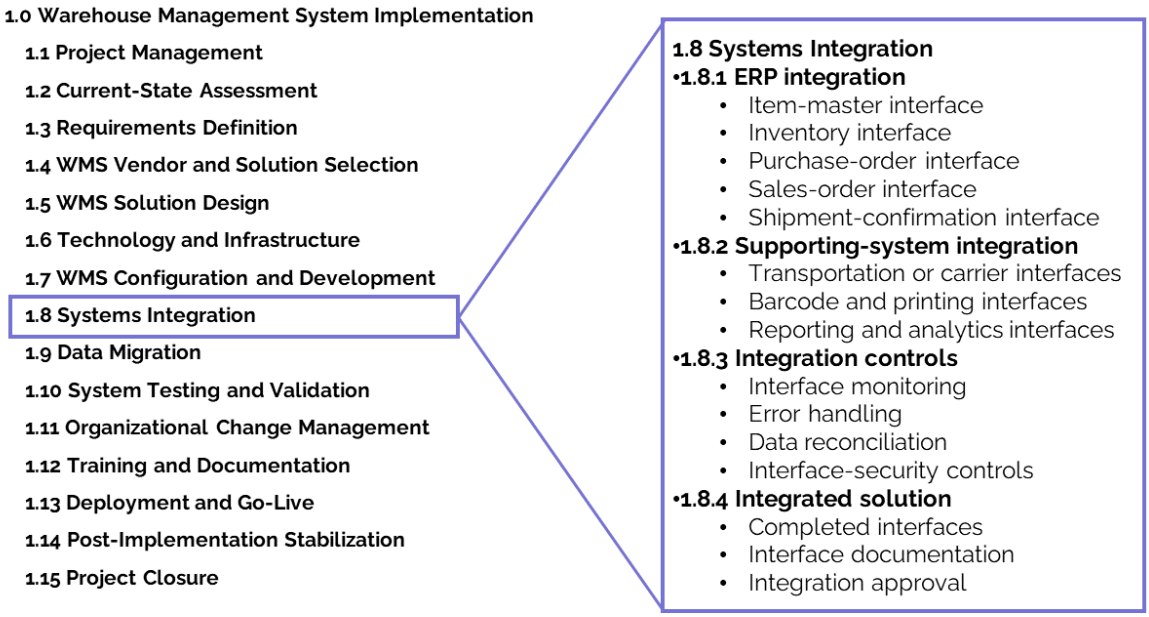


Figure 19. Indented work breakdown structure example (Source: The Author's Own Work)

2.5 Project Schedule Management

After the project scope has been defined and the WBS organized, the next important endeavor is to determine when the work will be performed and how individual activities will be coordinated. The PMI defines project schedule management as the processes required to manage the timely completion of the project, including methods used to identify project activities, determine sequences, estimate resources, and approximate the time required to complete them [16].

The Sixth Edition of the PMI PMBOK® Guide organizes project schedule management into six processes as outlined in Table 8 including: 1) plan schedule management, 2) define activities, 3) sequence activities, 4) estimate activity durations, 5) develop schedule, and 6) control schedule. These processes are important regardless of the project management approach. Predictive projects may develop a comprehensive schedule at the beginning of the project, while Agile projects typically plan work in shorter increments and update the schedule as priorities and requirements evolve.

Table 8. Project schedule management processes. (Source: [16])

Process	Purpose
Plan Schedule Management	Establishes the policies, procedures, tools, and documentation that will be used to develop and control the schedule
Define Activities	Identifies the specific activities required to complete the project work packages
Sequence Activities	Determines the logical relationships and dependencies among project activities
Estimate Activity Durations	Estimates the amount of time required to complete each activity
Develop Schedule	Integrates activity sequences, durations, resources, and constraints into an approved project schedule
Control Schedule	Monitors schedule performance and manages changes to the schedule baseline

When sequencing activities, dependency relationships are identified, and a determination is made to which activities must occur before, after, or at the same time (in parallel) as other activities. Four common relationship dependencies include [49]:

- **Finish-to-start**: The successor cannot begin until the predecessor is complete
- **Finish-to-finish**: The successor cannot finish until the predecessor finishes
- **Start-to-start**: The successor cannot begin until the predecessor begins
- **Start-to-finish**: The predecessor cannot finish until the successor begins

Gantt charts, critical path method (CPM), and network diagrams are among the most popular and essential tools to ensure that project scheduling management is organized and visualized [50]. All are time-oriented diagrams based on the basic unit, “the task,” which is an activity that the project team will perform to accomplish the project’s goals [51]. Tasks are comprised of a name, or description, constructed in a verb-noun sequence (e.g., identify potential vendors), an estimate of the amount of calendar time required to complete it, and the resource assigned to complete it. Finally, tasks are linked by the dependencies that may exist between them. The following subsections provide overviews and examples of the common tools used to manage project schedules.

For an overview of project scheduling management, Gantt charts, PERT charts, CPM, and network diagrams, please reference the following:

- Scheduling 101 - The basic of best practices [49]

- Creating a Project Schedule: A Guide to Network Diagrams, CPM, and Gantt Charts [50]
- Graphical Project Planning Techniques: An Overview of Gantt, PERT, and CPM Charts [51]
- Gantt Chart vs. PERT Chart vs. Network Diagram: What Are the Differences? [52]
- What is a Gantt Chart? [53]
- Program Evaluation Review Technique (PERT) Chart Explained [54]
- Understanding the Basics of CPM [55]

2.5.1 Gantt Charts

The Gantt chart gets its name from Henry L. Gantt, an engineer and social scientist, who is credited with inventing it in the early 1900s [51]. A Gantt chart is a visual project management tool that assists in the planning and scheduling of projects of all sizes. Project management timelines and tasks are converted into horizontal bars to form a bar chart. The so-called Gantt bars show the start and end dates of individual tasks, as well as dependencies and prerequisite tasks (arrows), percent completion, and the task owner [53]. More advanced software can also include links to project budgets and other elements of managing the project portfolio. Its ease of interpretation, while including so much information, makes it one of the most useful and widely used project management tools. Illustrates a simple Gantt chart using the high-level tasks for the warehouse automation project described previously. In practice, project schedules will have many more project tasks and subtasks.

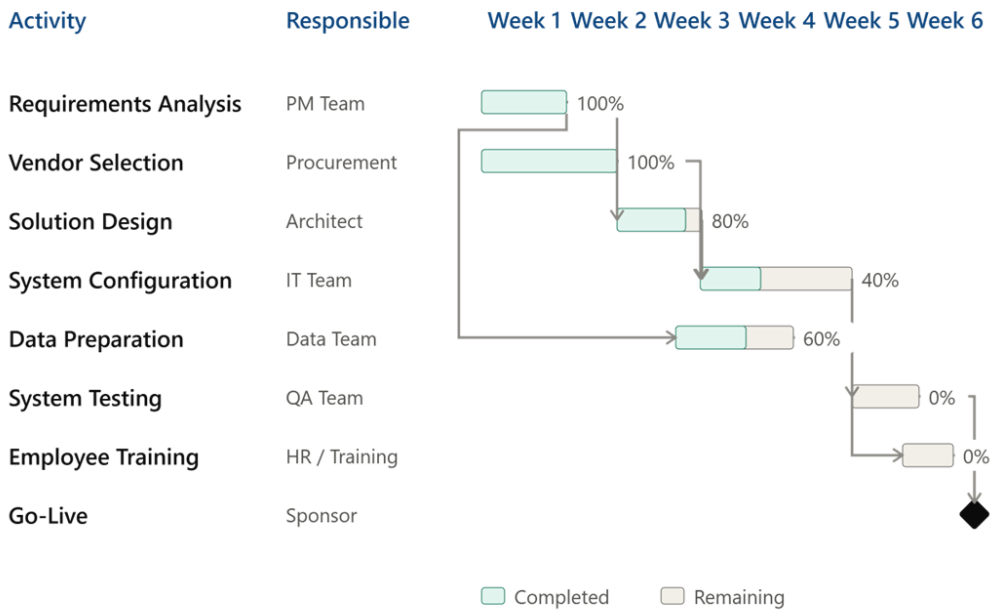


Figure 20. Gantt chart example (Source: Generated with the assistance of Claude.ai)

A variety of software tools, both free and for a fee, are available to construct Gantt charts. The most popular software is Microsoft Project®. Other Microsoft Excel® templates are also available and can be found with a simple internet search. AI tools, such as Microsoft CoPilot®, Claude, and ChatGPT, can also be used to generate Gantt charts and templates. Examples of software programs that can be used to generate Gantt charts can be found via the following links:

- Microsoft Project®
- Microsoft Excel® Templates
- Microsoft Excel® Template (American Society for Quality)
- Monday
- Asana
- Primavera

While Gantt charts provide an explicit (and linear) visualization of a project timeline, show all tasks and their relationships to one another, and provide information related to deadlines, project status, and progress, they do have some limitations [51]. For example, some representations may not indicate person-hours (only calendar time), explicitly outline dependencies, include all resources, explicitly show the critical paths for the project, or record the difference between planned and actual durations. Many of

these issues can be resolved by customizing the Gantt chart to suit the needs of the project team or selecting software that includes some of these advanced features.

2.5.2 Network Diagrams

A network diagram represents project tasks and the relationships and sequences between them. It shows which tasks are completed in parallel and the dependencies that may exist between them. To create a network diagram, list all of the tasks in the project and identify the dependencies between the tasks. Next, draw nodes for each task and connect them with arrows to represent the dependencies. Finally, number the nodes/tasks to show the sequence in which they should be completed [50].

Network diagrams can be created using a variety of software programs such as Microsoft Office® products and AI tools. Figure 21 illustrates an example of a network diagram.

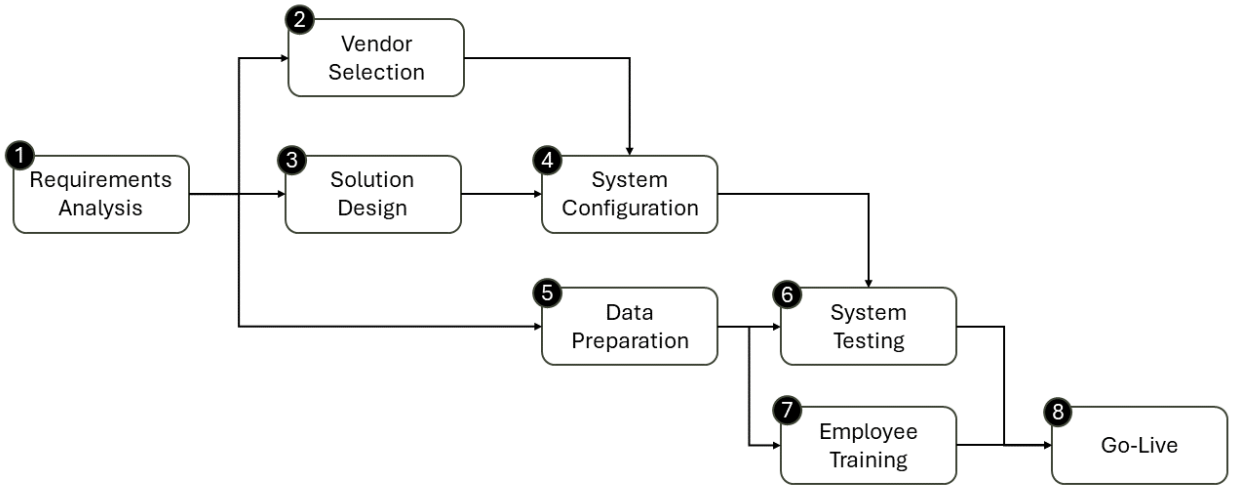


Figure 21. Network diagram example. (Source: The Author's Own Work)

2.5.3 Program Evaluation and Review Technique (PERT)

A program evaluation and review technique (PERT) chart is another tool that allows project managers to visualize a project's timeline in relation to the individual tasks of the project [54]. PERT charts can be constructed using Microsoft Excel® and many other software packages. The chart comprises nodes, represented as numbered circles or rectangles, that represent project events or milestones and are connected by arrows that represent dependent tasks and their respective durations. In addition, the direction of the arrows represents the flow and sequence of tasks. PERT was originally developed in the late 1950s by the U.S. Navy in support of the Polaris nuclear submarine project to improve planning and scheduling for large, complex projects with

uncertainty [51]. Figure 22 illustrates a PERT chart for the automated warehouse management system project. For more information and details on how to create a PERT chart, please see Video 6.

