Managing Project Costs, Risks, Quality and Procurement

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FLORENCE DADDEY

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About

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BOOK DESCRIPTION

This open textbook offers students of project management an opportunity to focus on estimating, planning and managing project costs, risks, procurement and quality throughout a project. It makes references to PMBOK 7th edition and makes references to PMI Practice Standards for Estimating Costs, PMI Practice Standards for Project Risks Management. The textbook is broken up into sections reflecting key components of project costs, risks, procurement and quality. This book was collected, adapted, and edited from multiple openly licensed sources.

BOOK INFORMATION

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Author

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Subject

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LICENSE

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This book is an adaptation of Project Management from Simple to Complex originally published by the University of Minnesota Libraries Publishing, as well as Project Management by Adrienne Watt, published by BCcampus Open Education.

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Project Management Fundamentals: Adapted for Douglas College for use in third year project management project management courses is licensed under a Creative Commons Attribution-NonCommercial–ShareAlike 4.0 International License, except where otherwise noted. It is assumed that student would have completed a foundational or introductory project management course.

The author would like to acknowledge the contributions of several important individuals, whose efforts made this text possible.

Dejon Douglas – Douglas College Student

Ongoing edits from various colleagues.

Overview

The world we live in is constantly evolving and changing around us. In the business world, global competition is putting pressure on prices, response time, product/service innovations, customer expectations etc. The business landscape is changing where we have many emerging new businesses and some businesses have ceased to exist. New innovations and technologies solutions are continuously evolving to address the needs of industries and markets globally. New emerging employment trends are shaping the ways both employers and employee think about the workforce and hiring practices.

Disruption is the new normal especially as we gradually come out of experiencing life in the midst of a global pandemic. The pandemic began against a backdrop of extraordinary change driven by new technologies, a push for governments and organizations to demonstrate a deeper commitment to social accountability, and rapidly evolving customer expectations. So much is at stake and unfortunately, many organizations have not survived the economic conditions brought about by these forces of change. Government, non-profit, and business leaders alike know that continued success depends on an agile mindset. Organizations need highly adaptive people to deliver on bold and complex project ideas.

This open textbook focuses on planning and managing four critical processes of project work – cost, uncertainty (Risk), procurement and quality. We will discuss applicable project management artifacts created during projects. It is assumed that this book will be used by students who have already completed an introductory or foundational Project Management course.

This open book follows the approach taken by Project

Management Institute (PMI) and will remain aligned with PMI as their best practices evolve.

PMI in 2021 released the Megatrends 2021 report which identifies five global trends reshaping the world:

1. COVID-19
2. Climate Crisis
3. Civil, Civic and Equality Movements
4. Shifting Globalization Dynamics
5. Mainstream Artificial Intelligence

Sunil Prashara PMI president and CEO, stated in the Megatrends 2021 report introduction... "As this year made clear, change is inevitable. But by understanding the drivers behind the volatility, organizations and their leaders can thrive in the Project Economy, delivering positive social impact at a time when it's needed most."

Based on research, industry data and interviews with project leaders, the report summarizes each of the five megatrends and then offers guidance on ways that organizations can address these developments through their projects and their approach to executing them. Organizations must:

- Make social impact projects a strategic priority
- Foster open, innovative partnership ecosystems
- Rethink relationships with customers and wider stakeholders

To do any of this, organization need change-makers—project leaders, the report concludes, that rely on three critical capabilities:

- New ways of working, including agile, waterfall and hybrid approaches; micro learning apps, and AI-driven tools.
- Power skillssuch as collaborative leadership, innovative mindsets and empathy.

- Business acumen, including an understanding of how work relates to strategy.

Check out the Megatrends 2021 report.

Preface

The primary purpose of this text is to provide professors and students with an open-source textbook that can be used in an advanced management courses incorporating PMBOK 7th edition. The objective is to develop a concise, widely applicable open-source textbook that can be used in the for-profit and non-profit sectors. For this reason, the term “organization” is used instead of “business” and “corporation.”

In addition, the author has intentionally left out examples from fields of practice, such as business, engineering, and information technology, in order to ensure this text has universal applicability. The intention is to allow students and instructors to work with their own program-specific case studies, exercises, and assessments to fulfil the appropriate learning objectives.

The material in the text was obtained from a variety of sources. Sources are found in the reference section at the end of each chapter as well as in the Acknowledgement section.

I welcome your feedback and would love to know how you are using the materials. Please send your feedback to:

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Version 1. Released on December 30, 2021.

1.0 THE PROJECT ENVIRONMENT

Learning Objectives

By the end of this session, you will be able to:

- Discuss the organizational environment and its impact on projects
- Discuss the impact of digitalization on project management
- Apply PMI standards and principles to your project work
- Examine diverse project stakeholders and discuss effective tools to engage them

- Explain the importance of modelling appropriate leadership behaviours and skills in project work.
- Explain the importance of creating high performance teams in project work
- Identify factors to consider when selecting projects

Introduction

A lot has changed in the field of project management and this is reflected in the release of the Project Management Body of Knowledge (PMBOK) 7th edition. The establishment of performance domains is a move away from implied process based standards using inputs, tools and outputs to principle-based standards.

The performance domains are the lynchpins – what one draws on, not the prescriptive explanations of how it needs to be done.

Projects produce value in a number of ways including:

- Creating a new product, service or result that meets the needs of customers or end users
- Creating positive social or environmental contributions
- Improving efficiency, productivity, effectiveness or responsiveness
- Enabling the changes needed to facilitate organizational transition to its desired future and state
- Sustaining benefits enabled by previous programs,

projects or business operations.

We will discuss the organization environment and components that enables organization to realize benefits which creates value. Value is something of worth, importance or usefulness so creating a system for value delivery is part of any organization's internal and external environments. The value delivery system works most effectively when information and feedback are shared consistently among all components, keeping the system aligned with strategy and in harmony to the environment.

SHOW WHAT YOU KNOW!

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=21#h5p-2

1.1 Projects and Project Management

What is a Project?

According to PMBOK 7th edition, a project is a temporary endeavour undertaken to create a unique product, service, or result. The temporary nature of the projects indicates a beginning and end to the project work or a phase of the project work. Projects can stand alone or be part of a program or portfolio.

Organizations often choose to manage a related group of projects in a coordinated way to obtain benefits and control unachievable by managing projects individually. When this occurs, it is known as program management.

As an organization grows and matures, change becomes necessary to its sustained viability. Understanding the drivers of a change is the first step in understanding how the project should be managed. Some changes are mandatory. This is often the case with changing legislation and regulations. Mandatory changes often have compliance deadlines and penalties for non-compliance. Operational changes seek to address deficiencies in the day-to-day operations of an organization and can involve repairing or replacing equipment and facilities. Further, strategic changes are optional but once pursued, help take the organization to the next level of performance in the marketplace.

Regardless of the underlying driver(s) for a project, all projects have unique objectives. These unique objectives lead to specific and measurable time, as well as cost and performance requirements. Projects end when their objectives

have been met, as well as when they are no longer desirable and/or achievable. In contrast, operational work is not temporary. Operational activities are ongoing and are performed to sustain the organization. The daily processing of sales transactions is a good example of an operational activity. In contrast, replacing the system that processes daily sales transactions is a project.

Projects and the United Nations 17 Sustainable Development Goals (SDGs)

The international community has responded to the sustainable development challenge with the Sustainable Development Goals (SDGs) for 2030. In their report, 'Transforming Our World: The 2030 agenda for sustainable development', was adopted by the United Nations General Assembly in 2015.

The 17 Sustainable Development Goals (SDGs) are "an urgent call for action by all countries"—developed and developing—in a global partnership. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, equality and job opportunities, while tackling climate change and working to preserve our ocean and forests (UNESCO, n.d.).

The 17 SDGs contain targets for building a better world for people & planet by 2030. Businesses, non-profits, Non-governmental Organizations (NGO's), and educational institutions have developed their own frameworks to address the SDGs and meet individual targets.

This is relevant for project managers because much of tomorrow's development will be delivered by project management professionals across all sectors.

Exhibit 1.1: UN 17 Sustainable Development Goals (SDGs)

Project Management

PMI PMBOK 7th edition defines project management as 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 leaders are evaluated on how effectively they apply their project management knowledge, skills, tools, and techniques to a change in a functional area(s) and how effectively they prepare the functional area(s) to sustain the change. They ask themselves questions such as, "Will this change add value to the organization?" As a team, they may ask, "Will we deliver solutions when they are needed, within the funding parameters available in the organization, and will we meet the expectations of the end–user community?" They also frequently ask, "Are the stakeholders, including the impacted functional leaders, still supportive of the changes to

be delivered?" Answers to these questions guide the project team's work.

To help keep project management terms and concepts clear and consistent, PMI introduced the book "A Guide to the Project Management Body of Knowledge" (PMBOK Guide) in 1987. It was updated in 1996, 2000, 2004, 2009, 2013, 2017 and most recently in 2021 when the seventh edition was released.

PMI's 2020 Pulse of the Profession, revealed that in organizations with mature project delivery practices, an average of 11 percent of the investments made in change was wasted due to poor project performance. Further, organizations that undervalue project management as a strategic competency for driving change report an average of 67 percent more of their projects failing outright. On a global scale, this translates into billions of dollars wasted. In these turbulent times, failures of this magnitude can lead to disastrous outcomes for organizations already struggling to survive. For those that do survive their failed change attempts, many find themselves forced to reimagine what they do and how they do it.

This new decade has introduced us to the "Project Economy." Organizations are constantly searching for ways to adapt and thrive. This means high-stakes projects are frequently launched with a variety of titles, executed through a variety of approaches, and are focused on delivering financial and societal value.

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In the Project Economy, change is introduced rapidly, and some organizations call upon their functional managers to deliver low complexity change into their environments. These functional managers are often successful in leading these change initiatives when they have the needed skills and capacity to apply the appropriate project management tools and techniques while overseeing the daily operational activities of their teams. In addition, simple changes with a well-defined solution and a low level of complexity can be successfully introduced using predictive (also known as waterfall) development approaches.

However, if a functional manager lacks the skills required to manage a project or finds themselves frequently putting out fires started by product/service performance issues, unreliable suppliers, aggressive competitors, and/or ongoing human resource issues, a project management professional is often asked to lead the change. Furthermore, when the change requires cross-functional teams to understand the needs of the end customer and deeply explore these needs before building a solution, project management professionals are better suited for these types of change initiatives.

1.2 Organizational Environment and the Project Environment

Organizational Environment

Executives select projects based on their potential value to their organization. Prioritizing projects in any organization depends on a number of factors such as strategy, economics, social, political situation, technology, competition and other environmental factors. The PMI Standard for Organizational Project Management (OPM, 2018), provides a framework by which organizations can achieve their strategic objectives by means of a portfolio, program and project management.

Selecting and prioritizing projects has to be aligned with the goals, values and strategy of the organization. For example if a core value of an organization is “customer focus” or “customer centered” then the activities selected for requirements, features and scope validation must reflect customer-focus approaches to create value for the stakeholders. This aligns with the idea of efficiently engaging with stakeholders to meet their expectation and optimize the value delivered.

Organization environment represents the organization governance, policies, organizational culture and supporting practices of the organization that are created to support OPM and organizational strategy delivery and the system must be set up for value delivery.