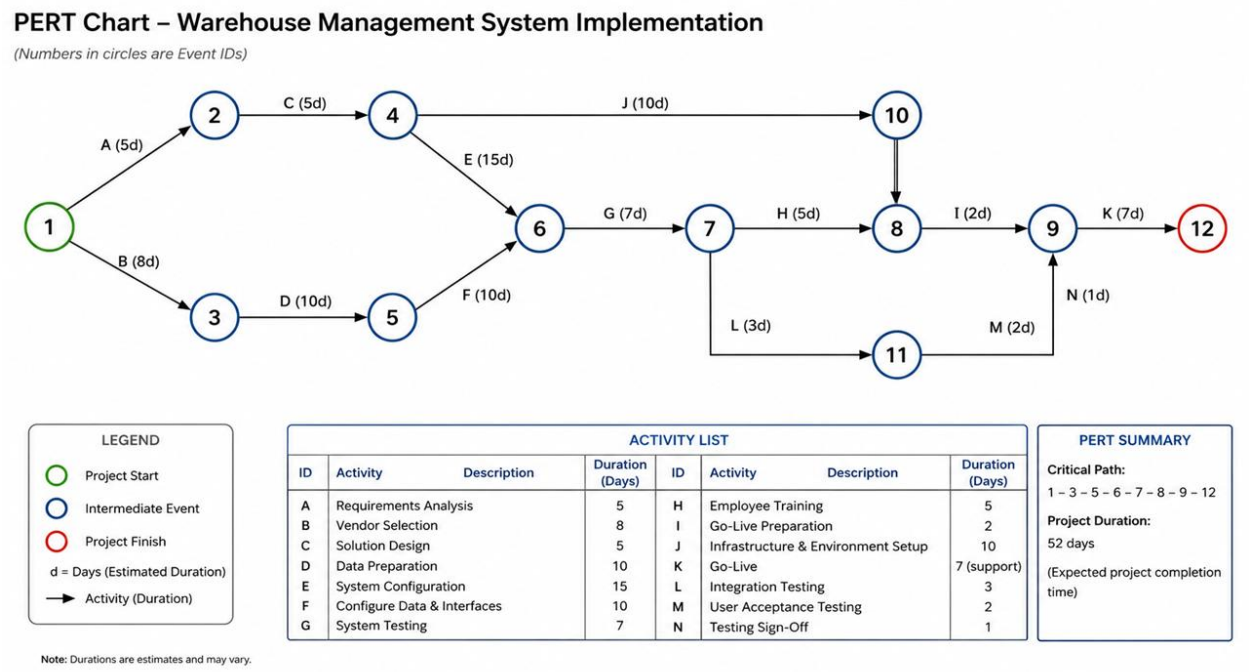
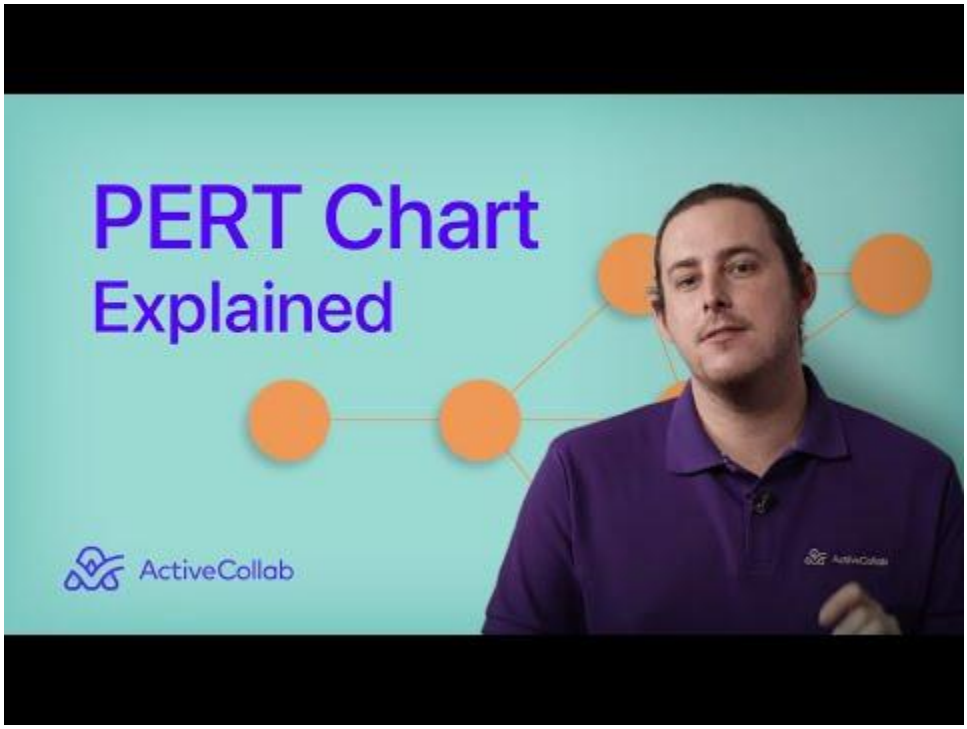


Figure 22. PERT chart example. (Source: Generated with the assistance of ChatGPT)



Video 6. How to create a PERT chart. (Source: https://www.youtube.com/watch?v=PZTqepDRIas&t=40s)

2.5.4 Critical Path Method (CPM)

Critical path method (CPM) is another technique useful in project schedule management and determines the shortest possible time to complete a project by identifying a critical path, which describes the sequence of tasks that directly impacts the project duration [50]. Any activity on the critical path generally does not have schedule flexibility if the project is to remain on time. A diagram showing the critical path of the warehouse management system project described previously is illustrated in Figure 23 and Video 7 walks through an example of the steps to determine the critical path of a project.

In general, there are eight steps to determine the critical path. They are as follows [55]:

1. **List activities**: Identify and list every task required to finish the project.
2. **Identify dependencies**: Determine which tasks must finish before other tasks can start, and which can be completed in parallel.
3. **Create a network diagram**: Draw a network diagram that maps the tasks, their connections, and precedence with arrows.
4. **Estimate task duration**: Assign an estimated time to each activity.

5. **Perform a forward pass**: Calculate the earliest start and earliest finish times for every task by moving from start to finish (left to right) through the project schedule.
6. **Perform a backward pass**: Calculate the latest start and latest finish times for every task by moving from finish to start (right to left) through the project schedule.
7. **Calculate float**: Find the buffer time (i.e., slack time) for each task to determine if there is flexibility in delays or not. Please see [55] for detailed calculations.
    a. Total Float (Start) = Late Start – Early Start
    b. Total Float (Finish) = Late Finish – Early Finish
    c. Free Float = Lowest of Early Start of Successors – Early Finish
8. **Identify the critical path**: Find the longest continuous chain of dependent tasks with zero float. This chain is the minimum project timeline, or critical path.

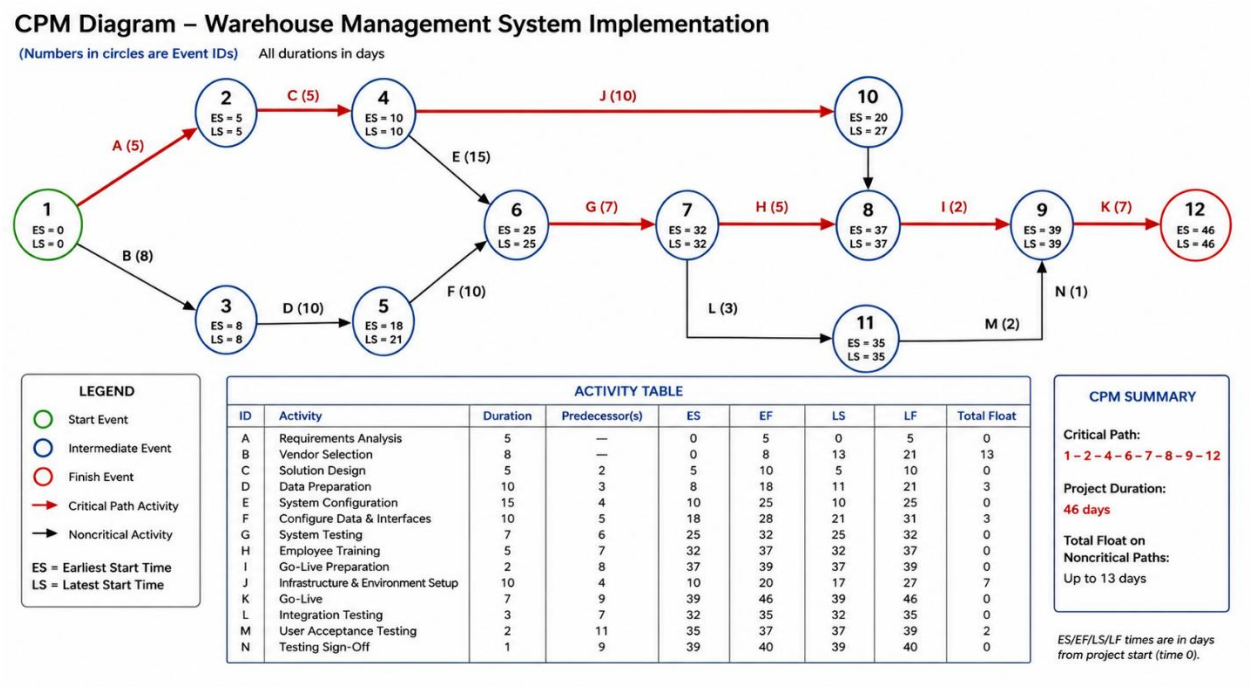
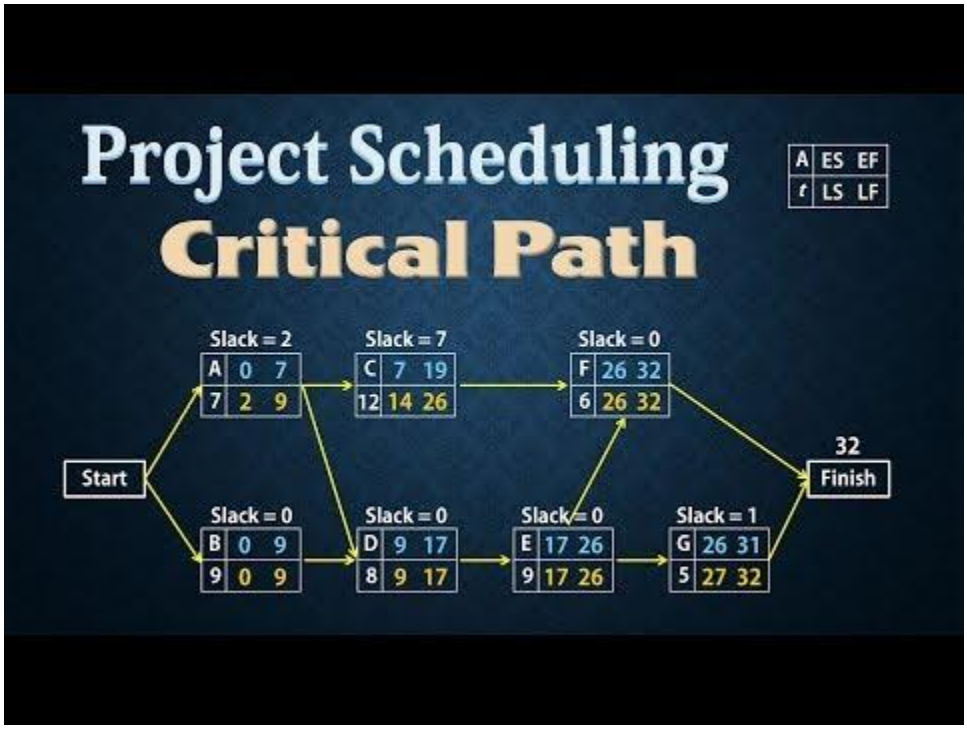


Figure 23. Critical path method example. (Source: Generated with the assistance of ChatGPT)



Video 7. Critical path method explained. (Source: https://www.youtube.com/watch?v=-TDh-5n90vk)

2.6 Project Cost Management

Project cost management is the knowledge area concerned with planning, estimating, budgeting, financing, and controlling costs so that a project can be completed within its approved budget [16]. Because costs, together with scope and schedule, form one leg of the traditional triple constraint, deficiencies in cost management tend to surface quickly when schedules slip, scopes change, and stakeholders become dissatisfied. Effective cost management therefore functions as both a planning discipline and an early-warning system throughout the project life cycle.

The Sixth Edition of the PMI PMBOK Guide organizes cost management into four sequential processes (see Figure 24). In the first step of the process, plan cost management, the policies, procedures, and documentation are established that will govern how costs are estimated, budgeted, managed, and controlled throughout the life cycle of the project. Next, costs are estimated to approximate the monetary resources required to complete each activity or work package. Common techniques include using historical data from similar projects (analogous estimating), applying statistical relationships between variables (parametric estimating), aggregating detailed estimates from the lowest WBS level (bottom-up estimating), and blending optimistic, pessimistic, and most-likely scenarios to account for uncertainty (three-point estimating). Once costs are estimated, the budget is then determined by aggregating the estimated costs of

each individual activity to establish an authorized baseline, typically inclusive of contingency reserves for identified risks and management reserves for unforeseen work [56]. The last step of the cost management process is to monitor project status in order to update the budget and manage any changes to the cost baseline, comparing actual expenditures against the baseline to detect and respond to variances.

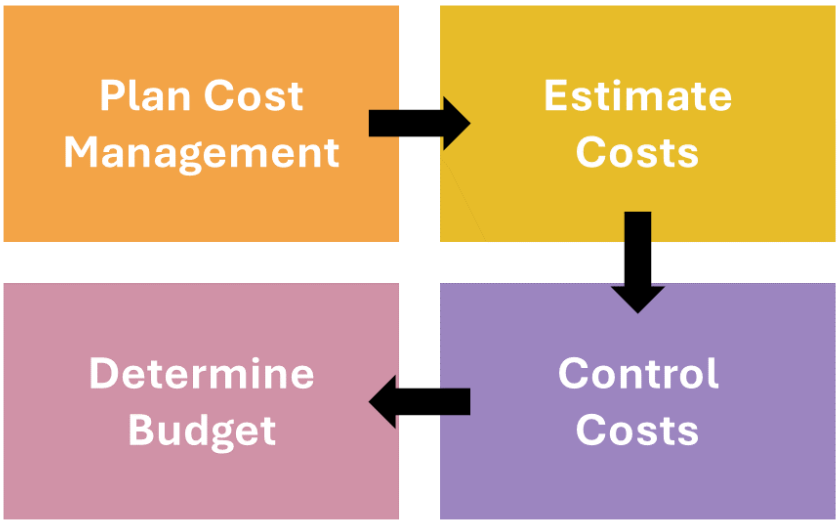


Figure 24. Cost management sequential processes. (Source: [16], The Author's Own Work)

Earned value management is widely used in practice for integrating scope, schedule, and cost data into a single performance measurement system. It compares the budgeted cost of work scheduled, the budgeted cost of work performed, and the actual cost of work performed to generate indices such as the cost performance index (CPI) and schedule performance index (SPI), which project managers use to forecast final cost and completion date (see Figure 25). Related refinements, such as earned schedule analysis, extend these indices to provide more accurate time-based forecasts, particularly for projects that are significantly ahead of or behind schedule.

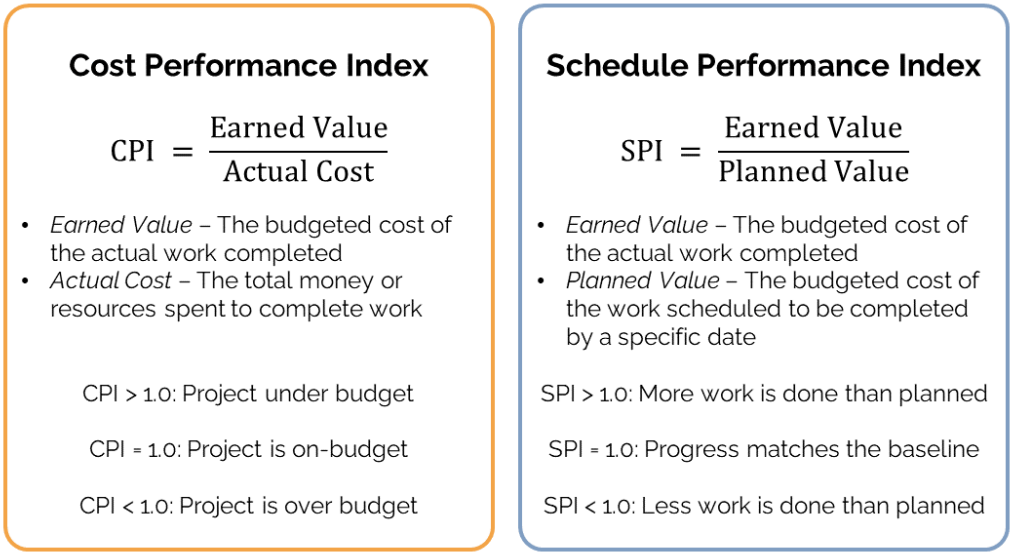


Figure 25. Cost performance index and schedule performance index. (Source: [57], [58], The Author's Own Work)

Because cost estimates are made under uncertainty, mature cost management practice distinguishes between contingency reserves (i.e., funds allocated for identified risks within the project's risk register) and management reserves, which cover unidentified risk exposure and are typically controlled outside the project manager's direct authority [56]. This distinction supports transparent reporting to sponsors and reduces the temptation to treat all reserve funds as a general-purpose buffer.

Across all of the cost management processes, a recurring theme is that different stakeholders measure and care about project cost differently, and often at different points in time. For example, a sponsor may focus on the total authorized budget, a controller on burn rate against forecast, and a project manager on variance at the work-package level. A well-designed cost management plan reconciles these perspectives by defining, up front, how cost data will be estimated, reported, and escalated, thereby reducing the likelihood that cost issues are discovered only after they have become schedule or scope issues. For additional information on project cost management, explore Video 8.



Video 8. How to deliver effective project cost management. (Source: https://www.youtube.com/watch?v=7bXcc7AYajo)

2.7 Earned Value Analysis

Earned value analysis (EVA) is a quantitative method used to evaluate project performance by comparing the value of the work completed with the work planned and the actual cost incurred. In comparison, earned value management (see Section 2.6) is the broader management system in which EVA is applied and integrates measurements of scope accomplishment, schedule progress, and cost performance [59].

EVA allows project managers to answer three fundamental questions. By answering the following questions, the project manager can determine whether the project is ahead or behind schedule, under or over budget, and likely to meet its approved cost objectives.

1. How much work did the project plan to complete?
2. How much work has actually been completed?
3. How much did the completed work cost?

There are three core data points associated with EVA. They are planned value, earned value, and actual cost. The planned value (PV), or budgeted cost of work scheduled (BCWS), represents the authorized budget for the planned work to be accomplished, calculated as the project's budget multiplied by the percentage of work planned to be complete at a given point in time [60]. Earned value (EV) is also known as budgeted

cost of work performed (BCWP) and is the budget value of work completed to date. It is found by taking the actual percentage of completed work and multiplying it by the project budget [61]. The third data point associated with EVA is actual cost (AC), sometimes referred to as actual cost of work performed (ACWP), and represents the money spent on the work accomplished (i.e., what has been spent so far) [62].

Measures of variance and performance are subsequently derived from PV, EV, and AC. They include schedule variance (SV), cost variance (CV), schedule performance index (SPI), and cost performance index (CPI). Please reference Section 2.6 and Figure 25 for details regarding SPI and CPI. Figure 26 includes the formulas and guidelines associated with the variance metrics, SV and CV.

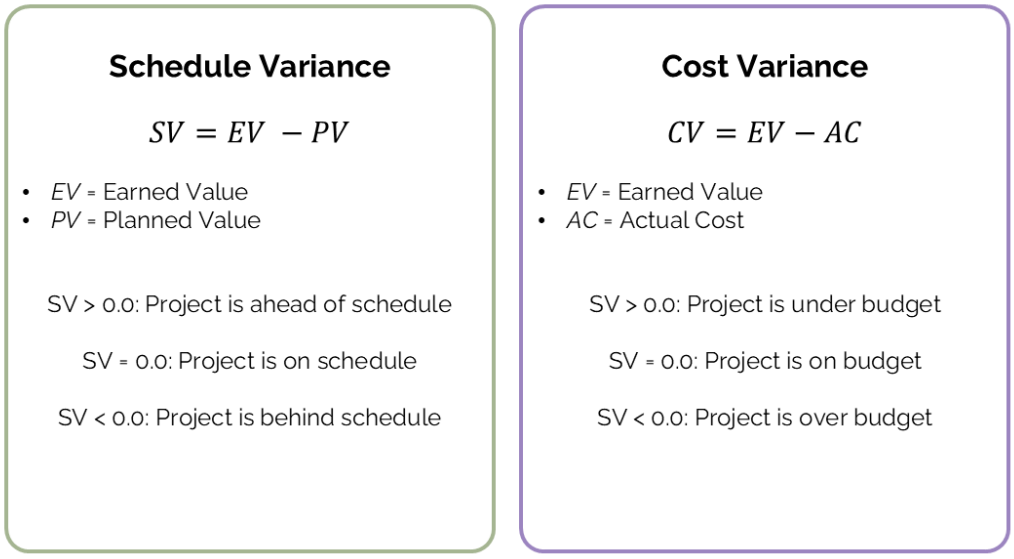


Figure 26. Schedule variance and cost variance. (Source: [59], The Author's Own Work)

While SPI, CPI, SV, and CV serve as good diagnostic tools, they are reactive measures by nature. Budget at completion (BAC), estimate at completion (EAC), estimate to complete (ETC), variance at completion (VAC), and to-complete performance index (TCPI) are forecasting metrics that can help mitigate schedule and cost issues before they arise. Figure 27 illustrates the formulas, definitions, and uses for EAC, ETC, VAC, and TCPI.

For additional resources and examples on EVA, please refer to the following articles as well as Video 9.

- Earned Value Management Systems (EVMS) [59]
- Earned Value Management: Earned Value Formulas You Need To Know For the PMP Exam [60]

- Planned Value (PV), Earned Value (EV) & Actual Cost (AC) in Project Cost Management [61]
- Earned Value Management & 12 Earned Value Formula for PMP [62]

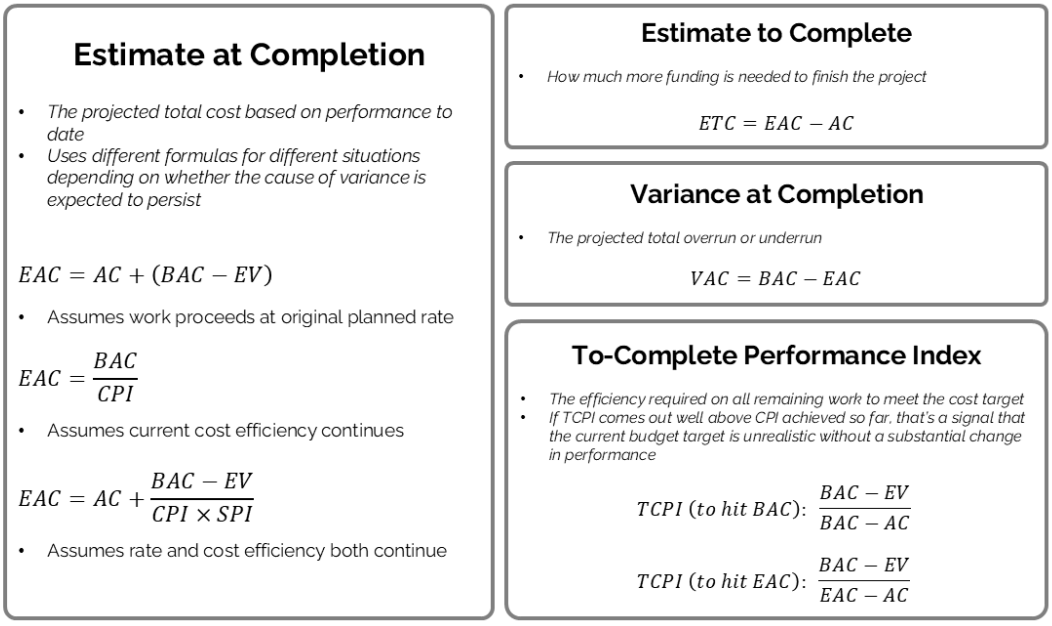


Figure 27. Project forecasting metrics. (Source: [59], [60], [61], [62], The Author's Own Work)



Video 9. Earned value analysis. (Source: https://www.youtube.com/watch?v=o_BG-wxLGzg)

2.8 Project Quality Management

Project quality management is the knowledge area concerned with ensuring that a project's deliverables meet the requirements expected by the customer. PMI defines quality as "the degree to which deliverables fulfill requirements" [63]. The PMI PMBOK® Guide frames the broader discipline as "the activity of developing the best possible products and services required to meet customers' expectations using the best possible processes and procedures" [16].

Modern treatments typically organize the knowledge area into three interrelated processes. The first, plan quality management, involves identifying quality requirements and standards for the project and its deliverables and documenting how the project will demonstrate compliance. The second area, manage quality, is sometimes referred to as quality assurance and translates the quality management plan into executable activities. Per the PMI definition, manage quality "determines the organization, design objectives, and resources needed to provide the project team, client, and stakeholders with performance standards and feedback on the project's performance" [64]. Lastly, control quality, which is "the process of monitoring and recording the results of quality management activities to assess performance" [64].

A useful distinction within project quality management is between quality assurance and quality control [64], [65]. Quality assurance is process-oriented, while quality control is product-oriented. Quality assurance emphasizes prevention over inspection and aligns with the idea of doing it ‘right the first time’ because deliverables should be error-free from the start, since it is more costly to fix mistakes than to prevent them. Quality control, in contrast, is the process of comparing product quality against applicable standards, with a focus on defect detection and removal through testing, review, inspection, and verification.

Underlying both quality assurance and quality control is the concept of the cost of quality (COQ), which captures the tradeoff that organizations must manage between prevention and failure. PMI describes this as the costs required to achieve quality management and includes the costs necessary for ensuring conformance to specifications as well as the costs incurred as a result of non-conformance [66]. In practice, this means there is an optimal cost of quality where additional investment in prevention and appraisal activities stops being cost-effective relative to the failure costs it avoids, which is why quality planning should establish quantitative rather than purely qualitative standards from the outset.