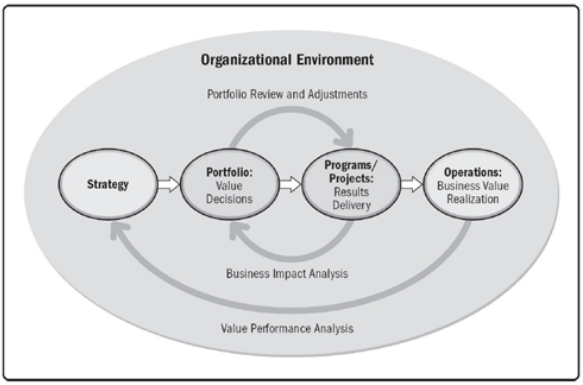

Exhibit 1.2: Organizational Environment

Adapting to the unique objectives, stakeholders, and complexity of the organization environment contributes to project success or failures. The PMBOK 7th edition discusses 'tailoring' which is the deliberate adaptation of approach, governance, and processes to make them more suitable for the given environment and the work at hand. Tailoring involves understanding the project context, goals and operating environment. It encourages project leaders to tailor their approach to the challenge that they are tackling, the work that they are doing, the team that they are engaged with and the context within which they are working.

Effective project management and execution start with choosing the right projects. While you might not have control over which projects your organization pursues, you do need to understand why your organization chooses to invest in particular projects so that you can effectively manage your projects and contribute to decisions about how to develop and, if necessary, terminate a project. It is important to start with the definitions:

Product: Is an artifact that is produced, is quantifiable, and can be either an end item in itself or a component item.

Project: A temporary endeavor undertaken to create a unique product, service or result.

Program: Related projects, subsidiary programs, and program activities that are managed in a coordinated manner to obtain benefits not available from managing them individually.

Portfolio: Projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives.

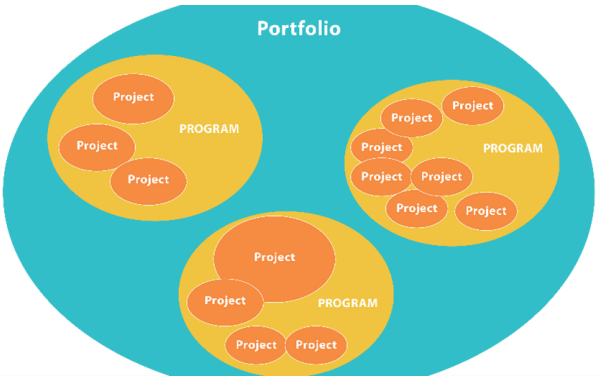

Exhibit 1.3: Relationship between a portfolio, programs, and projects

It is important to understand the similarities and differences amongst portfolio, program and projects since the management of portfolios, programs and projects are driven by organization strategies. However, they interact at different levels to achieve strategic goals and objectives.

Exhibit 1.4: Projects, Program and Portfolio

Projects are best if there is one primary goal for the project to focus on delivering; multiple goals are best dealt with by way of a program, with a series of projects each focusing on a particular goal.

It is also important to understand the concept of 'product' – which is an artifact that is produced, is quantifiable and can be either an end item in itself or a component item. Product management may initiate programs or projects at any point in the product life cycle to create or enhance specific components, functions or capabilities. Product management is a separate discipline with its own body of knowledge representing key integration point within the program management and project management disciplines.

The value delivery system is a new concept introduced in the standards section of the PMBOK 7th edition. Being very successful in completing a project does not always mean that organization's strategies also achieve success. You may have produced more than one product as a result of successive successful projects, but this does not mean that you added value to the company.

According to the value delivery system, the strategies, goals, and tasks that an organization decides, drives the portfolio, programs, and projects that are carried out by the organization. These must be considered holistic, reviewed, and aimed at adding value to the organization.

The results of completed projects are evaluated, measured and analyzed to determine whether the expected impact has occurred. According to the results of this analysis, the portfolios owned by the organization are updated to create the highest value for the organization.

As long as the product or delivery included in the scope of the project was produced, the question of whether the targeted value was achieved remained somewhat ambiguous. In every project a benefits realization happens in the short term or long term. In a value management system, this

benefits realization should be measured precisely and important value decisions should be taken according to feedbacks from operations, projects results, programs, and portfolios. In order to be able to do this, we have to build feedback loops into the system. Feedback is collected at the end of every project and these are used for value decisions at the portfolio level.

Project Environment

Project leaders who are able to effectively understand the environment in which they are operating can not only refine their approach to tailoring the tools and techniques required, they can also significantly increase the likelihood of successfully delivering change.

There are many factors that need to be understood within a project environment this can be classified as internal and external factors.

Internal factors can arise from the organization itself, a portfolio, a program, another project or a combination of these.

External factors can enhance, constrain, or have a neutral influence on project outcomes. See examples:

Internal Factors	External Factors
Process Assets	Market place conditions
Government documentation	Social and cultural influences and issues
Data assets	Regulatory environment
Knowledge assets	Commercial databases
Security and safety	Academic research
Organizational culture , structure and governance	Industry standards
Geographic distribution of facilities and resources	Financial Considerations
Infrastructure	Physical environment
Information technology software	
Resources availability	
Employee capability	

The cultural and social environments consider people, demographics, and education. It is about understanding the cultural differences of unique countries and the impact that local and national governments have on organizations. The physical environment is about working conditions and locations. Delivering a project that has global impacts is much more challenging than delivering a project that only impacts the local environment.

Of all the factors, the physical ones are the easiest to understand, and it is the cultural and global factors that are often misunderstood or ignored. How we deal with clients, customers, or project members from other countries can be critical to the success of the project. For example, North American cultures value accomplishments and individualism, and tend to be more informal, calling each other by first names, even if having just met. Europeans tend to be more formal, using surnames instead of first names in a business setting, even if they know each other well. In addition, their

communication style is more formal than in the North American setting, and while they tend to value individualism, they also value history, hierarchy, and loyalty.

How a product is received can be very dependent on international cultural differences. For example, in the 1990s, when many large American and European telecommunications companies were cultivating new markets in Asia, their customers' cultural differences often produced unexpected situations. Western companies planned their telephone systems to work the same way in Asia, as they did in Europe and the United States. But the protocol of conversation was different. Call-waiting, a popular feature in the West, is considered impolite in some parts of Asia. This cultural blunder could have been avoided had the team captured the project environment requirements and involved the customer.

Project leaders in multicultural projects must appreciate the cultural dimensions and try to learn relevant customs, courtesies, and business protocols before taking responsibility for managing an international project. A project leader must take into consideration these various cultural influences and how they may affect the project's completion, schedule, scope, and cost.

Other key consideration in understanding project environments – include operational and project management processes, policies, procedures, success metrics, and knowledge repositories. The degree to which they are utilized in a project, as well as the expectations surrounding their use, have a big impact on how projects are delivered.

1.3 Digitalization of Project Management

The Digital Age

We live in an era characterized by accelerating exponential change driven by a cluster of technologies, such as the internet, social media, mobile, big data/analytics, artificial intelligence, automation, and robotics. Beginning with the introduction of the very first personal computer in the seventies, today, with an Internet connection, one can use video and audio to communicate and transact anytime, anywhere, and anyplace. We live in a digital realm in what is loosely described as "cyberspace," in which information is exchanged and shared in a space that is virtual.

Though these digital technologies have been developing for many years, it is only in the past decade or so that their cumulative impacts have become so deep-rooted, extensive, fast-changing, and profoundly impactful as to herald the dawn of a new age – the "Digital Age" or the Digital Economy. The cluster of technologies driving this is varyingly referred to as digital technologies or digital forces.

The role of digital technologies will continue to expand. This will occur because more devices are accessing the Internet; an ever-increasing number of people are using digital services and more value chains are being digitally connected. Therefore, access to digital technologies is a source of major competitive advantage for organizations, particularly when paired with the ability to use them to transform the way value is delivered to the market. In the education sector for instance, despite the challenges due to COVID-19, virtual learning environments

have made it possible for academic institutions to continue seamlessly with their academic programmes.

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The Organizational Response – Digitization, Digitalization, and Digital Transformation

The onset of the Digital Age and the availability of new technologies have been the enabling factor in organizational change and innovation. Organizations have been putting in place strategies and launching projects to become agile, profitable, and smart in order to cope with an increasingly competitive environment and the unpredictability of markets.

Given this, companies have been in a rush to become digital and they are going about it in different ways. Some of them are implementing digital technologies to engage in new ways with customers and others are completely transforming their way of doing business or creating an entirely new business model. To understand this, let us consider a simple process like performance reporting. Such reporting systems have moved from paper to spreadsheets to smart applications with digital technologies such as artificial intelligence (AI) and data analytics.

However, to reach the maturity of "smart reporting," one

would have to reimagine the way reporting is done in terms of the reporting formats, the periodicity, the flexibility in the use of variables, the application on which the reports are developed, and finally, the way the reports are presented. Such a move in reporting systems would also mean new ways in which we engage our customers who would be receiving, in real-time, such reports all laden with infographics.

To elaborate this further, historically, businesses kept handwritten or typed paper-based records. During this time, business data was in a stage which is referred to as **analog**, and if you wanted to move or share this data or information it was done through the physical movement of papers and documents.

When computers went mainstream, most businesses started converting all those paper records to digital computer files. This stage was called **digitization**, which is the process of converting information from analog to digital. Through the process of digitization, finding and sharing information became much easier, but the ways in which businesses used their new digital records largely imitated the old analog methods. Computer operating systems and thumbnails were even designed around icons of file folders to feel familiar and less intimidating to new users. Digital data was exponentially more efficient for businesses than analog had been, but business systems and processes were still largely using analog-era ideas about how to find, share, and use information.

Then organizations began the process of **digitalization**, which is the use of digital data to simplify the way work is done. A good example would be how call centres would use digitized data and information to provide customer service. Digitalization would enable call centres to provide better service by making customer records easily and quickly retrievable via multiple devices. The basic methodology of customer service did not change, but the process of fielding an inquiry, looking up the relevant data, and offering a resolution

became much more efficient. In summary, digitalization is about the way business operations employ transformative digital technologies and information.

With digital technologies continuing to evolve and newer technologies becoming available, strategists have started generating ideas for using these digital technologies to improve existing ways of doing business, but more importantly, new ways of doing business. That is when the concept of digital transformation began to take shape. Organizations were now able to change their fundamental business models. Uber, for example, heavily incorporated digital transformation to change the way we rideshare.

Digital transformation is about changing the way business gets done and, in some cases, creating entirely new classes of businesses. With digital transformation, organizations are taking a step back and revisiting everything they do, from internal systems to online and in-person customer interactions. The questions being asked are, "Can we change our processes in a way that will enable better decision-making, increase efficiencies, enhance customer experience, empower personalization, and, most importantly, boost profits?"

Therefore, the organizational response to the capabilities provided by the Digital Age is to embark on a strategy of digital transformation of their businesses. Most organizations are integrating their digital strategy with their overall strategy to disrupt the marketplace.

Impact of Digitalization on Project Management

With a major percentage of organizations embarking on a strategy of digital transformation and disruption being the new norm, project leaders are becoming even more essential as

organizations recognize that strategy is implemented through projects and programs.