For a deeper dive into the understanding of project quality management, the reader is encouraged to read the following articles:

- Plan and Manage Quality of Products/Deliverables [67]
- Welcome Back, Quality ... from a Project Management Perspective [63]
- Quality Management [66]
- Difference Between Quality Assurance and Quality Control for the PMP® Exam [64]
- Practical Quality Management for Project Managers [65]

2.9 Resource Planning

Resource planning is the process of identifying, quantifying, and scheduling the people, equipment, materials, and facilities a project requires to deliver its scope on time and within budget. It sits alongside the WBS as one of the two foundational data structures PMI recognizes for organizing project data. The WBS defines the tasks needed to achieve project deliverables, while the resource breakdown structure (RBS) defines the resources needed to complete each task [68].

The primary tool for resource planning is the RBS and plays a pivotal role in project management [69]. The RBS is a hierarchical list of resources related by function and resource type that is used to facilitate planning and control of project work. At a minimum, an RBS should include the personnel resources needed for successful completion of a project, and preferably all resources on which project funds will be spent. This includes, but is not limited to, personnel, tools, machinery, materials,

equipment, licenses, and supplies. Money is not treated as a resource in the RBS; only resources that cost money are included. The structure decomposes from a top level representing the whole project down through progressively more detailed categories.

Common top-level resource categories include human resources (broken down by role, department, or skill set), equipment, materials, facilities, technology, or software resources. Building this structure early pays dividends downstream. An RBS enhances communication and collaboration by giving the team a common framework for resource planning and allocation, helping avoid future resource constraints, and supporting risk management by helping identify potential resource risks such as skill shortages. Used with the WBS, the RBS also helps define work package assignments and connects *what* needs to be done with *who* will do it [70]. Figure 28 provides an illustration of the RBS for the automated warehouse management system project discussed previously.

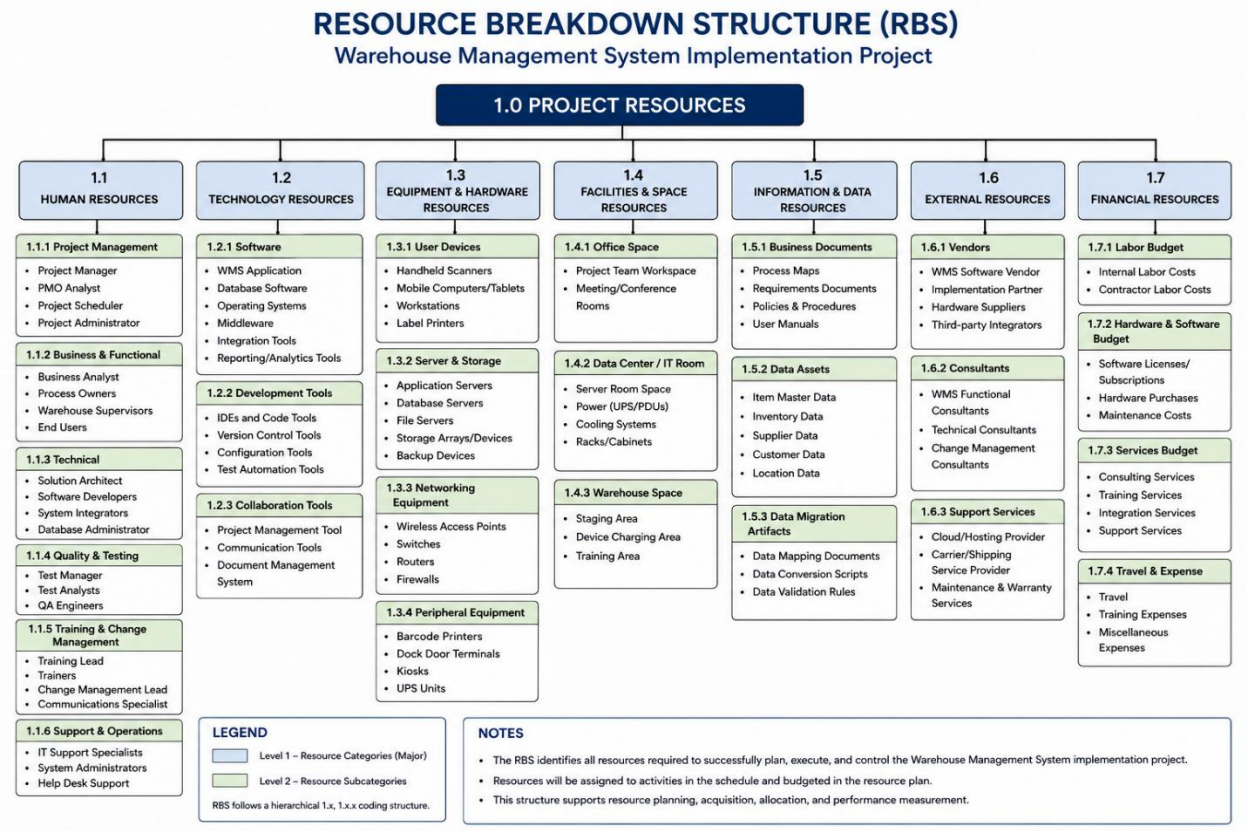


Figure 28. Resource breakdown structure. (Source: Generated with the assistance of ChatGPT)

Once resources are identified and assigned, conflicts inevitably arise when multiple activities compete for the same limited people or equipment. Resource leveling is a mechanism to address this. The PMI PMBOK® Guide defines it as “a technique in which start and finish dates are adjusted based on resource limitations, with the goals of

balancing the demand for resources against the available supply” [1]. In practice, when a schedule calls for more of a resource than is available, tasks must be rescheduled concurrently or sequentially to resolve the constraint. This process often trades off against one of the traditional constraints of time, cost, or scope. Resource leveling is often automated within the functions of project scheduling software. Together, the RBS and resource leveling form the backbone of resource planning. Video 10 provides a general overview of what RBS is and how to create one in an alternative format.



Video 10. Resource breakdown structure. (Source: https://www.youtube.com/watch?v=54QGQQzynH8)

3 Project Resource and Stakeholder Management

Every project, regardless of size or industry, ultimately succeeds or fails on two practical questions: 1) Do we have what we need to do the work, and 2) are the right people supportive of how we’re doing it? This chapter addresses both questions. On the resource side, project managers must identify, secure, and schedule the people, equipment, materials, and facilities required to execute project tasks. This work begins with structured tools like the RBS and continues through the life of the project as resources are allocated and adjusted to meet shifting demands.

On the stakeholder side, project managers must account for everyone with a stake in the outcome. The PMI PMBOK® Guide broadly defines a stakeholder as “an individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project” [16]. This definition is intentionally wide enough to capture not just sponsors and team members, but customers, regulators, and other affected parties who may never set foot in a project meeting.

Though resources and stakeholders are often approached as separate knowledge areas, they are deeply intertwined in practice. Resource constraints frequently become stakeholder issues. For example, a delayed vendor shipment becomes a sponsor’s schedule concern. Alternatively, stakeholder expectations frequently shape resource decisions, as when a client’s quality demands may require specialized skills or equipment not originally budgeted for.

3.1 Project Resource Management

Project resource management is concerned with making sure a project has the right people, equipment, materials, and facilities available at the right time to get the work done. According to the PMI PMBOK® Guide, this knowledge area includes the processes to identify, acquire, and manage the resources needed for the successful completion of the project, ensuring that the right resources are available to the project manager and project team at the right time and the right place. Before a project can move forward, someone has to determine what it will take to build it and then get those things.

The Sixth Edition of the PMI PMBOK® Guide organizes resource management into six sequential processes (see Figure 29 and Video 11). It begins with “plan resource management,” which is the process of defining how the project will estimate, acquire, manage, and use its team and physical resources [16]. From there, “estimate activity resources” involves estimating the team resources needed, along with the type and quantities of materials, equipment, and supplies necessary to perform the project’s work. Once those needs are known, “acquire resources” is the process of obtaining team members, facilities, equipment, and other resources the project requires.

The remaining processes shift the focus from logistics to people. “Develop team” is the process of improving competencies, team member interaction, and the overall team environment to enhance project performance, while “manage team” involves tracking team member performance, providing feedback, resolving issues, and managing team changes to optimize project performance. Finally, “control resources” monitors whether the physical resources are being used as planned and adjusts as needed.

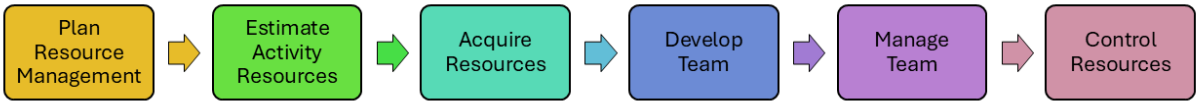


Figure 29. Project resource management processes. (Source: [16], [71], The Author's Own Work)



Video 11. Resource management in plain English. (Source: https://youtu.be/VJcuJSIzuAw?si=7GpYeVeL7K58eogI)

For a deeper dive into the six resource management processes, please see the following:

- Project Resource Management According to the PMBOK [71]

3.2 Team Leadership

Leading a project team *well* requires distinguishing between two related, but different responsibilities: management and leadership. Leadership expert Simon Sinek describes management as fundamentally overseeing a system of already-defined processes to hit specific goals, while leadership is about building trust, a vision, and a future state that

the team wants to work toward together (see Video 12). Both are necessary in project work, but PMI's own framework, the Talent Triangle, reflects this same distinction by placing interpersonal, leadership-oriented power skills alongside technical project management knowledge as one of the three pillars that every project manager needs to develop [72]. Power skills are described as interpersonal capabilities including collaborative leadership, communication, an innovative mindset, and empathy. These are all skills that let a project manager maintain influence across a variety of stakeholders, which is critical for driving change on a project [72].



Video 12. Management vs. leadership: what's the real difference? (Source: https://youtu.be/p4uNIirSPaE?si=ylYUwpXR9BpXjpJj)

Trust is frequently cited as the single most important ingredient in high-performing teams. In his discussion of Navy SEAL (SEa, Air, and Land) team selection, Sinek makes the point that the strongest teams are not necessarily made up of the most talented or technically skilled individuals, but of people who have demonstrated a willingness to put the team's success ahead of their own (see Video 13). In other words, service, not raw skill, is what differentiates the highest-performing teams from ordinary teams. This aligns closely with PMI's guidance on project leadership, which notes that servant leadership, or leading by focusing on relationships and the needs of the team first, is especially valuable for project managers who often have limited formal authority over the people they depend on to get the work done [73]. Because project team members and stakeholders typically have competing priorities pulling at their time, PMI

observes that heavy-handed, authoritarian leadership styles tend to break down, while an approach built on trust and service tends to hold up.



Video 13. What makes the highest performing teams in the world. (Source: https://youtu.be/zP9jpxitfb4?si=r2r_DVtujMyVU-vq)

Team leadership is not only about earning trust conceptually, but involves the concrete, day-to-day work of understanding individual team members and deploying them well. Strong teams are built on self-discipline and mindset, and effective leaders assign roles based on each person's individual strengths and characteristics rather than treating team members as interchangeable pieces (see Video 14). This concept mirrors a recurring theme related to project management. Since project teams inevitably have skill gaps and mismatches between the people available and the skills a project actually needs, project managers benefit from proactively assessing each team member's strengths and weaknesses via informal one-on-one conversations, surveys, and direct observation rather than waiting until a gap causes a missed deadline or quality problem [74]. The most effective project managers tend to lead with honesty, consistency, and a genuine willingness to tackle difficult conversations directly. In addition, recognizing team member contributions throughout the project can increase team morale and team member contribution and commitment to the project outcomes.



Video 14. How to build great teams. (Source: https://youtu.be/7eAh7uEFhdg?si=0st6ox2udve0ok34)

Taken together, these perspectives suggest that team leadership in a project setting rests on three mutually reinforcing habits: 1) building trust through servant leadership rather than authority, 2) flexing between management and leadership behaviors depending on what the situation calls for, and 3) taking the time to understand what each individual team member needs in order to contribute their best work.

For more information on team leadership, please refer to the following:

- Leadership essentials for project management professionals (PMPs) [73]
- Plan Your Development to The PMI Talent Triangle [72]
- Project Team Realities: Turning the Team You Have Into the Team You Need [74]
- Team Leadership Effectiveness in Technology-Based Project Environments [75]
- Team Leadership and Performance: Combining the Roles of Direction and Contribution [76]
- Linkages of Project Environment to Performance: Lessons for Team Leadership [77]

3.3 Project Stakeholder Management

A stakeholder, according to the Sixth Edition of the PMI PMBOK® Guide, is “any individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project” [16]. An older, but still widely cited PMI definition puts it more concisely: “stakeholders are individuals and organizations who are actively involved in a project, or whose interests may be positively or negatively affected as a result of the project’s execution or completion” [26]. A party doesn’t need formal authority or a contractual relationship with the project to count as a stakeholder, only exposure to its outcome. Stakeholders are ultimately the people who will determine whether a project is judged as a success, which is why engaging with them proactively is core project management work rather than a side task (see Video 15).



Video 15. What is stakeholder management? (Source: https://youtu.be/-tNHplQ_-hw?si=xWmikXvy7LJG2ND4)

Stakeholders can be further broken down into internal, external, and key stakeholders as follows [78]:

> ***Internal Stakeholder****: Operates inside the performing organization (i.e., the sponsor, project team, functional managers)*

***External Stakeholder**: Operates outside the performing organization (i.e., customers, suppliers, regulators, local community)*

***Key Stakeholder**: Those with the most power, interest, or control over a project's resources or outcomes. They require focused engagement because they can influence decisions, unlock resources, or create roadblocks if ignored.*

Identifying and managing stakeholders can be challenging on large projects. In one construction project example, it is possible to identify 40 to 50 significant stakeholder groups on a single project, each with different levels of power and interest, which substantially increases the complexity of the management tasks and the risk the project carries [79].

Stakeholder needs are not limited to the technical specifications a project team usually focuses on gathering. A frequently overlooked category is sometimes referred to as derived requirements: needs that are primarily about communication rather than deliverables, such as a sponsor's expectation of being updated on progress at agreeable intervals, or a team member's basic need to understand the project's goals and their specific role in achieving them [26]. These requirements tend to be forgotten precisely because they rarely change and are easy to take for granted. Failing to meet them is often what causes a project to suffer even when the technical execution is sound. This is one reason stakeholder analysis is treated as touching nearly every knowledge area in the PMI PMBOK® Guide (scope, cost management, risk identification, communications planning) rather than being confined to any single process.

Because stakeholders can emerge from anywhere, identification should be approached deliberately. Be aware that an overlooked stakeholder can resurface late in a project with enough authority to force costly rework. One article proposes treating stakeholder management as "risk management for people" by applying the same systematic logic used to identify project risks to the identification of the people surrounding a project [80]. Useful techniques include structured brainstorming with the full project team, reviewing the project's decision trail to see who holds veto authority over key approvals, and deliberately searching for secondary stakeholders (e.g., regulators, second-tier customers) who are easy to overlook early on but who can become significant primary stakeholders if their interests are disturbed. Where possible, it also helps to identify stakeholders by name rather than by generic role labels like "customer" or "sponsor," since a named individual is easier to understand and engage with [26].

Once identified, stakeholders are typically assessed in two or more dimensions, such as influence vs. impact, interest vs. power, or power vs. legitimacy vs. urgency [26], [81]. Figure 30 illustrates examples of the two-dimensional interest vs. power and influence vs. impact matrices (see template in Project Management Toolkit.zip). Two of the more common dimensions are influence vs. impact. Influence refers to a stakeholder's relative power to affect key project decisions. Importance is defined as the degree to

which the project cannot be considered successful if that stakeholder's needs are unmet. These two dimensions are related, but separate. For example, a financial sponsor may have very strong influence while participating little in day-to-day work. Distinguishing the two helps a project team look past raw authority to figure out whose needs determine success. Plotting stakeholders on an influence vs interest (or impact) grid gives a distinct management strategy for each quadrant. Those high in both influential power and interest need to be closely managed and kept satisfied through regular involvement, while a high-power, low-interest stakeholder is someone whose interest could suddenly spike if the project changes. Therefore, the low-interest stakeholder needs to be watched carefully [79]. Positive stakeholders are those who stand to benefit from the project and need to be nurtured and kept informed to maintain their advocacy. Negative stakeholders are engaged to better understand their concerns and, where possible, to build their confidence in the project team. For an overview of the process to develop a stakeholder analysis tool as well as other similar tools and analyses, please see Video 16.

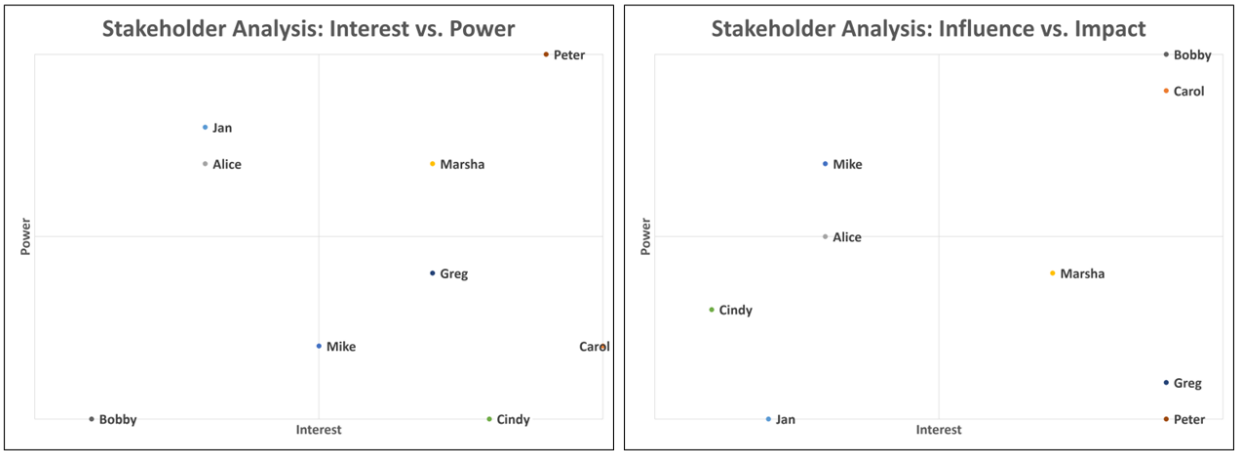


Figure 30. Examples of stakeholder analysis matrices. (Source: The Author's Own Work)



Video 16. Six must-know project stakeholder tools from the PMBOK® Guide (Source: https://youtu.be/W-Js-ITyO8Q?si=QSrGtqPQqPfwTJFu)

Stakeholder management does not end once the initial analysis and plan are in place. Instead, it continues throughout the project life cycle. A communications plan describing what information goes to whom, in what format, and how often is one of the primary tools for operationalizing this engagement. Taking the time to plan communication deliberately tends to shift a project team from a reactive perspective to a proactive perspective [80]. The influence that stakeholders have is not static. While it is felt most strongly in the earlier stages of a project, it typically resurfaces as the project reaches its final stages when results are becoming known, and stakeholder interest is greatest [79]. A dynamic, phase-by-phase view of where key stakeholders stand is generally more useful for anticipating shifts throughout the project life cycle since stakeholders' priorities and levels of involvement can change as the project moves from initiation to completion.

For additional details regarding stakeholder analysis, please refer to the following resources:

- Section 1.4.9
- Project Management Toolkit.zip
- What is a Stakeholder in Project Management? [78]
- Stakeholder Management [79]

- Stakeholder Management Strategies: Applying Risk Management to People [80]
- Your Guide to Stakeholder Analysis Matrix: Master Project Management [81]

4 Project Execution, Monitoring, and Control

Once a project plan is approved, the real work begins, and the planning becomes a reality during the execution, monitoring, and control phases. This chapter covers the two process groups that follow planning in the Sixth Edition of the PMI PMBOK® Guide: 1) Executing and 2) Monitoring and Controlling [16]. It's worth noting that PMI restructured this area around principle and performance domains and away from process groups beginning with the Seventh Edition. However, the process-group framework is still an important element of sound project management and provides a structure for learning how projects are executed.

The Executing process group includes the processes related to completing project activities and tasks to satisfy project specifications [82]. The processes required to track, review, and regulate project progress and performance, identify where changes to the plan are needed, and initiate those changes fall within the scope of the Monitoring and Controlling process group [83]. Though treated as separate knowledge domains, the two run concurrently for most of the project's life cycle. Execution produces the project work, and the processes associated with Monitoring and Control continuously check whether that work is still heading in the right direction [84].

Execution is typically where a project spends the largest share of its time, budget, and effort, since it's the phase in which deliverables are produced, and the project team's performance is focused on driving success [85]. Monitoring and Controlling, by contrast, produces few deliverables of its own. Its output is corrective action when deviations from the plan are identified. Since it is not a matter of if, but when, a disciplined monitoring and control process can catch variances to scope, schedule, cost, and quality early and before small issues compound into major problems [83].

This chapter walks through these phases of the project work in two parts. It begins with the supporting disciplines that run throughout project execution and control (Project Communications Management, Project Risk Management, Project Procurement, and Contract Management) and keep information flowing, uncertainty managed, and relationships maintained. We then turn toward the core activities of the process groups themselves (Project Execution, Project Monitoring, and Project Control), which include the quantitative techniques such as EVA introduced in Section 2.7 and give project managers an evidence-based way to know whether the plan and the work being performed are aligned.

4.1 Project Communications Management

Project communications management is concerned with making sure the right information reaches the right people, in the right format, at the right time. The PMI PMBOK® Guide's original definition frames its "the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information" [86]. More recent editions of the PMBOK® Guide organize the work associated with project communications management into three primary processes: planning, managing, and monitoring communications [87]. It's worth noting how central this discipline is in practice. One PMBOK®-based training organization observes that an effective project manager spends roughly 90% of their time communicating, with about half of that time focused on communications with the project team [88]. For an overview of project communications management and an introduction to the tools used, please see Video 17.



Video 17. Project communications management overview (Source: https://youtu.be/S2lLKYV4e6M?si=LKSlIS4aIIg-O1QB)

The first of the three PMI PMBOK® processes, Plan Communications Management, is the process of developing an approach and plan for all project-based communication activities, based on the information needs of the stakeholder, the resources available in the organization, and the needs of the project itself [89]. In practice, this means identifying what information will be shared, who will receive it, how often, and by what

method [88]. The plan is not a one-time deliverable produced during the early stages of the project's life cycle. Instead, it is meant to be revisited periodically throughout the project as stakeholders' needs and project circumstances evolve [90]. For a project management communications plan template, please reference eplc_communications_management_template.doc in the accompanying Project Management Toolkit [91].

Once the plan exists, the next process within the PMI PMBOK® framework is Manage Communications. This puts communication into practice by creating, collecting, distributing, storing, accessing, managing, monitoring, and disposing of project information [87]. This is where the communication plan translates into the actual status updates, meeting minutes, deliverable reports, and other outputs that stakeholders were told to expect [92]. During project execution, the communication process can be the difference between a successful and unsuccessful project [93].

The final process, Monitor Communications, ensures that the information needs of the project and its stakeholders are being met [86]. This is fundamentally a control activity where, at regular project status points, the project manager must seek feedback on whether the current means of communication are adequate [93]. If they are not, it is up to the project manager to improve communications and close any gaps that may exist. The communications plan is a living document and must be updated as the project and stakeholder landscapes evolve [90]. Otherwise, it will become inadequate very quickly.

For additional details on project communication management, please refer to the following:

- Project Management Toolkit.zip
- Project Communication: Foundation for Project Success [86]
- Project Management Communication Plan [87]
- Project Communications Management PMBOK Sixth Edition [88]
- Project Communications Management [89]
- The Foundations of Project Communication [90]
- Communication Management [92]
- Project Communications Management According to the PMBOK [93]

4.2 Project Risk Management

Every project operates under uncertainty. Project Risk Management is the PMI PMBOK® Guide knowledge area devoted to handling this uncertainty proactively, rather than reactively, and includes six primary processes (see Figure 31 and Video 18). The PMBOK Guide® defines risk management as the "systematic process of identifying, analyzing, and responding to project risks" [94]. This definition is not just limited to threats. Instead, the process aims to increase the probability and impact of positive risks

(i.e., opportunities) and decrease the probability and impact of negative risks (i.e., threats), with the overall goal of optimizing project success.

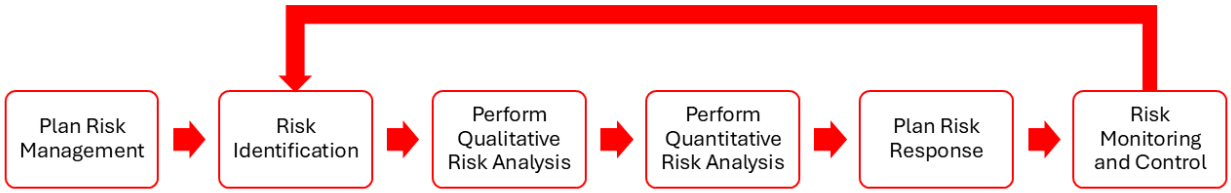


Figure 31. PMI PMBOK® risk management process. (Source: [94], The Author's Own Work)



Video 18. Project risk management overview. (Source: https://youtu.be/h7UjWPfD47g?si=tBPZd0iWpzuC5tuZ)

The process, Plan Risk Management, is completed first and defines how risk management activities will be approached within the project. The amount of effort and detail should be scaled with the size, potential for risk, and importance of the project

[95]. The next process involves risk identification and consists of identifying individual project risks and broader sources of project risk, and documenting them. Because new risks can emerge and existing ones can change as the environment surrounding the project evolves, this process is repeated several time throughout the project life cycle [96]. The primary output of the Risk Identification process is a risk register, which serves as an input for the subsequent risk management processes. Figure 32 illustrates an example of a risk register, and a template can be found in the Project Management Toolkit (see Risk_Register_Template.xlsx). Video 19 provides an overview of a risk register as well as other common tools associated with project risk management.