So how exactly are the Digital Age and digital transformation changing project management? The impact is seen broadly at three levels in terms of skills, approaches to the delivery of projects, and the use of next-level tools and approaches that work. This creates both challenges and opportunities for project management and those who manage projects.

According to a recent PMI survey and subsequent study called, "The Project Manager of the Future – Developing Digital-Age Project Management Skills to Thrive in Disruptive Times," project management will require organizations and individuals alike to embrace a full spectrum of competencies and approaches, along with a wide range of skills.

From skills and competencies perspective, project leaders will continue to need a thorough combination of technical and project management skills, leadership skills, and strategic and business management skills, which are already part of the PMI Talent Triangle. In addition to this important triad of skills, organizations will need project leaders to learn and keep pace with existing and emerging technology. In the reality of the "Digital Age," a new digital overlay has been given to the PMI Talent Triangle to emphasize how digital transformation is impacting every aspect of our work.

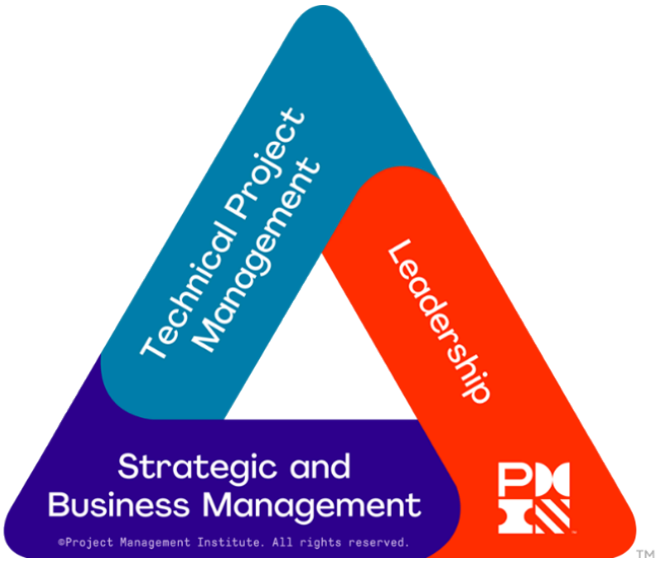


Exhibit 1.5: PMI's Talent Triangle

The three points of the triangle (which represents the ideal triad of skills) are technical project management, strategic and business management, and leadership.

Technical project management skills are about successfully tailoring the tools, techniques and processes used. This domain also includes the ability to thoroughly plan, prioritize and effectively manage the scope, schedule, budget, resources and risks associated with a project.

Strategic and business management skills are about communicating a project's organizational aspects, develop delivery strategies and maximize business value.

Some projects require specific organizational and/or industry knowledge. This knowledge can be defined by industry group (pharmaceutical, financial, etc.), department (accounting, marketing, legal, etc.), technology (software development, engineering, etc.), or management specialty (procurement,

research and development, etc.). These application areas are usually concerned with disciplines, regulations, and the specific needs of the project, the customer, or the industry.

It is important for project leaders to embrace a life-long learning mindset as internal and external environments often change very quickly. During the "initiation stage," project leaders assess the strategic and business management knowledge they have and its value to the new project underway. If necessary, effective project leaders seek to close their knowledge gaps through their own research and by seeking the support of mentors. As discussed earlier, it is important for project leaders to understand the organization's vision, mission, and strategies.

Leadership skills are useful for all project team members whether the project team is operating in an environment with centralized authority or shared leadership environment. Some of the traits and activities associated with leadership includes;

- Establishing and maintaining vision
- Developing and applying critical thinking skills so you can recognize bias, identify the root cause of problems, and consider challenging issues such as ambiguity, complexity, etc.
- Understanding what motivates team members to perform and working with project team members to remain committed to the project and its outcomes.
- Developing interpersonal skills such as emotional intelligence, decision-making skills, and conflict management.

Success in today's digital environment requires a combination of skills, some of which include data science (data management, analytics, and big data), an innovative mindset, security and privacy knowledge, legal and regulatory compliance knowledge, the ability to make data-driven

decisions, and collaborative leadership. The crux of it is that technical skills are not enough on their own and must be paired with leadership, as well as strategic and business management, in order to support the longer-term strategic objectives of organizations.

How Project Leaders Manage Disruptive Technologies

With regard to project delivery, organizations have been using a spectrum of approaches— predictive, iterative, incremental, agile, hybrid, and whatever approach will come next to change how work is carried out. Most organizations have embraced the entire value delivery landscape to deliver their projects and programs. Project leaders in organizations see disciplined agile delivery and design thinking as the growing approaches or processes that will be needed.

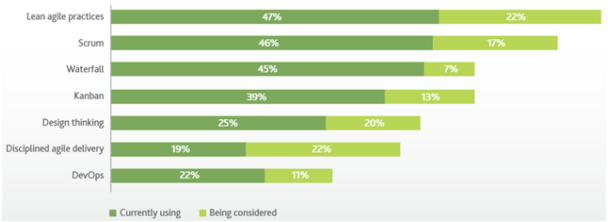


Exhibit 1.6: Approaches currently used or being considered by project leaders to manage disruptive technologies

The cluster of technologies available in the Digital Age is cutting-edge and disruptive. Organizations must be able to not only understand these technologies, but also to integrate these technologies and tools into their organization. Regarding projects being carried out, leaders and team members must

embrace the next-level tools and technologies, applying and integrating them into their project work.

These tools and technologies are a combination of collaborative work management tools, as well as traditional tools, including spreadsheets and traditional project management tools (e.g., Microsoft Project and Portfolio Management, Accolade, etc.), collaboration platforms (e.g., IBM Watson Workplace, Slack, etc.), agile planning tools (e.g., Atlassian, CollabNet, VersionOne, etc.), and collaborative work management tools (e.g., Smartsheet, Trello, etc.). (PMI 2018).

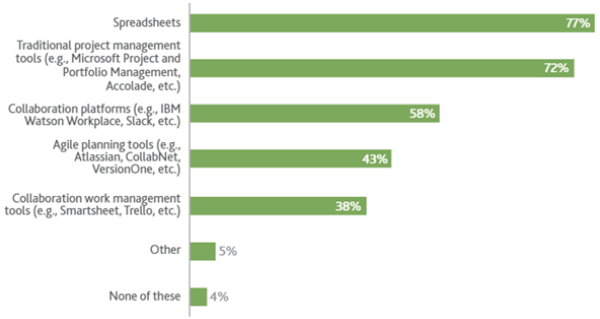


Exhibit 1.7: Tools project leaders use to deliver disruptive technology initiatives

In addition to these tools and technologies, project leaders are also relying heavily on technologies that enable effective cross-team communication. Traditional tools, such as email, are cumbersome when it comes to collaboration, as they are not designed for real-time dialogue. Important information is easily buried within endless email chains, and constant email overload negatively affects productivity. On the other hand, collaborative work management software allows team members and co-workers across departments to engage, connect, and interact in real-time, significantly cutting down on email clutter and saving loads of time in the process.

But more than just increasing the efficiency of intra-work communication, these technologies are improving its

effectiveness as well. When team members are freed from filtering through hundreds of emails a day just to keep up with a project's status, they are able to spend more time talking about project strategy — which is precisely where the bulk of your team's conversation needs to be focused.

Along with facilitating more efficient, strategy-focused communication, modern work management technologies are making it easier for teams to truly collaborate. With the right platform in place, executives, project leaders, and team members can add comments, assign tasks, organize dashboards, approve assets, and handle just about everything else related to the project all in one convenient solution. This deep level of collaboration inevitably leads to a greater sense of shared ownership from teammates and helps foster a cooperative, synergistic environment. Workers who feel they are part of a collaborative effort have been shown to have greater engagement, lower fatigue, and higher success rates than those who are isolated from peers.

As digital transformation automates workflows and coordinates traditional project management tasks like scheduling, Project leaders are getting more time to focus on strategy optimization and project delivery. In fact, the PMI predicts that as digital transformation continues to touch companies across every industry and vertical, Project Leaders will be viewed more as strategic leaders in their organizations: With more digital tools and automated processes at their disposal, Project leaders are homing in on the best ways to align each project with the business' strategies and goals — and delivering more successful outcomes in the process.

Digital transformation is providing project leaders with the analytical technology to make data-driven decisions, break down patterns and trends, and ultimately enhance project outcomes and success rates. This access to deep data also assists executives and managers in making better-informed decisions faster and easier than ever before. Robust analytic

reports help managers keep projects on track and on budget with real-time cost and labour analyses. In-depth data sets can also be easily broken down for stakeholders and executives, giving them precise insight into business impact and return on investment (ROI) on every project and helping them strategically plan future initiatives.

As technology continues to advance at exponential rates, organizations must adapt to the digital landscape or risk getting left behind. Companies that have implemented a digital transformation strategy have been shown to increase performance and revenues. According to McAbee (2019) a project leader who is mandated to deliver projects for organizations carrying out digital transformation would need to focus on streamlining communication, improving collaboration, and shifting focus from project processes status to strategy and outcomes.

Reflective Exercise

- What do you think are the major differences between project management and general management?

1.4 PMI – Standards for Project Management and Project Performance Domains

PMI PMBOK 7th edition introduced a number of new concepts including the value delivery system, project delivery principles, performance domains and tailoring. The PMI Standards for project management identifies 12 principles of project management which are aligned with the values identified in the PMI Code of Ethics and Professional Conduct.

A **principle** is a norm, rule, value or fundamental truth which serve as a guide for behaviour or action. Principles serve as foundational guidelines for strategy, decision making and problem solving. Principles are not prescriptive and they do not tell you how to do something. Principles are intended to guide the behaviour of people involved in projects. They are not specific to any methodologies and will work regardless of the delivery approaches. Below are the principles:

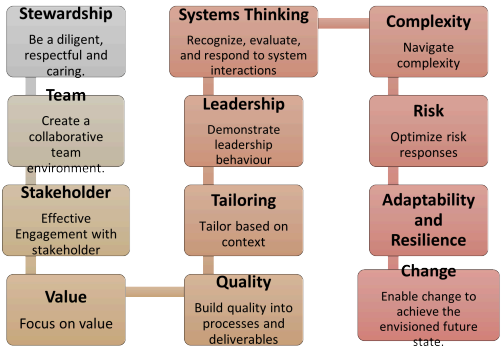


Exhibit 1.8: Project Management Principles

Project Performance Domains

Successful project leaders know how to uniquely apply the knowledge and skills they have learned to each project by tailoring the tools and techniques they use. The complexity of a project has a big impact on the tools and techniques required throughout the project lifecycle. PMI has identified eight performance domains that form an integrated system to enable successful delivery of project and intended outcomes. The performance domains are applicable for both agile and predictive development approaches.

A Project Performance Domain is defined as "a group of related activities that are critical for the effective delivery of project outcomes." Each performance domain has a set of measurable outcomes.

Exhibit 1.9: Project Performance Domains

The PMBOK 7th edition offers the following definitions and discussions:

1.4.1 Stakeholder Performance Domain

Stakeholder is an individual, group, or organization that may

affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio. A project may have a small group of stakeholders or potentially millions, however, there may be different stakeholders in different phases of the project, and the influence, power, or interests of stakeholders may change as the project unfolds. Some stakeholders can be internal and external to organization, some may be supportive or neutral and therefore developing interpersonal skills to engage stakeholders is essential.

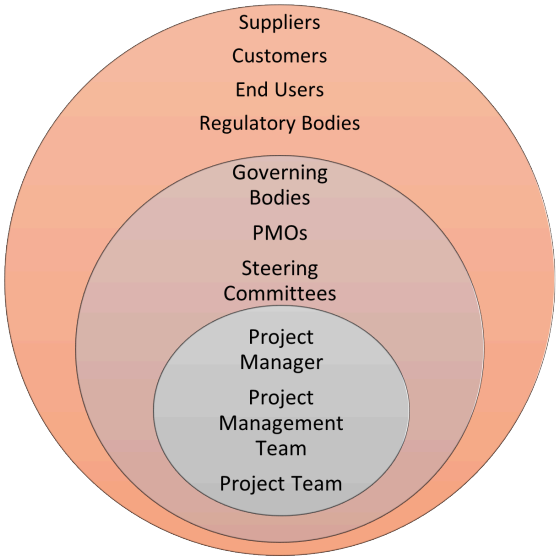


Exhibit 1.10: Types of Stakeholders

Stakeholder engagement is a critical success factor in project management since if stakeholders are not satisfied with the outcomes of a project, the project will not be successful so effective stakeholder interaction contributes to successful project outcomes.

Achieving a project's objectives requires a focused, well-organized project leader who can engage with a committed project team and gain the support of all stakeholders. Building

strong, trusting relationships with interested parties can make the difference between project success and failure.

Stakeholder engagement includes implementing strategies and actions to promote productive involvement of stakeholders in project decision making and implementation. Navigating effective stakeholder engagement requires effective communication. Note that various activities may start before or when the project starts and continue throughout the project and may start with:

- Identify stakeholders
- Understand and analyze stakeholders
- Prioritize stakeholders
- Engage stakeholders
- Monitor stakeholders

Understanding a stakeholder's interest is about understanding "what is in it for them?" In addition, asking stakeholders how they define project success is a powerful way of identifying their expectations. Knowing what each stakeholder needs or wants from the project will enable the project leader to anticipate the stakeholder's level of support and identify any potential conflicts that may arise. Conflicts are common and often healthy for projects. When managed effectively, conflicts lead to good decisions that optimize the value of the project. At the outset, conflicts often arise when prioritizing project constraints.

For instance, one stakeholder may believe it is more important to complete the project with an aggressive timeline while another may feel minimizing project cost is the priority. Another common example is in defining solution requirements. Project leaders need to ensure the voice of their stakeholders is continuously heard during solution design and development. This may lead to differences of opinion and these differences need to be resolved in a respectful, timely fashion.

Depending on the development methodology chosen, resolving these differences may be part of the product owner, business subject matter expert, scrum master, business analyst, and/or project leader's accountabilities.

When project leaders are accountable for resolving these differences, interpersonal skills are key. Active listening and a clear willingness to facilitate relationship-building between stakeholders are important. In addition, staying 'passionately neutral' in the eyes of stakeholders is important. As a project leader, it is not about what is best for you, it is about identifying what is best for the project and the organization, and passionately pursuing that with stakeholders. Resolving conflicts in respectful ways is a skill that can be developed over time.

In some cases, project leaders will be working with stakeholders that are not supportive of the project. They may feel the project is not going to benefit them and their team in the ways it should. They may also resist making the changes that are necessary to support the project's outcomes. Some stakeholders are very upfront about their resistance and others are not. In these situations, the project Sponsor may be integral to winning these stakeholders over. Knowing when to tactfully involve others in stakeholder management is another key success factor for effective project management.

Building trust and maintaining an open line of communication is critical in working with all stakeholders. Keeping stakeholders involved is essential and it requires more than simply sharing information. The project leader must ask for their input and demonstrate an understanding of a stakeholder's unique business challenges. This level of understanding is often done through simple and regular check-ins with stakeholders. Lastly, project leaders who are successful in relationship building understand each stakeholder's capacity to participate and honour their time constraints.

The stakeholder register is an effective tool for project leaders to use throughout the project. It allows the project team to keep track of all the stakeholders and ensure their needs are represented in the communications plan. When communicating with stakeholders different types of communication may be used – written/verbal, formal/informal, push/pull, synchronous/asynchronous.

Every stakeholder has different requirements and expectations so it's important to identify, classify and analyze stakeholders. Stakeholders analyzing is a method of systematically gathering and analyzing quantitative and qualitative information to determine whose interest should be taken into account throughout the project. In analyzing stakeholders consider power, impact, attitude, belief, expectation, degree of influence, proximity to the project, interest in the project and other aspects surrounding stakeholder's interactions with the project. After analyzing stakeholders a stakeholder's engagement strategy will be developed.

Four models below can be used to classify stakeholders:

1. Power/interest grid
2. Power/influence grid
3. Influence/impact grid
4. Salience model

The first three models use two attributes. The fourth model uses three attributes.

The stakeholder Salience Model was proposed by Ronald K. Mitchell, Bradley R. Agle, & Donna J. Wood in 1997. The authors denoted a stakeholder identification based on three variables:

Here, a stakeholder has three attributes:

1. Power to influence
2. Legitimacy of the stakeholder's relationships with the

project
3. Urgency of the stakeholders claim on the project for stakeholder engagement.

Project teams will choose appropriate models for their specific environment and context.

Working with Indigenous populations

As project leaders, managers and team members, it is our responsibility to ensure that we develop the knowledge and skills necessary to work with and build relationships with Indigenous Peoples and communities. Forging close ties with diverse Indigenous peoples requires an understanding of their protocols, a deep respect for their unique cultures, customs, languages, and environment. Building trust is an important ingredient in building relations with indigenous communities. Bob Joseph, a Gwawaenuk Nation member, owner of Indigenous Corporate Training, and former associate professor at Royal Roads University, provides 7 Tips on Building Relationships with Indigenous Peoples. Source

On-going training is required to ensure that project team leaders and members are provided with the appropriate cultural awareness training as we engage with indigenous stakeholders.

You may have heard the term protocol in relation to working with Indigenous people. The term protocol includes many things, but overall it refers to ways of interacting with Indigenous people in a manner that respects traditional ways of being. Protocols are not just manners or rules – they are a representation of a culture's deeply held ethical system. They also have highly practical applications that may have arisen in a pre-contact context but still apply today. Protocols differ vastly

from one Indigenous culture or community to another, and they can be highly complex and multi-layered.

Coming to understand and practice protocols appropriately is a lifelong learning process even for Indigenous people growing up within their culture. Following protocols is a significant sign of respect and awareness. It shows that you are taking the time to learn about Indigenous cultures and are challenging the often-unconscious bias that everyone should interact in the way that mainstream settler culture dictates. Through following protocols, you can build stronger relationships with Indigenous communities and learn about diverse ways of interacting

Watch this video of Bradley Dick – TedX Talk and the First Nations Projects Coalition. In this video, pay close attention to how Bradley Dick (Lekwungen First Nation) follows traditional protocols, explains his own learning process, and reflects on the meaning and importance of those protocols.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=28#oembed-1

1.4.2 Team Performance Domain

We have all had the experience of working on teams either in our volunteer roles or in our organizations and have probably suffered the pain of working on a team lacking in complementary skills, with no clear common purpose, and plagued by uncommitted members who refuse to hold themselves accountable. As a project manager, you need to

work with the team you have, not with the team you wish you had, leading your team through the uncertainty inherent in project work, and encouraging collaboration at every turn.

The most powerful sources of uncertainty in any project are the people charged with carrying it out. What's more, because a project is, by definition, a temporary endeavor, the team that completes it is usually temporary as well, and often must come together very quickly. These facts can exacerbate leadership challenges that are not an issue in more stable situations. Some organizations maintain standing teams that tackle a variety of projects as they arise. But even in those cases, individual team members come and go. These minor changes in personnel can hugely affect the team's overall cohesion and effectiveness.

As a project leader, your ultimate goal is to encourage an overall sense of **psychological safety**, which is "a shared belief held by members of a team that the team is safe for interpersonal risk taking." Teams that do their work under the umbrella of psychological safety are more effective, in part because they are willing to take the risks required to learn and innovate (Edmondson 1999).

According to PMBOK 7th edition, the project team is a set of individuals performing the work of the project to achieve its objectives. An environment can be established to support the team in evolving into a high performance team.

Team performance domain according to PPMBOK 7th edition entails establishing activities and functions associated with the people who are responsible for producing project deliverables that realize business outcomes. This performance domain focuses on all actions and processes about the project team, including managing conflicts, encouraging leadership behaviors from all project team members and sharing ownership for the outcomes, developing teams, and monitoring their interactions.

The essential elements for team effectiveness include—clear

objectives, well-defined roles and responsibilities with matching capabilities, effective communications, respect for diversity, conscious relationship management, and commitment to working together to get the job done within pre-established, agreed-upon rational constraints.

Each project team must develop rules and processes which they can build an effective working team environment. This can be in the form of creating a team charter for example. Each project team then develop its own team culture however, the project team culture operates within the organization's culture and reflects the project team's individual ways of working and interacting. Individuals in any type of leadership role are significant in inspiring others to maintain appropriate behavior and effective working environments. The project manager is instrumental in establishing a safe, respectful, nonjudgmental environment to allow the team to communicate openly. Some desired ways of modelling this includes:

- Transparency
- Integrity
- Respect
- Positive discourse
- Support
- Courage
- Celebrating success

Self-Organizing Agile Teams

Agile software development was founded as a way to help team members work together more efficiently and companionably. In fact, three of the twelve founding principles of the methodology focus on building better teams:

1. The most efficient and effective method of conveying

information to and within a development team is face-to-face conversation.
2. The best architectures, requirements, and designs emerge from self-organizing teams.
3. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly (Beedle et al. 2001).

The term 'self-organizing teams' is especially important to Agile. Nitin Mittal (2013), writing for Scrum Alliance, describes a **self-organizing team** as "a group of motivated individuals, who work together toward a goal, have the ability and authority to take decisions, and readily adapt to changing demands."

The Power of Diversity

The rationale for putting together a team is to combine different people, personalities, and perspectives to solve a problem. Difference is the whole point. Diverse teams are more effective than homogenous teams because they are better at processing information and using it to come up with new ideas. According to David Rock and Heidi Grant, diverse teams tend to focus more on facts, process those facts more carefully, and are more innovative (2016).

What's more, researchers investigating creativity and innovation have consistently demonstrated "the value of exposing individuals to experiences with multiple perspectives and worldviews. It is the combination of these various perspectives in novel ways that results in new ideas 'popping up.' Creative 'aha' moments do not happen by themselves" (Viki 2016). In his book, *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies,* Scott Page (2007) puts it like this:

> As individuals we can accomplish only so much. We

> are limited in our abilities. Our heads contain only so many neurons and axons. Collectively, we face no such constraint. We possess incredible capacity to think differently. These differences can provide the seeds of innovation, progress, and understanding.

Within the team it is important to recognize and support diversity by including members who are qualified and have appropriate skills such as:

- Visible minorities
- Ethnic minorities
- Women
- Indigenous peoples
- People with disabilities.

Project Leadership skills

Leadership is about using one's interpersonal skills in order to guide, motivate and direct a team.