Risk Register – Warehouse Management System Implementation Project

ID	Risk Description	Category	Probability (1–Low, 2–Med, 3–High)	Impact (1–Low, 2–Med, 3–High)	Risk Score*	Response Strategy	Mitigation Actions	Contingency Plan	Risk Owner	Status
R1	Requirements are incomplete or misunderstood, resulting in system rework.	Scope	3	3	9	Mitigate	Conduct workshops; validate requirements; obtain approval.	Implement controlled change requests.	Business Analyst	Open
R2	ERP integration is more complex than anticipated.	Technical	2	3	6	Mitigate	Complete interface design early; perform integration testing.	Delay noncritical functionality until after go-live.	Technical Lead	Open
R3	Data migration results in inaccurate inventory records.	Technical	2	3	6	Mitigate	Cleanse data; trial migrations; validate inventory before cutover.	Restore backup and repeat migration.	Data Migration Lead	Open
R4	Warehouse operations experience disruption during system cutover.	Operational	2	3	6	Mitigate	Develop cutover plan; test rollback procedures.	Execute rollback plan and resume legacy system.	Project Manager	Open
R5	Warehouse employees resist adopting the new WMS.	Organizational	2	2	4	Mitigate	Communicate early; provide training; change management.	Provide additional coaching and on-site support.	Change Mgmt Lead	Open
R6	Vendor implementation resources become unavailable.	Vendor	1	3	3	Transfer/ Mitigate	Include staffing in contract; monitor vendor commitments.	Escalate to vendor management and engage backup consultants.	Vendor Manager	Open
R7	Wireless network performance is insufficient for mobile scanners.	Infrastructure	2	3	6	Mitigate	Conduct site survey and performance testing.	Install temporary access points; prioritize areas.	IT Infrastructure Manager	Open
R8	Project exceeds approved budget because of scope changes.	Cost	2	3	6	Avoid/ Mitigate	Enforce change control; obtain management approval.	Request contingency funding if justified.	Project Sponsor	Open
R9	User Acceptance Testing identifies critical defects late in the project.	Quality	2	3	6	Mitigate	Incremental testing; frequent defect reviews.	Delay go-live until critical defects are resolved.	Test Manager	Open
R10	Cybersecurity vulnerabilities are discovered before deployment.	Security	1	3	3	Mitigate	Conduct penetration testing and security reviews.	Apply patches and postpone deployment if needed.	Info Security Manager	Open
R11	Barcode scanners or hardware are delivered late.	Procurement	2	2	4	Mitigate	Order early and monitor supplier schedules.	Borrow equipment or phase deployment by area.	Procurement Manager	Open
R12	Project completion is delayed because critical-path activities slip.	Schedule	2	3	6	Mitigate	Monitor critical path weekly; reallocate resources.	Fast-track or crash activities after sponsor approval.	Project Manager	Open

Risk Score Key

Risk Score = Probability × Impact

7–9	Critical (Red)	
4–6	High (Orange)	
2–3	Moderate (Yellow)	
1	Low (Green)	

Probability & Impact Scale (1–Low, 2–Medium, 3–High)

Probability		
1	Low	Unlikely to occur
2	Medium	Possible to occur
3	High	Likely to occur

Impact		
1	Low	Minimal effect on cost, schedule, or scope
2	Medium	Moderate effect
3	High	Significant effect/ major disruption

Response Strategies

- **Avoid** – Change the plan to eliminate the threat.
- **Mitigate** – Reduce probability or impact.
- **Transfer** – Shift risk to another party.
- **Accept** – Acknowledge and monitor.

* Higher score indicates higher priority.

Figure 32. Risk register. (Source: Generated with the assistance of ChatGPT)



Video 19. Six risk management tools you must know from the PMBOK® Guide. (Source: https://youtu.be/cWQ3SUwA9aM?si=Temv75DG6-AqL2nL)

After identifying the risks, we are now ready for the next process: Perform Qualitative Risk Analysis. Here, we prioritize the risks on the risk register for further attention by assessing each one's probability of occurrence and impact and then combining the two ratings to derive an overall priority rating [97]. Because risk exposure is rarely distributed evenly across a project, this step often follows the Pareto principle in that a small number of high-priority risks tend to account for a large share of the project's total risk exposure [98].

After completing qualitative analysis, the next process is performing quantitative risk analysis. This goes beyond qualitative risk and numerically analyzes the combined effect of the individual risks and other sources of uncertainty with respect to the project's objectives [98]. In practice, this often means assigning probability estimates to different cost and schedule scenarios and using a probability distribution to simulate the overall probability [97]. Quantitative analysis isn't always employed and is typically saved for larger, more complex projects. Sensitivity analysis is one type of quantitative analysis that can be performed (see Video 20).



Video 20. Sensitivity analysis in quantitative project risk management. (Source: https://youtu.be/EXHP_0afd0w?si=YOeqXx7xaxPPk9Uy)

The final two processes, Plan Risk Response and Risk Monitoring and Control, develop specific strategies and actions to address, prioritize, track, monitor residual risks, and watch for new risks that may emerge throughout the project life cycle [95], [98]. In some simplifications of project risk management, the interconnected processes are viewed as sequential. However, a feedback loop is necessary from the Risk Monitoring and Control process back to Risk Identification for the emergence of new risks to be incorporated in the risk register and ongoing process [94]. This is why risk registers and risk management plans are treated as living documents throughout a project.

For additional information on project risk management, please refer to the following resources:

- Project Management Toolkit.zip
- A Practical Risk Management Approach [94]
- Risk Management [95]
- PMBOK PMP Identify Risks Process [96]
- Project Risk Management According to the PMBOK® [97]
- Guide to Risk Management Process and Plans for PMP Success [98]

4.3 Project Procurement Management

Project Procurement Management covers the processes by which a project team acquires goods and services from outside the performing organization. The scope of the process goes from deciding what to make or buy, through supplier selection, to closing out the contractor with the vendor. The PMI PMBOK® Guide organizes this work into three sequential processes: 1) Plan Procurement Management, 2) Conduct Procurements, and 3) Control Procurements [16].

The first process, Plan Procurement Management, involves identifying what needs to be procured and how. The primary output of the process is a written procurement management plan, which becomes a component of the overall project management plan [99], [100]. This planning stage covers a range of foundational decisions associated with making or buying the given item, what type of contract best fits the situation, and what criteria will be used to evaluate potential sellers [101]. Because individual judgment in supplier selection can be biased, effective procurement planning defines objective criteria in advance so that the eventual selection decision is defensible rather than purely subjective and draws on factors such as the project scope, schedule, requirements, payment terms, and quality certifications [102].

Execution of procurement activities occurs during Conduct Procurements. Here, bid documents such as requests for information (RFI), requests for proposals (RFP), or requests for quotations (RFQ) are released to potential vendors [101]. It involves obtaining seller responses, quotes, bids, and proposals as well as evaluating those responses against the selection criteria established during the planning phase [99]. Ultimately, a seller is chosen, and the contract is awarded. The process typically requires input from people with specialized expertise since these decisions carry financial, technical, and legal weight. Bidder conferences are a common mechanism at this stage, ensuring that every bidder has the same clear understanding of what is being procured before submitting a proposal [102]. Vendor negotiations and contract signing also occur during this process [100].

The final process, Control Procurements, shifts the focus from acquiring a vendor to managing the relationship with that vendor, which includes monitoring contract performance, tracking payments and invoices, inspecting delivered work, and performing audits as needed [101]. Although a project manager does not typically conduct the procurement transactions directly, they remain responsible for ensuring procurements are carried out appropriately and for staying aware of their status throughout execution [100]. Key activities within this process include resolving claims or disputes, processing changes through formal change control, conducting performance reviews that compare actual progress to the plan, and forecasting estimates to completion. Agreements with vendors are not static once they are signed. They may need to be amended at any point prior to the contract being closed, which is completed by mutual consent of both parties.

Active, disciplined control of the procurements ultimately protects projects from their most common procurement failure modes (i.e., cost overruns, delivery delays, and quality issues) [101]. Once all contractual obligations are fulfilled, procurements are formally closed out, often accompanied by a final inspection to confirm acceptance of the delivered goods or services [103].

For additional information on project procurement, please reference the following:

- Project Procurement Management [99]
- What Is Project Procurement Management? [100]
- Control Procurements Process in Project Management Explained [101]
- Conduct Procurements [102]
- 6th Edition PMBOK® Guide–Process 12.3 Control Procurements: Inputs [103]
- Contract/Procurement Management [104]

4.4 Contract Management

Once a seller has been selected under the procurement process covered in Section 4.3, the resulting agreement must be actively managed rather than simply filed away. Contract management is the discipline of overseeing the agreement across its full life cycle (i.e., negotiation, execution, monitoring, closeout) to ensure both parties fulfill their obligations and the project's goals are met. Many projects fail not because of poor technical execution, but because of undefined scope and deliverables for an under-managed vendor relationship, which is why successful contract initiation and management is considered a critical success factor in project management [105].

The specific type of contract selected has a direct bearing on how risk is shared between the buyer and the seller, and choosing the wrong type for a given situation is one of the more common (and avoidable) sources of contract trouble. There are three primary contract types, each allocating risk differently [106]:

- **Fixed-Price Contracts (lump-sum or firm-fixed-price contracts)**. In fixed-price contracts, a single price is set for the project regardless of the actual time or effort the vendor ends up investing [107]. The cost to the buyer remains constant no matter how much effort the vendor exerts, which means the vendor's profit shrinks if the work takes longer than expected [108]. This structure works best for projects with a clearly defined scope and minimal risk of requirements changing, since it offers predictability but leaves little room to absorb scope shifts without a formal change [109].
- **Cost-Reimbursable Contracts (cost-plus contracts)**. Cost-reimbursable contracts reimburse the vendor for the actual costs of doing the work, plus a negotiated fee or rate [108]. Because the buyer bears most of the financial risk under this arrangement, cost-reimbursable contracts are generally reserved for projects where the scope is not yet fully known or is likely to shift significantly (e.g., research and development or experimental work) [107], [109].

- **Time and Materials (T&M) Contracts.** T&M contracts function as a hybrid of the other two types and charge the buyer for actual labor hours and materials used at agreed rates [108]. These types of contracts are well suited to situations where a clear statement of work cannot be produced up front, but because there's no natural cost ceiling built into the structure, it is considered good practice to negotiate a ceiling or "not-to-exceed" (NTE) price to guard against cost overruns [110].

A fixed-unit-price variant is also common when the type of work can be measured in standard units (i.e., labor hours, materials, or deliverable counts), but the total quantity isn't known precisely. In these instances, the project team assumes the risk of estimating quantity, so an inaccurate estimate doesn't require renegotiating the contract itself, but it will cause the project to exceed its budgeted cost [108].

Beyond selecting the right structure, disciplined contract management requires attention to a recurring set of elements through the engagement. Examples include a clearly defined set of resources and deliverables, reimbursable expense terms, payment schedules, and termination provisions [105]. A payment schedule should specify up front how changes to the project will affect payment terms, since ambiguity here can become a frequent source of dispute [110]. Agreements are not necessarily static once signed. Most contracts can be amended prior to closure by mutual consent, with amendments processed through the agreement's pre-defined change control terms.

Contract management increasingly relies on dedicated software tools, often referred to as contract lifecycle management (CLM) systems, to automate tracking, maintain version control, and capture performance data [110]. Regardless of the tools used, the underlying processes and discipline remain the same. Contracts exist to set clear expectations and responsibilities among project stakeholders, manage risk, resolve disputes efficiently when they arise, and provide a documented basis for quality assurance and performance measurement [106].

For more specific information on contract management, please refer to the following resources:

- Contracts: From the Vendor and the Buyer Point of Views [105]
- Types of Contracts in Project Management and Their Importance [106]
- Contracts Explained: Fixed Price, T&M, and Cost-Reimbursable [107]
- Contract Types [108]
- Cost vs. price: Examining three types of contracts in facilities and project management [109]
- Types and Best Practices for Project Management Contracts [110]

4.5 Project Execution

The Executing Process Group consists of the processes performed to complete the work defined in the project management plan and satisfy the project's requirements [111]. It is the phase most people picture when they think of the actual activities going on within the project. This is where deliverables are actually created and completed, where the bulk of the project's budget is spent, and where the project manager spends their day-to-day attention coordinating activities [111], [112]. In practice, this means directing the project resources (i.e., people, equipment, materials) efficiently to deliver the project's objectives.

The central process of the Executing Process Group is the process, Direct and Manage Project Work, which involves leading the project team to perform the work defined in the project management plan and ensuring that project objectives are achieved through the effective implementation of planned activities [113]. This process draws on several key inputs to guide day-to-day decisions, which include the project management plan and supporting project documents such as the schedule, requirements documentation, risk register, change management log, and stakeholder register [114]. Approved changes to scope, schedule, or budget also flow into this process, requiring the project manager to adjust planned activities as required. Beyond internal coordination, this process also involves managing the interfaces between the project and its stakeholders, working with vendors on procurement relationships, and reviewing vendor invoices and deliverables [112], [114].