In the sixth edition of the PMBOK Guide, PMI identified a very comprehensive list of the skills and attributes needed by project leaders. All the skills and attributes are important. For purposes of this text, the following key skills and attributes will be highlighted:

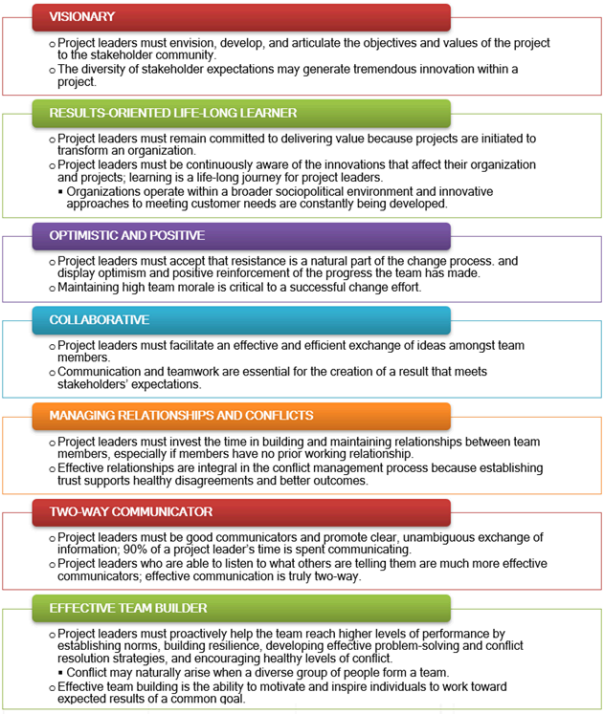


Exhibit 1.11: The key skills good project leaders possess

This is by no means a complete list of all the skills and attributes required to be a successful project leader. Moreover, the nature and complexity of a project can help identify which of these skills will be more instrumental to project success than others.

In PMBOK 7th edition, it is assumed that, if we successfully perform all tasks of the team performance domain then the outcome will be a high-performing team, shared ownership, and interpersonal skills.

Leadership behaviours that is important for project team leaders to develop include:

1. Critical thinking skills
2. Motivation

3. Interpersonal skills – Emotional intelligent, Decision making and Conflict management

To be effective in leadership the project leader also needs to develop a servant leadership style of leadership. Servant leadership focuses on understanding and addressing the needs and development of project team members in order to enable the highest possible project team performance. Servant leaders place emphasis on developing project team members to their highest potential. They allow project teams to self-organize when possible and increase levels of autonomy. Servant leadership behaviours include:

- Maximizing delivery by removing obstacles and impediments hampering the project team
- Projects project team from internal and external diversions that redirect the project team from the current objectives.
- Provides tools and encouragement to keep the project team satisfied and productive. This requires learning what motives individual team members and finding ways to reward them for good work.

Leading and managing virtual teams are challenging and require discipline yet flexible approaches. Due to globalization, impact of the pandemic, outsourcing, the use of the most talented people wherever they are based, flexible working etc. the virtual project teams are on the rise. (Pullan & Prokopi, 2016).

There are several models that describes the stages of project team formation, growth and development. However, the common aspects of project team development that are relevant for most project teams include:

- Everyone is aware of the project vision and objectives

- Setting clear roles and responsibilities
- Facilitating project team communication, problem solving and the process of coming to a consensus.
- Guiding the team in the right direction, including guidance on tasks or deliverables
- Working collaboratively to improve project team performance by growing to strengthen and deepen each individual skills and experiences in certain areas.

Core Considerations of Leadership

Good teamwork depends, ultimately, on a leader with a clear understanding of what it means to lead. To judge by the countless books on the topic, you'd think the essential nature of leadership was widely understood. However, few people really understand the meaning of 'leadership'.

In his book, *Leadership Theory: Cultivating Critical Perspectives*, John P. Dugan examines "core considerations of leadership," zeroing in on misunderstood terms and also false dichotomies that are nevertheless widely accepted as accurate explanations of the nature of leadership. Dugan argues that a confused understanding of these essential ideas makes becoming a leader seem like a far-off dream, which only a select few can attain (Dugan 2017). But in fact, he argues, anyone can learn how to be a better leader.

Here's what Dugan has to say about core considerations of leadership:

- **Born Versus Made:** This is one of the most pernicious false dichotomies regarding leadership. Dugan explains, "that there is even a need to address a consideration about whether leaders are born or made in this day and age is mind-numbingly frustrating. Ample empirical research illustrates that leadership is unequivocally learnable when

defined according to most contemporary theoretical parameters."

- **Leader Versus Leadership:** People tend to conflate the terms *leader* and *leadership*, but, according to Dugan, *"Leader* refers to an individual and is often, but not always, tied to the enactment of a particular role. This role typically flows from some form of formal or informal authority (e.g., a supervisor, teacher, coach). When not tied to a particular role, the term *leader* reflects individual actions within a larger group, the process of individual leader development, or individual enactments attempting to leverage movement on an issue or goal. *Leadership*, on the other hand, reflects a focus on collective processes of people working together toward common goals or collective leadership development efforts."
- **Leader Versus Follower:** *"*The conflation of leader and leadership makes it easier to create an additional false dichotomy around the terms *leader* and *follower,"* with *follower* considered a lesser role. "The label of *leader/follower*, then, is tied solely to positional authority rather than the contributions of individuals within the organization. If we flip the example to one from social movements, I often see an interesting shift in labeling. In the Civil Rights Movement in the United States there are multiple identified leaders (e.g., Martin Luther King, Jr., Malcom X, Rosa Parks, James Baldwin) along with many followers. However, the followers are often concurrently characterized as being leaders in their own right in the process. In social movements it seems we are more willing to simultaneously extend labels of leader and follower to a person."
- **Leadership Versus Management:** "Also tied up in leader/leadership and leader/follower dichotomies are arguments about whether leadership and management represent

the same or unique phenomena. Once again, the role of authority gets tied up in the understanding of this. Many scholars define management as bound to authority and focused on efficiency, maintenance of the status quo, and tactics for goal accomplishment. An exceptional manager keeps systems functioning through the social coordination of people and tasks. Leadership, on the other hand, is less concerned with the status quo and more attentive to issues of growth, change, and adaptation."

Psychologically Safe Leadership

The National Standard of Canada for Psychological Health and Safety in the Workplace (the Standard) requires leaders to be competent to manage, lead and supervise employees in a way that is psychologically safe.

A psychologically safe leader values the psychological well-being of their employees, inside and outside of the workplace, and encourages open communication and supportive relationships among team members.

Reflective Exercise

Using the internet, find out more about working in a psychological safe environment and how organizations and their leaders are promoting mental health and preventing psychological harm at work. Then reflect on these questions:

- How do you create a psychologically safe interactions in the workplace?
- How do you interact with others when you're frustrated at work?
- What do you feel constitutes psychologically unsafe behavior from a leader?

Additional Information

Teams in a Changing World – Use the link to read more about teams in a changing world here.

1.4.3 Development Approach and Life Cycle

Traditionally, the predictive lifecycles for conducting projects were one step ahead of others such as adaptive, incremental, and iterative. However, with the rapid changes in the sector and the requirements of stakeholders, it emerged as a necessity to react to the endless changes in the requirements of the project and the stakeholders.

With the tailoring approach, all projects are needed to be tailored according to their nature. As one of the first steps of the preparation phase of a project, the projected deliverables of a project should be evaluated carefully since the success of project outcomes eventually depends on the development approach chosen should be compatible with the nature of the deliverables. So for the project manager and the project team

it is important to identify an approach to deliver the value from the initiating phase to the end of the project which is a vital part of the project value delivery system.

An efficient project management endeavor, is when the project leader and project team follow the essence of the Development Approach and Lifecycle Performance Domain, to determine the right development approach, lifecycle and find the proper rhythm to conduct activities throughout the project to create value for the organization and stakeholders. It is important that the development approach matches the organization and project.

According to PMBOK 7th edition, the Development Approach & Life Cycle Performance Domain addresses activities and functions associated with the development approach, cadence and life cycle phases of the project. Projects that follow a process-based approach may use the following five process groupings as an organizing structure – Initiation, Planning, Execution, Monitoring and Controlling and Closing. Groups of processes are NOT project phases. Process Groups interact within each phase of the project life cycle. It is possible that all of these processes could occur within a single phase. Processes may be iterative within a phase or life cycle. The number of iterations and interactions between processes varies based on the needs of the project.

The project deliverables determine the most appropriate development approach such as a predictive, adaptive, or hybrid approach. The deliverables and the development approach influence the number and cadence for project deliveries. The development approach and delivery cadence influence the project life cycle and its phases.

The type of deliveries of projects may change from project to project. Some projects may have a single delivery, some may have multiple deliveries, and some may have periodic deliveries. Delivery cadence simply refers to the timing and frequency of projects deliveries. Maintaining the correct

rhythm of activities is important because the value creation and project delivery are like the heartbeat. When the heartbeat rhythm is steady it means your project is healthy, if it has irregularities it may point out potential problems.

Development approaches have different names, some organizations have created their own approaches given their industrial context. However the most common ones are predictive or waterfall, hybrid, and adaptive development approaches.

Project lifecycles live on a continuum, ranging from predictive 'Plan-Driven' on one end to adaptive 'Agile' on the other end. To understand this continuum, let us consider two aspects of adaptive which are 'Frequency of delivery' (Deliver Early and Often) and 'Degree of change' (Adapt to Change).

Project Lifecycles on a Continuum

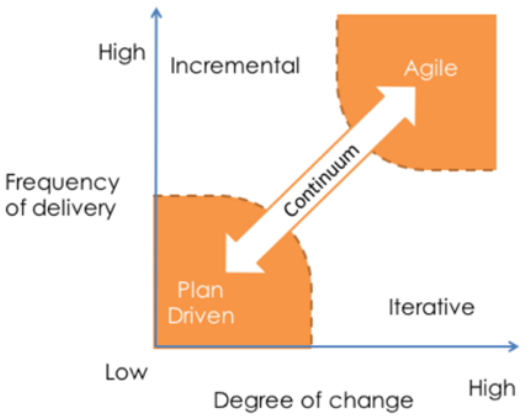


Exhibit 1.12: Project Lifecycles on a Continuum

On the continuum from Plan-Driven approaches (lower-left) to Agile approaches (upper-right) there are different degrees of delivery (incremental) and degrees of change (iterative). Those

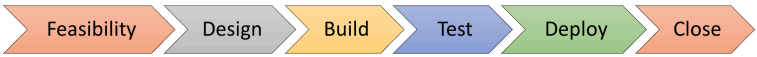
techniques that achieve BOTH high degrees of delivery AND high degrees of adaptability are called 'Agile'.

Predictive Life Cycle

The predictive approach is the most familiar one as it was the focus of former PMBOK guides. It is based on planning as much as possible before performing the project activities. It is useful when we are able to define, collect and analyze requirements at the beginning of a project.

Example 1: Predictive Life Cycle:

Example 2: Predictive Life Cycle



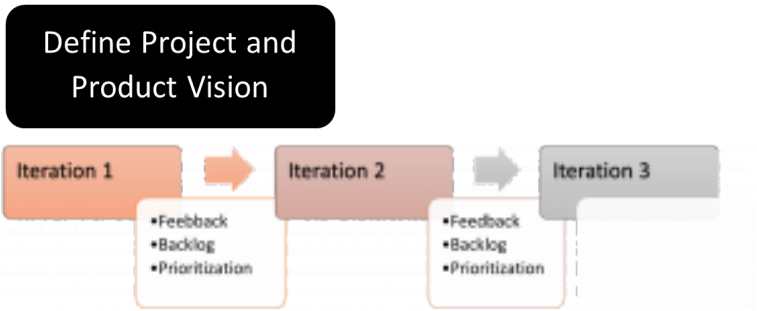
Adaptive Life Cycle

When uncertainty exists at the beginning of a project, then the adaptive approach is the most applicable one. In this type of project, requirements change frequently and the project needs to adapt itself to changing requirements. There are two approaches – iterative and incremental. At the end of each iteration or sprint, the customer reviews a functional deliverable. At the review the key stakeholders provide feedback and the project team updates the project backlog of features. Agile framework like Scrum and Kanban are used in adaptive life cycle.

Incremental development means that each successive version of the product is usable, and each builds upon the previous version by adding user-visible functionality.

Iterative development intentionally allow for 'repeating' developmental activities and potentially 'revisiting' the same work products.

Example 1: Adaptive Life Cycle



User stories are particularly important here to clarify details of the outcome of a product feature or functionality from a specific user.

Hybrid Approach

The third most common development approach is the hybrid approach. It is somewhere in the middle of predictive and adaptive approaches. For example, a detailed requirements effort, followed by sprints of incremental delivery would be a 'Hybrid Approach'.

Understanding the purpose of the lifecycle is important for project leaders and team to think about the stages in each life cycle and assess how to gain control of each stage. The goal is to deliver the right business outcome using the right techniques to:

- Realize customer value
- Increase return on investment

- Achieve customer satisfaction

Some Key Agile Concepts

Agile is term used to describe a mindset of values and principles as set forth in the Agile Manifesto.

Agile values are:

Individuals and Interactions over processes and tools
Working software over comprehensive documentation
Customer collaboration over contract negotiation
Responding a change over following a plan

note that there is value in the items on the right but the items on the left in BOLD are of more value.

Agile concepts are:

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=28#h5p-9

Additional Information

12 Principles behind the agile Manifesto – Review the principles.

1.4.4 Planning

The Planning Performance Domain addresses activities and functions associated with the initial, ongoing, and evolving organization and coordination necessary for delivering project deliverables and outcomes. Planning organizes, elaborates, and coordinates work throughout the project. Planning takes place up front and throughout the project. The amount, timing, and frequency varies depending on the product deliverables, development approach, organization requirements and environment, market conditions, legal and regulatory restrictions and stakeholders. *We will focus on planning for cost, risks, procurement and quality in this text.*

1.4.5 Project Work

The Project Work Performance Domain addresses activities and functions associated with establishing project processes, managing physical resources, and fostering a learning environment. Project work is associated with establishing the processes and performing the work to enable the project team to deliver the expected value and outcomes. Project work includes communication, engagement, managing physical resources, procurements and other work to keep project operations running smoothly.

Process tailoring can be used to optimize the process for the needs of the project. In general large projects have more process compared to smaller projects, and critical projects have more process than less significant projects. Tailoring takes into consideration the demands of the environment for example retrospectives or lesson learned meetings provide an opportunity for the project team to review the way in which

it works and to suggest changes to improve process and efficiency.

According to PMBOK 7th edition Project work includes the following activities but not limited to:

- Managing the flow of existing work, new work and changes to work
- Keeping the project team focused
- Establishing efficient project systems and processes
- Communicating with stakeholders
- Managing materials, equipment, supplies and logistics
- Working with contracting professionals and vendors to plan and manage procurements and contracts
- Monitoring changes that can affect the project
- Enabling project learning and knowledge transfer.

1.4.6 Delivery

The Delivery Performance Domain addresses activities and functions associated with delivering the scope and quality that the project was undertaken to achieve. Project delivery focuses on meeting requirements, scope, and quality expectations to deliver the expected outputs that will drive intended outcomes. Projects provide business value by developing new products or services, solving problems, or fixing things that were defective or sub-optimal. Projects may use a delivery approach that supports releasing deliverables throughout the project life cycle, at specific points, or at the end of the project. Business value often continues to be captured long after the project has ended.

Every project has a scope. In predictive projects, this scope may be predefined in the planning section and change control procedures are applied.

In adaptive approaches, the newly emerging scope is always

welcome. The delivery performance domain is simply delivering the scope of the project complying with the quality requirements. After the completion of the activities included in this performance domain, the aimed outcomes and the benefits of the projects get realized. This realization brings about stakeholder satisfaction. Every project delivers different and multiple outcomes. So, different stakeholders may have deliveries with priorities. This delivery action should be managed carefully as projects provide business value thanks to these deliveries.

The main sections evaluated under the delivery performance domain are;

- **Delivery of value:** All projects produce an outcome or a delivery at the end. However they also generate value for the organization. This value delivery sometimes continues even after years of completing the project.
- **Requirements elicitation:** It is about collecting and revealing requirements by using a variety of different methods. These will include criteria such as clear, concise, verifiable, consistent, complete and traceable.
- **Scope definition:** Scope definition is an endless process until the end of the project. When we define scope, it creates a need for further requirements elicitation. Scope decomposition follows the definition process.
- **Completion of deliveries:** There are different ways to describe the completion criteria of deliveries depending on the development approach. The most common ones are acceptance or completion criteria, technical performance measure, and definition of done.
- **Moving targets of completion:** Especially along with the existence of uncertainty and in changing environments, the project goal determined at the beginning of the project may change. In predictive environments, scope creep is avoided by using change control systems.

- **Quality:** Apart from the delivery requirements, quality is the performance level to be achieved. Cost of quality and cost of changes should be taken into consideration.
- **Suboptimal outcomes:** Many projects may fail to deliver expected outcomes and therefore yields suboptimal outcomes. It is a natural part of delivery performance domain.

1.4.7 Measurement

The Measurement Performance Domain addresses activities and functions associated with assessing project performance and taking appropriate actions to maintain acceptable or optimal performance. The Measurement Performance Domain evaluates the degree to which the project deliveries and performance are meeting the intended outcomes. Having timely and accurate information about delivery and performance allows the team to learn and determine the appropriate action to take to address current or expected variances from the desired performance.

A project manager should have an understanding of the current status of a project. This is one of the main responsibilities of both the project team and the project manager. This understanding can only be achieved by making a reliable performance assessment of a project. This way to keep the acceptable performance level, both corrective and preventive measures could be taken. Assessing the project performance reliably, helps the future project decisions to be more easily taken to the point.

The main sections under this performance domain are;

- **Establishing effective measures:** We measure many aspects of the project. However, we also need to measure the right thing by using the right method to be able to

have a good picture of the project at the hand and to be able to report right measures to the stakeholders.

- **Defining what to measure:** Deliverable metrics, Delivery, Baseline performance, Resources, Business value, Stakeholders, and Forecasts are the common categories of metrics.
- **Presenting information:** Dashboards, information radiators and visual controls are common methods of presenting information.
- **Measurement pitfalls:** Hawthorne effect, vanity metric, demoralization, misusing the metrics, confirmation bias, correlation versus causation are common pitfalls.
- **Troubleshooting performance:** A project team should react before exceeding the thresholds determined.
- **Growing and improving:** Continuously learning through the results of measurement actions.

1.4.8 Uncertainty

The Uncertainty Performance Domain addresses activities and functions associated with risk and uncertainty. Projects exist in environments with varying degrees of uncertainty, and uncertainty presents threats and opportunities that project teams explore and assess and then decide how to handle. Uncertainty, is a state of not knowing or unpredictability. There are many nuances to uncertainty, such as: risk associated with not knowing future events, ambiguity associated with not being aware of current or future conditions, complexity associated with dynamic systems with unpredictable outcomes, and many others.

Projects with adaptive and hybrid development approaches are generally and typically have more uncertain characteristics to deal with. The actions and activities are typically complex and have a high degree of uncertainty. This uncertainty may

stem from many things such as the uniqueness of the project, the organization might not have undertaken a similar project before, the approach or technology being used might be new, or there might be other significant unknowns.

There are various aspects of uncertainty. In this performance domain the ones listed are;

- **General uncertainty:** All projects have a degree of uncertainty and any action inside the project may yield different outcomes. The success of these outcomes is also uncertain. The positive and negative possibilities of outcomes are threats and opportunities for a project.
- **Ambiguity:** Two types of ambiguity may happen in projects. These are conceptual ambiguity and situational ambiguity.
- **Complexity:** Complexity is something difficult to understand or something that lacks simplicity. In projects, complexity is the difficulty to manage projects due to environmental and human factors and ambiguity. There may be a huge amount of responsible people, communications lines and any action may be unpredictable due to the complex structure of an aspect of the project. There are several ways described to deal with complexity.
- **Volatility:** While many projects have stable requirements and are done in a predictive way, an increasing number of projects have rapidly changing environments. Rapid and unpredictable changes bring about volatility.
- **Risks:** Risks are uncertain events or conditions that, if it occurs, has a positive or negative effect on one or more project objectives. They can be positive or negative. As part of this performance domain, the project team should identify risks proactively and continuously during the project's lifespan, prepare efficient risk responses and navigate risks efficiently. Therefore the main goal here

increasing the effect of positive risks and limiting the potential harm of negative risks.

An interactive H5P element has been excluded from this version of the text. You can view it online here:
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Reflective Exercise

Think about the following questions:

1. How can you make your project team more effective?
1. How can you create an environment to support the project team in evolving into a high performance team?
1. How can you effectively manage and lead virtual project teams?

Key Takeaways

- Building trust is key to creating an effective team. Reliable promising, emotional intelligence, realistic expectations, and good communication all help team members learn to rely on each other.
- The most effective project managers focus on building collaborative teams, rather than teams that require constant direction from management.
- Teams made up of diverse members are more creative, and better at processing information and coming up with innovative solutions. Organizations with a diverse workforce are significantly more profitable than organizations a homogeneous workforce.

Quiz Yourself: Do You Lead with Emotional Intelligence?

To find out where you fit on the emotional intelligence scale, try this Harvard Business Review Quiz

Interview Questions About Emotional Intelligence

In job interviews, employers are increasingly asking questions designed to gauge an applicant's level of emotional intelligence. This article by Alison Doyle provides sample questions: Article

1.5 Project Organization and Selection

Projects are the way organizations operationalize strategy and therefore executing a strategy effectively means pursuing the right projects. In other words, it is a matter of aligning projects and initiatives with the company's overall goals. As we discussed earlier a portfolio is made up of programs and projects. An organization's strategy is the game plan for ensuring that the organization's portfolios, programs, and projects are all directed toward a common goal and prioritized appropriately.

Project selection proceeds on two levels: the portfolio level and the project level. On the portfolio level, management works to ensure that all the projects in a portfolio support the organization's larger strategy. In other words, management focuses on optimizing its portfolio of projects.

On the project level, teams focus on selecting, refining, and then advancing or, if necessary, terminating individual projects that are not aligned with organizational goals. Many organizations find that they have three kinds of projects in their portfolios; compliance (emergency –must do), operational, and strategic projects. Compliance projects usually have penalties if they are not implemented.