Introduced in the Sixth Edition of the PMI PMBOK® Guide, the process Manage Project Knowledge is focused on the use of existing knowledge to generate new knowledge to achieve project objectives and contribute to organizational learning [112]. Its inclusion reflects a broader shift in project management practice to incorporate the foundations of agile methodologies for capturing lessons learned continuously throughout the project life cycle. In practice, this means the knowledge generated during execution is captured and fed back into the organization's process assets rather than lost once the project closes [115].

The remaining execution processes extend the same logic of implementing the plan into each of the knowledge areas covered elsewhere in this chapter. Manage Communications ensures the timely and appropriate distribution of project information as defined by the communications plan [112]. Implementing Risk Responses carries out the risk response strategies developed during planning. Conduct Procurements, discussed previously, obtains seller responses and awards contracts and purchase orders. Lastly, Acquire Resources, Develop Team, and Manage Team is focused on resource management and ensures that the project is properly staffed and the team is functioning well.

Altogether, these processes make execution the busiest and most resource-intensive phase of the project life cycle. Execution is rarely clean or uninterrupted. Instead, it runs

in constant parallel with monitoring and controlling activities, which exist specifically to catch and correct deviations before they compound into larger problems.

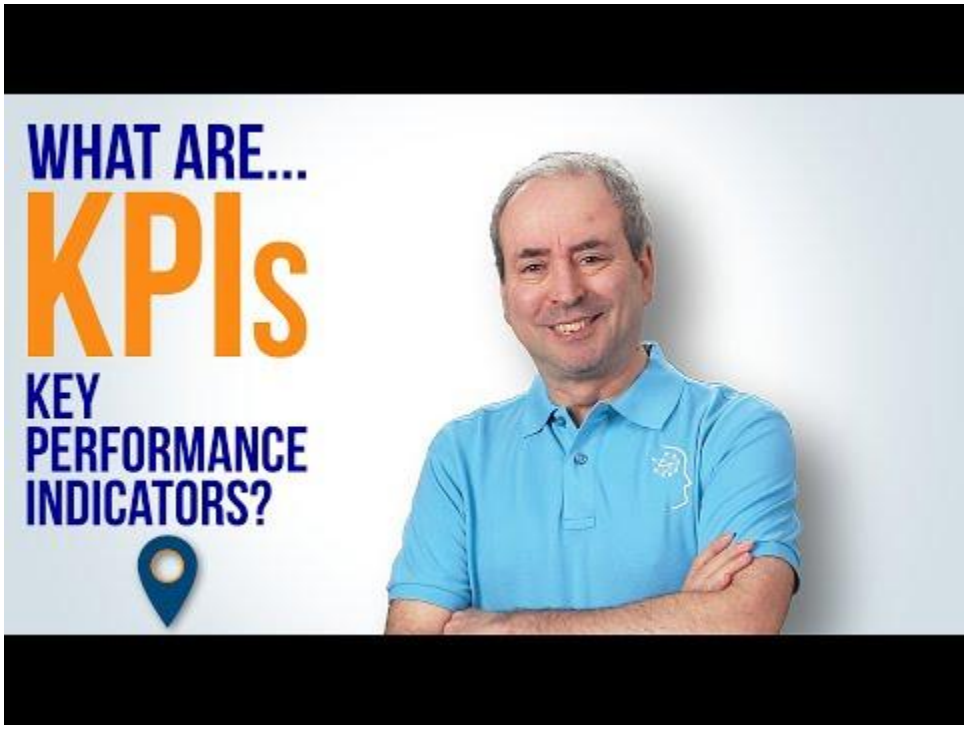
For additional resources on project execution, please refer to the following:

- Project Management Execution Phase: A Complete Step-by-Step Guide [111]
- The Executing Process Group [112]
- PMBOK Guide: The Project Management Body of Knowledge at a Glance [113]
- Direct and Manage Project Work: A Core Project Management Process [114]
- 6th Edition PMBOK® Guide–Process 4.4 Manage Project Knowledge: Inputs [115]
- Demystifying the PMBOK Process Groups [82]

4.6 Project Monitoring

Project monitoring is the ongoing discipline of tracking, reviewing, and regulating a project's progress and performance in order to catch deviations from the plan while corrections can still be made. The PMI PMBOK® Guide frames this activity as accomplishing three specific things: 1) tracking, 2) reviewing, and 3) regulating the progress and performance of the project. In addition, a key component of project monitoring activities is to identify areas in which changes to the plan are required and subsequently initiate the corresponding changes [116]. This work touches nearly every knowledge area covered in this text (i.e., scope, schedule, cost, quality, communications, risk, and procurement) since a project's health rarely depends on just one isolated dimension.

The means to monitor project health are key performance indicators (KPI). KPIs are measures that synthesize information gathered through monitoring processes into something meaningful enough to act on [116]. They serve a specific translation function in that they turn the scope statement into measurable objectives that the project's actual performance can be judged against. Selecting the right KPIs can be as much an art as a science, though ideally settling on three to five KPIs per project. Ideally, the project should have enough to focus on, but not so many that it can't capture the project's health from multiple angles. Video 21 provides an overview of project management KPIs.



Video 21. What is a KPI? (Source: https://youtu.be/soiChkomKmo?si=xGpfqhSdugsewgIz)

In practice, project managers rely on both quantitative and qualitative sources of data to monitor. Quantitative measures like earned value metrics (e.g., planned value tracked against earned value) give a project manager the kind of early warning needed to take corrective action before a schedule slip becomes unrecoverable [117]. However, experienced practitioners caution against relying on schedule, cost, and scope metrics alone. Real progress can also be reflected in less tabular measures, such as customer or end-user satisfaction at each project milestone, and that a cohesive, well-synchronized project team tends to produce more accurate day-to-day progress signals than metrics alone can capture [118]. A project manager can't manage what can't be measured and can't measure what hasn't been clearly defined as a metric worth tracking in the first place [118].

Because monitoring generates a continuous stream of information rather than a single end-of-project judgment, its real value lies in frequency and consistency. This includes the discipline of regular measurement and regular communication to stakeholders, which allows monitoring to function as an early warning system rather than a retrospective explanation for why a project went off track [117].

For additional information and resources on monitoring projects, please reference the following:

- How do you know the status of your project? [116]
- Meet the New Project Manager: Mr. KPI [119]
- Keeping Score [117]
- Q & A: On Track [118]

4.7 Project Control

Where monitoring is about knowing where a project stands, control is about acting on that knowledge. When invoking project control, we compare actual performance against the plan and take corrective steps to bring the project back on track. Corrective action itself is defined as “any action taken to bring expected future project performance in line with the project plan” [120]. That definition is important because corrective action is only possible if a clear project plan exists to measure against in the first place, which is why disciplined baselining during planning makes effective control possible later on.

The Sixth Edition of the PMI PMBOK® Guide’s central control process, Monitor and Control Project Work (see Video 22), exists specifically so that stakeholders can understand a project’s current state, recognize what actions have been taken to address performance issues, and see forward-looking cost and schedule forecasts. The process runs continuously through the life cycle of the project rather than at fixed checkpoints [16]. The continuous nature distinguishes control from a simple end-of-phase review. Since deviations from the baseline plan can compound quickly, control activities need to always be running, not just when a status report happens to be due.



Video 22. Monitor and control project work. (Source: https://youtu.be/co1s8b0VFsM?si=Rdj-qKU9hn0NRW3Z)

A defining feature of project control is that changes are never evaluated in isolation. The Perform Integrated Change Control process (see Video 23) is the process of reviewing all change requests, approving changes, and managing changes to deliverables, project documents, and the project management plan [16]. The integrated portion in the process's title reflects a core principle of project management. Any change to one aspect of the project (i.e., scope) has a cascading effect on schedule, costs, quality, risk, resourcing, etc. Therefore, a change cannot be responsibly approved by looking at its impact on a single knowledge area alone [121]. Instead, all areas need to be evaluated for impact. This is why change requests are typically evaluated against a change management plan, which provides direction for managing the change control process itself and documents the roles and responsibilities of everyone involved in reviewing and approving changes [16].



Video 23. Perform integrated change control. (Source: https://youtu.be/n3h-Ht4PMhk?si=5WR-yAcTdq2BE-M9)

As a mechanism, change control exists to limit frivolous or unjustified changes while still allowing genuinely value-added changes through. Additionally, the underlying goal of the process is to keep the project on track, on schedule, and within cost [121]. It is applied across the entire life of a project, from initiation to closure, rather than being confined only to the execution phase.

Control activities generate specific, trackable outputs that feed back into the rest of the project. As change requests are processed, cost and schedule forecasts are updated to reflect the decisions made, new risks identified during the review are logged in the risk register, and the lessons learned register is updated with effective responses used to address variances through corrective and preventive action [16]. This creates a document trail that lets a project manager show that they understand the project intimately, are in control of it, and can defend the decisions being made along the way [120]. One recommended control-level metric is to measure the number of approved change requests across all phases of the project, alongside monitoring risk exposure to confirm that every identified risk still has an active response strategy [122].

For additional information related to the topic of project control, please refer to the following:

- What Does a Project Manager Really Need to Know? [120]
- Is there a new definition for "change control" in project management? [121]
- Project Management Reinforcement and Support Process [122]

5 Project Closure and Continuous Improvement

Every project ends, whether through successful completion or early termination, but how it ends has a disproportionate influence on the organization's ability to do better the next time. The PMI PMBOK® Guide frames the Closing Process Group as the smallest set of processes in the project life cycle, yet one with an outsized effect on the future, since it is here that a project's documentation, lessons, and issues get captured and stored for future reference [123]. In practice, closing is often the phase most likely to be shortchanged. As resources move on to their next assignments and organizational attention shifts elsewhere, project closure is frequently rushed or skipped altogether. For these reasons, it is sometimes called the forgotten phase [124].

This chapter's two subsections address the two halves of the value delivered when project closeout is done properly. The subsection, Project Closing, covers the administrative and procedural work of formally ending a project. This includes finalizing all activities for the project, phase, or contract, obtaining formal acceptance from the customer or sponsor, and transferring the completed project to others. If the project was canceled prior to completion, it is at the point of deciding the project is being canceled that it is closed out [123]. Closeout includes reconciling final costs, releasing project resources, archiving documentation, and closing out any remaining contracts. Failing to complete these tasks can create liability or confusion long after the project team has disbanded [125].

The subsection, Lessons Learned, covers the reflective, knowledge-capturing work that turns a project's experience into an asset for the next one. Lessons learned are commonly defined as the knowledge gained through the process of conducting a project. This includes the problems encountered, the solutions found, and the recommendations that would help avoid repeating the same mistakes in the future. Although lessons learned are strongly associated with closure, PMI's own guidance emphasizes that capturing them should not be treated as an end-of-project event alone; it is a vital activity that project teams should perform continually throughout a project's life cycle, so that improvements can be identified and implemented while the project is still underway rather than only after it has ended [126]. When lessons learned are gathered consistently and fed into a shared repository, organizations can develop progressively more effective and efficient project management practices over time and thereby reduce the time and cost required to deliver future projects [127].

For additional references on the topics of project closure and continuous improvement in project management, please refer to the following resources:

- Closing Process Group [123]
- The Forgotten Phase [124]
- Project Closing: Ensure Success with Proven Strategies [125]
- Lessons Learned: Taking it to the Next Level [126]
- Project Closing: The Small Process Group with Big Impact [127]

5.1 Project Closing

The process group, Project Closing, is responsible for formally finalizing all activities of a project, phase, or contract, and for transferring the completed product or service to whoever will own it going forward. Ownership can be transferred to the customer, an operations team, or, when the project is terminated, it concludes with a formal record of why the work was stopped [123]. The PMI PMBOK® Guide's Closing Process Group contains only a single process, Close Project or Phase, but its narrow scope belies its importance. It is the last thing that happens on a project and is also the process most often overlooked as team members and resources are reassigned before the paperwork catches up.

Closing a project is more than just declaring that it is "done." It requires confirming that all deliverables have been completed and formally accepted, and that all documentation is current and complete [125]. Financially, this means completing all outstanding financial matters (e.g., final payments, budget reviews, and cost reconciliations) so that project accounts can be properly closed rather than left open indefinitely. Where the project involved external vendors, procurement closure requires resolving any outstanding claims or disputes and formally closing out each contract, following the change-control and dispute-resolution terms established when those agreements were signed. Resources are also formally reassigned during this stage.

A project closeout meeting typically anchors this work [128]. This formal gathering serves several purposes. First, the original project objectives are reviewed to assess whether they were met. Next, completion of all deliverables is confirmed. And, finally, a final financial review is conducted to verify the project stayed within budget. Some organizations refer to a related, but distinct gathering as a "post-mortem," used specifically to analyze what went well, recognize contributing team members, and surface issues that didn't go as planned [123].