Operational projects are those that are needed to support current operations. These projects are designed to improve efficiency of delivery systems, reduce product costs, improve performance etc. Strategic projects on the other hand are those that directly support the organization's long-run mission. The goals of such projects are to increase revenue or market share and examples of strategic projects include new products, research and development.

It is important to note that some compliance-related projects have to be completed no matter what. But companies typically generate far more ideas for new projects than they can reasonably carry out. So to optimize its portfolio, every organization needs an efficient process for capturing, sorting, and screening ideas for new projects, and then for approving and prioritizing projects that are ultimately green-lighted. We will discuss the factors that influence project selection and some project-selection methods.

In any organization, project selection is influenced by the available resources. When money is short, organizations often terminate existing projects and postpone investing in new ones.

An organization's project selection process is also influenced by the nature of the organization and its priorities. At a huge aerospace technology corporation, for example, the impetus for a project nearly always comes from the market, and is loaded with government regulations. Such projects are decades-long undertakings, which necessarily require significant financial analysis. At a consumer products company, the idea for a project often originates inside the company as a way to respond to a perceived consumer demand. In that case, with less time and fewer resources at stake, the project selection process typically proceeds more quickly.

Size is a major influence on an organization's project selection process. At a large, well-established corporation, the entrenched bureaucracy can impede quick decision-making. By contrast, a twenty-person start-up can make decisions quickly and with great agility.

Accessing the value of the project to customers and other stakeholders and identifying the magnitude and impact of risks, as well as potential mitigation strategies, are key elements of the initial feasibility analysis of a project. Decision-

makers will need such information to assess whether the potential value of the project outweighs the costs and risks.

Financial and Non-Financial Criteria

When you have a number of interesting and challenging projects to choose from, finding a project that is the right fit for the organization is the first step in effective project management. Project Selection Methods offer a set of time-tested techniques based on sound logical reasoning to choose a project and filter out undesirable projects with a very low likelihood of success. Project selection methods are an important concept for practicing project managers. The criteria can be classified as financial and non-financial.

Assuming the organization you are working for has been handed a number of project contracts. Due to resource constraints, the organization can not handle all the projects at once, so they need to decide which project(s) will maximize profitability. Note that financial return such as profitability while important does not always reflect strategic importance. Organizations have to be disciplined in saying no to potentially profitable projects that are outside the realm of their core mission. This may require the consideration of other criteria beyond profitability such as:

- To capture larger market share
- To make it difficult for competitors to enter the market
- To develop core technology that will be used in next-generation products
- To reduce dependency on unreliable suppliers

Financial Criteria

1. **Cost/Benefit Ratio**

    - Cost/Benefit Ratio, as the name suggests, is the ratio between the Present Value of Inflow or the cost invested in a project to the Present Value of Outflow, which is the value of return from the project. Projects that have a higher Benefit-Cost Ratio or lower Cost-Benefit Ratio are generally chosen over others.

2. **Payback Period**

    - Payback Period is the ratio of the total cash to the average per period cash. It is the time necessary to recover the cost invested in the project. The Payback Period is a basic project selection method. As the name suggests, the payback period takes into consideration the payback period of an investment. It is the time frame that is required for the return on an investment to repay the original cost that was invested. The calculation for payback is fairly simple:
    - **Payback Period = Cost of the Project/Average Annual Cash Inflows**
    - When the Payback period is used as the Project Selection Method, the project that has the shortest Payback period is preferred since the organization can regain the original investment faster. There are, however, a few limitations to this method:
        - It does not consider the time value of money.
        - Benefits accrued after the payback period are not considered; it focuses more on the liquidity while profitability is neglected.
        - Risks involved in individual projects are neglected.

3. **Net Present Value**

    - Net Present Value is the difference between the project's current value of cash inflow and the current value of cash outflow. The NPV must always be positive. When picking a project, one with a higher NPV is preferred. The advantage of considering the NPV over the Payback Period is that it takes into consideration the future value of money. However, there are limitations of the NPV, too:
        - No generally accepted method of deriving the discount value used for the present value calculation.
        - The NPV does not provide any picture of profit or loss that the organization can make by embarking on a certain project.

4. **Discounted Cash Flow**

    - As you know the future value of money will not be the same as it is today. For example, $20,000 will not have the same worth ten years from now. Therefore, during calculations of cost of investment and return on investment it is important to consider the concept of discounted cash flow.

5. **Internal Rate of Return (IRR)**

    - The Internal Rate of Return is the interest rate at which the Net Present Value is zero. This is attained when the present value of outflow is equal to the present value of inflow. Internal Rate of Return is defined as the "annualized effective compounded return rate" or the "discount rate that makes the net present value of all cash flows (both positive and

negative) from a particular investment equal to zero." The IRR is used to select the project with the best profitability; when picking a project, the one with the higher IRR is chosen.
    - When using the IRR as the project selection criteria, organizations should remember not to use this exclusively to judge the worth of a project; a project with a lower IRR might have a higher NPV and, assuming there is no capital constraint, the project with the higher NPV should be chosen as this increases the shareholders' profits.

6. **Opportunity cost**

    - Opportunity cost is the cost that is given up when selecting another project. During project selection, the project that has the lower opportunity cost is chosen.

Non-Financial Criteria

There are non-financial gains that an organization must consider; these factors are related to the overall organizational goals. The organizational strategy is a major factor in project selection methods that will affect the organization's choice in the choice of project. Organizations may support projects to restore corporate image or enhance brand recognition, community support development projects. Two models that allow multi-criteria screening are: Checklist Model and Multi-Weight Scoring Models

Checklist Model

The simplest method of project screening and selection is

developing a checklist, or a list of criteria that pertain to the organization choice of projects, and then applying them to different possible projects. The approach uses a list of questions to review potential projects and to determine their acceptance or rejection. The justification for the checklist model is that they allow great flexibility in selecting among many different types of projects and are easily used across different divisions and locations.

The shortcomings of this project includes the fact that it fails to answer the relative importance or value of a potential project to the organization and fails to allow for comparison with other potential projects. This approach also creates opportunities for power, politics and other form of manipulations. To overcome some of theses problems the Multi-Weight Scoring is recommended by experts.

Multi-Weight Scoring Models

The scoring model in project management is an objective technique: the project selection committee lists relevant criteria, weighs them according to their importance and their priorities, and then adds the weighted values. Once the scoring of these projects is completed, the project with the highest score is chosen.

While selection models may yield numerical solutions to project selection decisions, models should not make the final *decisions—the* people using the models should.

Reflective Exercise

- What strategies do organizations use to select projects?

Key Takeaways

- Project selection proceeds on two levels: the portfolio level and the project level.
- Project selection is influenced by a number of factors including the nature of the organization and its priorities.
- Examples of financial criteria for selecting projects includes – Cost/Benefit Ratio, Payback Period, Net Present Value, Discounted Cash Flow, Internal Rate of Return and Opportunity Cost.
- Two models used for non-financial multi-criteria screening are: Checklist Model and Multi-Weight Scoring Models.

2.0 PLANNING AND MANAGING PROJECT COST

Learning Objectives

By the end of this session, you will be able to:

- Define project estimation
- Plan and allocate resources in a project
- Identify distinct types of cost
- Apply appropriate concepts, tools, and techniques for estimating project costs
- Create estimates and budgets (including,

resources, duration, schedules, and costs

- Manage estimates including cost in projects and how to budget
- Analyze and evaluate budget and cost estimates
- Apply variance analysis and earned value management to manage and track project progress
- Apply strategies to improve estimating process and respond to budget uncertainties.

Introduction

"An estimate is a quantitative assessment of the likely amount or outcome of a variable, such as project costs, resources, effort or durations and benefits" (PMBOK 7th Edition).

Project estimation is the process of analyzing available data to predict the time, cost, and resources needed to complete a project. Typically, project estimation includes scope, time-frames, budget, and risks (PMBOK 7th Edition).

According to PMBOK 7th edition, planning performance domain involves organizing, elaborating and coordinating project work throughout the project. Planning any project or program entails developing estimates. Estimating a piece of work is hard and as project managers and team members our task is to find ways of making estimation of a project as accurate as possible. Many factors impact the decision-making process such as the choice of estimating techniques and for the project owner or sponsor or product owner the decision may affect the entire project team–and the business.

It is important to continually evaluate the value and benefits of the project to the stakeholders since the inherent worth of a product is judged by the stakeholders in particular the customer. Since all projects have a range of, different values generated for each group of stakeholders have to be considered and balanced with the whole, while focusing on the customer perspective.

Estimating cost in project management is a process and it forms the basis for determining and controlling the project budget. Costs are estimated for the first time before the project starts and the cost estimates may be used to build a business case. Cost estimation also takes place at the beginning of a project and subsequently, the (re-)estimation of the project cost is repeated on an ongoing basis to account for more detailed information or changes to the scope or timelines or budget.

A project's budget has the potential to impact every facet of the project, making it one of the most critical responsibilities of a project manager. A poorly designed budget leads to improper asset allocation, unrealistic expectations, and potentially, a failed project. Thus the budget *must* be accurate for a project to succeed. Estimation is therefore one of the most effective tools in the project manager's tool box for planning an accurate budget.

SHOW WHAT YOU KNOW

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https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=32#h5p-6

2.1 The Concept of Estimation in Projects

Project estimating directly links to activities and sections in the PMBOK Guide and other Practice Guides. Project estimates are classified into categories based on how well the scope is defined at the time of estimation, on the types of estimation techniques used, and on the general accuracy of estimates. Regarding the general accuracy – accuracy can be viewed on a range continuum where the range decreases over time as in Exhibit 2.1

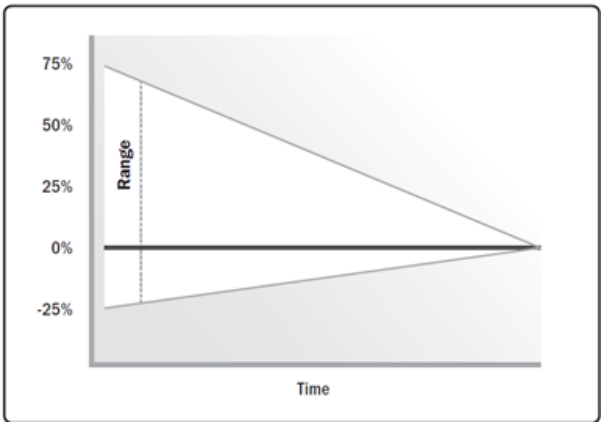

Exhibit 2.1: Estimate range decreases over time.