A defining feature of closure is formal, documented acceptance. The project is not considered closed until the customer or sponsor has formally signed off that the deliverables satisfy the original requirements [125]. This acceptance is typically documented in a final project report (closure report), which summarizes how the project performed relative to its original goals [128]. A well-constructed closeout report generally includes an executive summary, a final status report against the original baseline, a summary of stakeholder feedback, and any long-term impacts the project is expected to have, such as sustainability improvements or best practices worth carrying forward [128], [129]. This report is typically routed through a sponsor review meeting

before it is formally issued, giving leadership the opportunity to weigh in before the record is finalized [124]. Figure 33 illustrates an example of a project closeout report for the warehouse automation project discussed previously. Please reference the template, ProjectManager-Project-Closure-Template-WLNK.docx, which can be found in the Project Management Toolkit.zip file [128].

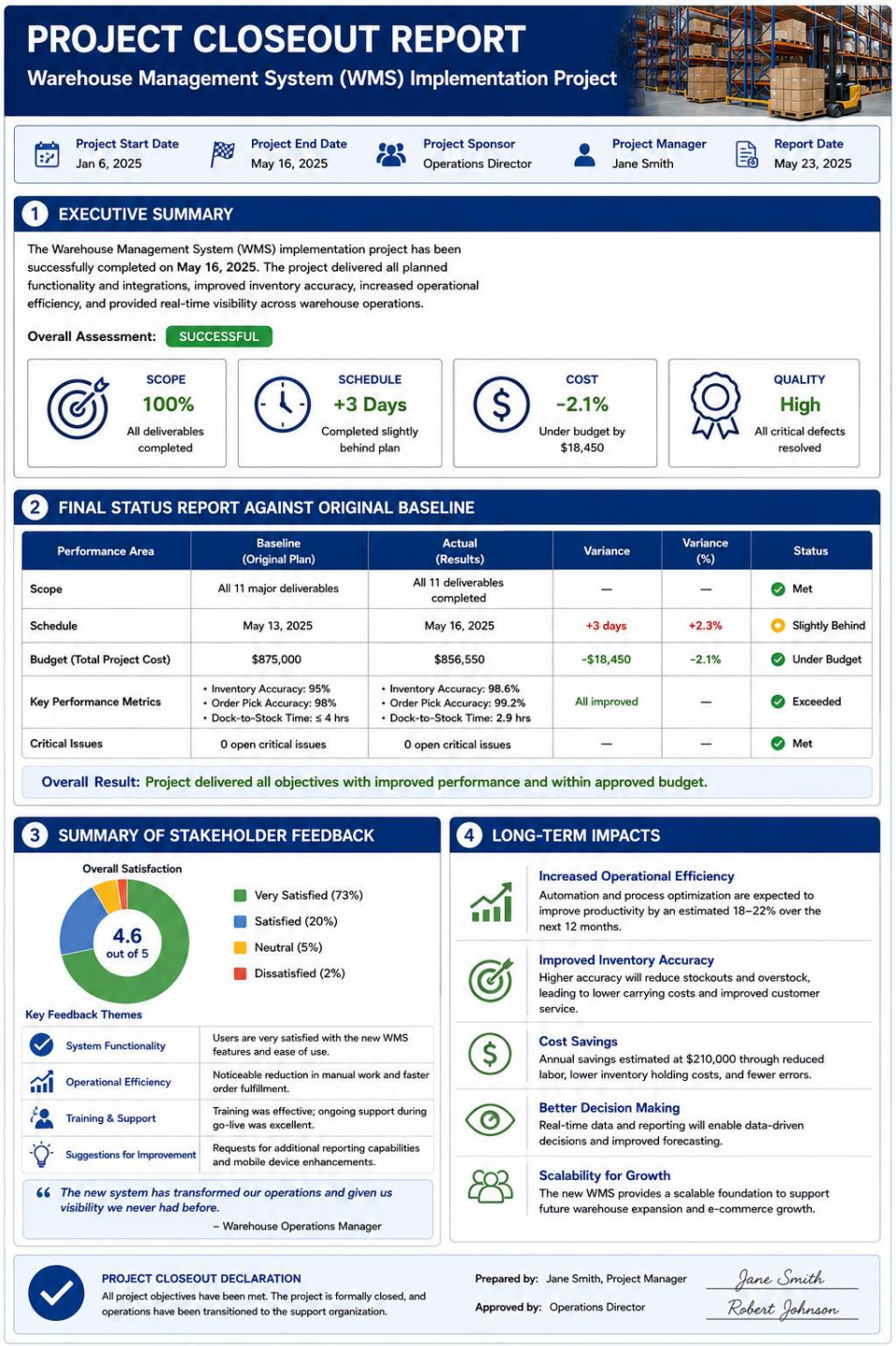


Figure 33. Project closeout report example. (Source: Generated with the assistance of ChatGPT)

Because closure activities rarely have the same visible urgency as active project work, they are frequently rushed, deprioritized, or skipped altogether once a project's core

deliverables have shipped [123]. This is a costly mistake. Investing real time and effort in closure pays dividends by enabling a smoother transition of the deliverable to its new owner, generating lessons learned that carry forward into future projects, and building the kind of stakeholder trust and transparency for the long term [125]. Properly closing a project is also what makes organizational learning possible in the first place. Post-project reviews and formal closure activities are what allow an organization to build a genuine culture of continuous improvement, rather than relying on individual memory to carry knowledge from one project to the next.

For additional resources on closing a project, please refer to the following:

- Project Management Toolkit.zip
- 7 Steps to Project Closure [128]
- Project Closure: 8 Steps + Checklist to Close Projects [129]

5.2 Lessons Learned

If project closing is about tying off the administrative and contractual loose ends of a project, lessons learned is about making sure the knowledge gained along the way doesn't disappear with the project team. Lessons learned are commonly defined as the knowledge gained through the process of conducting a project. They include the problems encountered, the solutions found, and the recommendations that would help avoid repeating the same mistakes on future work. Conducting a lessons learned exercise gives a project team the chance to reflect deliberately on the project's successes, challenges, and experiences, and to translate those reflections into documented best practices that can be applied going forward [130].

Although lessons learned are strongly associated with the closing phase, treating them as an end-of-project activity alone undersells their value. It is a vital action that project teams should continually perform throughout the project. By soliciting feedback during the project, improvements can be identified and implemented right away so that their benefits can be realized within the current project [126]. In practice, lessons should be captured at multiple points, including during project phase-gate reviews, rather than saved up entirely for a single session at the very end [127].

At its core, the exercise is deceptively simple. It generally comes down to asking the project team two questions: 1) What was done well? and 2) What could have been done better and how? [127]. Despite the simplicity, capturing lessons learned is often skipped in practice because of the perceived administrative burden. However, organizations that commit to doing it consistently gain value over those that don't. Video 24 summarizes some key points on how to make lessons learned meetings more effective and efficient.



Video 24. Lessons learned meeting: how to make it excellent. (Source: https://youtu.be/cemERTeeQ7M?si=hCos0RqDtgYTLyTZ)

A well-run lessons learned session typically walks through the project's final status report section by section, asking how the team did and what could have been done better. Martin & Tate [124] recommend capturing initial input silently and anonymously. For example, have team members write and submit ideas individually before grouping them into like categories. This approach tends to surface more candid feedback than open group sessions and even more so on sensitive topics such as missed deadlines or interpersonal friction. From there, the team can work together to turn those individual notes into consensus lessons-learned statements, and ultimately into concrete recommendations for improving the organization's broader project management practices.

Effective lessons-learned documentation is also organized rather than free-form. Suggested categories can include project management process (initiating, planning, executing, monitoring and controlling, and closing), resources, technical issues, communication, business processes, requirements, design and build, testing, implementation, and external factors [126]. This structure makes lessons easier to search for and retrieve later, rather than burying useful insights inside a single report. A simple template for collecting lessons learned can be found in the accompanying Project Management Toolkit (see "Lessons Learned Template.docx"). Figure 34 also illustrates a final lessons learned report example.

LESSONS LEARNED REPORT

Warehouse Management System (WMS) Implementation Project



Project Start Date	Project End Date	Project Sponsor	Project Manager	Report Date
Jan 6, 2025	May 16, 2025	Operations Director	Jane Smith	May 23, 2025

EXECUTIVE SUMMARY

The WMS implementation project was successfully completed and delivered significant operational improvements. This report captures key lessons learned to help improve future projects. Each lesson identifies what went well, what could be improved, and recommended actions.

CATEGORY	WHAT WENT WELL	WHAT COULD BE IMPROVED	RECOMMENDED ACTIONS
1. PROJECT MANAGEMENT PROCESS (Initiating, Planning, Executing, Monitoring & Controlling, Closing)	• Strong project charter and clear objectives. • Regular status meetings and effective risk management. • Change control process helped manage scope.	• Planning phase took longer than expected. • Some risks were identified late. • Closeout documentation started late.	• Start planning activities earlier with dedicated resources. • Conduct earlier and more frequent risk workshops. • Begin closeout activities earlier in the final phase.
2. RESOURCES	• Core team was engaged and knowledgeable. • Vendor resources were highly skilled. • Adequate training staff availability.	• Internal resources were over-allocated at times. • Some key subject matter experts were unavailable during peak periods.	• Confirm resource availability before finalizing schedule. • Secure SME commitments earlier. • Use resource planning tools to identify conflicts sooner.
3. TECHNICAL ISSUES	• System performance met expectations. • Integration with ERP was successful. • Minimal system downtime during testing.	• Wireless coverage gaps discovered late. • Data conversion required multiple iterations.	• Conduct site surveys earlier in the design phase. • Perform trial data conversions earlier and allow more time for cleanup.
4. COMMUNICATION	• Stakeholders were engaged throughout the project. • Weekly updates kept everyone informed.	• End-user communication before go-live could have been stronger. • Some changes were not communicated quickly enough.	• Increase end-user touchpoints and updates. • Use multiple communication channels for change notices.
5. BUSINESS PROCESSES	• Standardizing processes improved efficiency. • Process mapping sessions were effective.	• Some legacy workarounds were not identified early. • More time needed for process adoption.	• Conduct process discovery with front-line users earlier. • Plan additional time for change management and adoption support.
6. REQUIREMENTS	• Requirements were well documented. • Stakeholder sign-off obtained.	• A few requirements were unclear, causing rework. • Future-state requirements evolved during the project.	• Use more detailed acceptance criteria. • Expect evolving requirements and plan iterative reviews.
7. DESIGN & BUILD	• System configuration aligned with requirements. • Build completed within planned timeframe.	• Some configuration decisions were made late. • Additional peer reviews would have helped.	• Finalize key design decisions earlier. • Implement formal peer review checkpoints.
8. TESTING	• Test plan was comprehensive. • Defect resolution process was effective.	• More time needed for integration testing. • Test data preparation was challenging.	• Start integration testing earlier in the schedule. • Allocate more time for test data creation and validation.
9. IMPLEMENTATION	• Cutover completed with minimal disruption. • Go-live support was well organized.	• Some users needed more hands-on training. • Hypercare support period could be longer.	• Provide additional hands-on practice before go-live. • Extend hypercare period based on user readiness.
10. EXTERNAL FACTORS	• Strong support from the vendor and partners. • No major external disruptions.	• Vendor response times varied. • Hardware lead times created minor delays.	• Set clearer SLAs and escalation paths with vendors. • Order hardware earlier and build in buffer time.

OVERALL TAKEAWAY

The project achieved its goals and delivered measurable benefits. By applying these lessons learned, future initiatives can be executed more efficiently, with less risk and greater stakeholder satisfaction.

Prepared by:
Jane Smith, Project Manager
Jane Smith

Approved by:
Operations Director
Robert Johnson

Figure 34. Lessons learned report example. (Source: Generated with the assistance of ChatGPT)

The real benefit of lessons learned comes only when individual project insights are captured somewhere the rest of the organization can find and use them. A completed lessons-learned report should be stored alongside other project documentation and summarized for leadership, typically covering an overview of the process used, project strengths (what went well), project weaknesses (what went wrong), and specific recommendations for improvement [126]. Sustaining this practice over time depends heavily on visible commitment from senior leadership, demonstrated through regular review of the lessons-learned repository, action taken on identified best practices, and active support for correcting negative or recurring project trends.

Organizations that build on this kind of recurring, well-supported lessons-learned process are able to capture and learn from experience systematically, which ultimately reduces the time and cost needed to deliver future projects [126]. IN this sense, lessons learned function as the direct mechanism connecting one project's closure to the next project's improved starting point. Thus, turning individual project experience into a lasting organizational asset rather than knowledge that leaves the team.

For additional resources on lessons learned, please reference the following:

- Project Management Toolkit.zip
- How to Wrap Up a Project Effectively: Project Management Closure and Lessons Learned [130]

Declaration of the Use of Artificial Intelligence and Artificial Intelligence Technologies

During the preparation of this textbook, the author used artificial intelligence (AI) technologies to generate images (where noted in captions) and improve the clarity, grammar, and overall readability of the text. After using AI tools, the author reviewed and edited the content and takes full responsibility for the final version of the textbook.

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