Gray and Erik Larson (2021) identified seven factors that impact estimate accuracy as follows:

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Characteristics of Estimation

In general estimates should have several characteristics including some of the basic elements that contributes to the creation of estimates for portfolios, programs and projects.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=333#h5p-10

Roles and Responsibilities in Project Estimating

Within organizations, several key roles are involved in project estimating. It is important that each individual fulfilling a project role is aware of his or her responsibilities in project estimating. Review the key roles, description and

responsibilities in the Practice Standards for Estimating on Table 2-1. Key roles include:

- Project Sponsor
- Project Manager
- Program and /or portfolio managers
- Estimators and Subject matter experts (SME)
- Project team members
- Analysts
- Senior management
- Customers of estimate

Development Approaches and Life Cycles

Every project must pass through a series of phases from its start to its completion. The type of project deliverables determines how it can be developed. The type of deliverables and the development approach influence the number and cadence for project deliverables. The deliverable approach and the desired delivery cadences determine the project life cycle and it phases. PMI identifies three development approaches – predictive, hybrid and adaptive. The choice of each approach is influenced by the following:

- Degree of innovation
- Requirements certainty
- Scope stability
- Ease of change
- Delivery options
- Risk
- Safety requirements
- Regulations

The type and number of project phases in a project life cycle

depends upon many variables including delivery cadence (whether a single delivery, multiple deliveries or periodic deliveries) and developmental approaches. The phases in a typical project life cycle for creating a project may include:

Waterfall (Predictive Life Cycle)

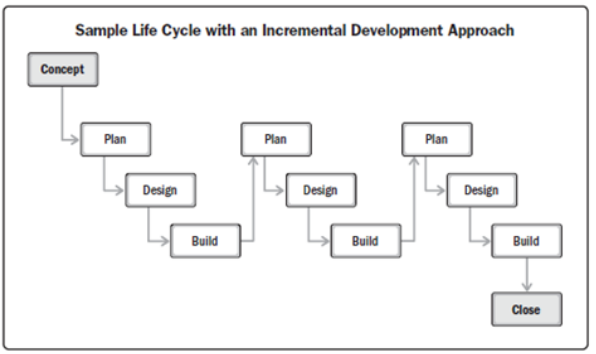

Exhibit 2.2: Predictive Project Life cycle

Agile (Adaptive Life Cycle)

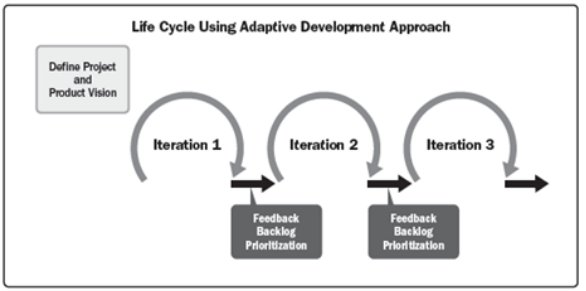

Exhibit 2.3: Adaptive Project Life Cycle

Stages in the Project Estimating Life Cycle

Projects are unique and therefore each business will have a slightly different approach to how to do project estimating. In some organizations it could be the Project Management Office

(PMO) setting the methodology or the Finance Department setting out how estimates for budgeting are to be calculated. According to the Practice Standards for Estimating, there are four stages in the project estimating life cycle:

Exhibit 2.4: Project Estimating Life Cycle

Step 1: Prepare to estimate

The purpose of this step is to establish an estimating plan. This requires the identification documentation about estimation approaches, company's policies and processes, PMO Standards, estimation techniques, estimation team etc.

Before a project estimate can be created it is important to plan how you will obtain all relevant information to understand the context of what is being estimated as information becomes available. Some of these relevant information includes project documentation, experts, estimating techniques, constraints and assumptions, additional influences and historical project information.

Step 2: Create the estimates

This step estimates are created using information, documentations, techniques identified in prepare to estimate step.

Team collaboration is extremely important to get all the input and support from critical stakeholders. Appropriate resources, budget and time will need to be identified and the

application of techniques, so different opinions make a difference to the estimates.

Step 3: Manage the estimating

This step requires the team to manage the estimates created for example the budget or schedule for the project. It is important to maintained and managed as the project progresses – revising them appropriately as the team do the work to ensure they accurately reflect the initial estimates. Comparing estimated figures against actual figures to determine any differences (variances) is on going as the project progresses.

Step 4: Improve estimating

This step requires the application of continuous improvement principles to the estimates in the project. Calibrating models, tweaking techniques and making changes as a result of new information and what has been learned on the project are activities performed at this stage. Providing feedback to PMO or Finance department to improve templates, models and processes for future improvements are good practices.

The project estimation life cycle and the various phases of a project shows an overlap the – progressive elaboration which involves the continuous improvement and detailing of the project's estimates as more accurate and precise information becomes available.

Example: Cost estimation approach applied to a typical project with a specific life cycle

The following cost estimation approach can be applied to a typical project with a specific life cycle.

1. **Start- up (Prepare, Create and Manage Estimates)**
    - The primary goal of the project team is to define the project in its broadest terms. For project cost estimating, the team will identify resources that will be required to produce the estimates, then begin preparing the estimate and identify any known constraints, such as funding or resources. The requirements of the business case will lead to the development of the project charter and project initiation document. These documents will include the information necessary to begin the creation of the project cost estimate, including business needs and a stakeholder registrar that will identify who will be responsible for the management of the budget and who will be approving the budget.
    - Often during the initiation phase, the project team will create a rough order magnitude budget to determine if the project is achievable and if it should move forward. This estimate serves as a quantitative assessment of the likely costs for the project. As the project moves forward, the estimate will become more

definitive in nature.

2. **Plan (Continue to Prepare, Create and Refine, Manage Estimates)**

    - The project team will consider the cost estimation techniques and approach they will use to create and maintain the budget. Often this is heavily reliant on environmental factors such as market conditions and exchange rates, and organizational process assets such as policies, templates, and lessons learned.
    - Once a project management team has assessed these factors, they will continue the progressive elaboration of the cost estimate using one or more estimation techniques – analogous estimation, parametric estimation, bottom-up estimation etc. The process of elaboration will continue and will result in the establishment of a project cost baseline that can be used to gauge a project's success. It is important to clearly document the basis of the cost estimation by clearly stating any assumptions, known constraints, identified risks, the estimate range, and the level of accuracy of the estimate in the project plan to ensure stakeholders understand that the project estimates may change if the factors documented change. The project manager should update the assumptions log and risk register regularly to ensure that cost

estimate information is accurately captured and effectively communicated.

3. **Development (Create and Refine, Manage, Improve Estimates)**

    - During the development phase of the project, the project manager will oversee multiple phases of the cost estimation process. It is during this phase that required resources will be procured. This will result in more specific cost estimates from vendors, which will allow the project manager to continue the progressive elaboration of the budget.
    - As work is completed, the project manager will update the project forecast with the actual expenditures. This will allow the project manager to better manage stakeholder expectations and facilitate transparent communication about the project costs. As resources are used, they can be compared to the original assumptions made during the planning phase of the estimation process.

4. **Test and Deploy (Manage and Improve Estimates)**

    - During the test and deploy phase of the project team and project manager will continue the management and improvement of project cost estimates. Key

performance indicators (KPIs) will be used to measure the success of the project. These KPIs can include a measurement of project objectives, effort, and cost tracking, and project performance.

- Managing and monitoring change request is an important activity to prevent unauthorized changes from moving forward. Monitoring cost variances to the approved cost baseline can assist the project manager in isolating the cause of variances. This is typically done by performing an Earned Value Analysis, which compares the data from the planned value, the earned value, and cost actuals.
- Cost estimates will be reviewed using lessons learned through the life of the project, and by updating methods and forms used for the cost estimation process.

5. **Close**

    - When the entire project is completed, lessons learned will be completed and an evaluation will be conducted. The project charter and business case will be reviewed to determine if the deliverables achieved the intended benefits and value.

2.2 Cost Estimation and Management in Projects

Cost estimation is the process of estimating all of the costs associated with completing a project within scope and according to its timeline. It is important to realize that different programs, projects, organizations, industries and situations requires different approaches to estimating. As such the process of estimating must be tailored for specific programs and projects taking into account the uncertainties and complexities of the programs and projects. It is important to remember that estimating is a continuous activity throughout the project life cycle or program. Project Estimation is needed to:

- Support good decision making?
- Schedule work?
- Determine how long the project should take and its cost?
- Determine whether or not the project is worth doing?
- Develop cash flow needs.
- Determine how well the project is progressing

Project cost estimating is linked to so many other aspects of the project, including but not limited to, scheduling, resource planning, procurement, and stakeholder expectation management.

Estimating costs is one of the core activities of project management and planning. This is because a project is defined as being subject to at least three fundamental constraints: scope, budget and time. Cost estimates address

the budget constraint; hence they are highly relevant for the management of a project. The initial rough cost estimate is usually included in the project charter as well as in the business case of a project.

The estimation of costs is also necessary to compute the project budget which is subject to the approval of the project sponsor(s).

Cost estimates are the basis for allocating budget to work packages and deliverables which can be politically sensitive within a project as well as among its stakeholders. Therefore, budget determination and assignment require some stakeholder involvement, communication and, in many cases, their approval.

Cost estimates are also used for the earned value and variance analyses as well as forecasting of project costs. Below are different definitions of costs:

Cost Management in Projects

Cost is an important factor in determining project success. Cost is measured in monetary terms – dollars for example. Projects that are over budget are often terminated because stakeholders either run out of money. Many projects that run out of money do so because of poor estimating, poor budgeting and poor controlling. The management of cost in projects is a process where organizations monitor and control the costs of implementing projects.

Effective cost management will increase value delivered to the customer. Before a project is started, the anticipated costs of that project should be identified. These costs should be evaluated and approved before any purchases are made. During the implementation all costs should be recorded, tracked and monitored to keep them in line with initial expectation.

Direct Material and Labour Costs

Direct costs: These are direct cost of material and labour used in projects and are essential part of the finished product system or service. In other words these direct costs are linked to the production of the final product or service.

Indirect costs (Overhead): Indirect costs which includes materials and labour costs that are necessary to complete a project but do not become an actual part of the final project. Overhead expenses, ongoing operational cost incurred by an organization for projects in general, and administration cost shared amongst many projects are indirect costs. Cost of utilities, paper towels, office supplies other services etc. are examples of indirect cost. Other group of indirect cost includes overheads and general administration costs.

Fixed and Variable Costs

Fixed costs remains constant in total regardless of the changes in the level of project activities. Examples include: rent and administrative salaries are not affected by the level of project activities.

Variable costs vary directly with the changes in the level of project activities. Direct materials and direct labour are examples of variable costs.

Tangible and Intangible Costs

Tangible costs are quantifiable costs related to an identifiable resource or asset and are expenses from procuring materials paying projects team members and renting or leasing equipment.

Intangible costs are unquantifiable costs relating to an identifiable source customer goodwill or losses in productivity.

Sunk Costs

Sunk costs are costs that have already been incurred in a project and cannot be changed by present or future decision or actions. Sunk costs in a project should be forgotten.

Opportunity Costs

Opportunity costs are potential benefits given up when one activity is selected over another. For example if there are two projects – Project Bono and Project Vono being considered by an organization and project Bono is promising $50,000 more in return than Project Vono, assuming the organization proceeds with Project Vono, then there is an opportunity cost of $50,000 being lost.

2.3 Project Estimating Process

Project Estimating Process apply estimating techniques to deliver project estimates with known level of accuracy. There are different ways of presenting and adjusting estimates given a particular context as follows:

Deterministic and Probabilistic estimating: Deterministic estimates are also known as point estimates and it presents a single number or amount such as 24 months. Probabilistic estimating include a range of estimates along with associated probabilities within the range.

Absolute and relative estimating: Absolute estimates are specific information and use actual numbers – eg. 100 hours of work. Relative estimates are shown in comparison to other estimates. Relative estimates only have meaning within a given context.

Flow-based estimating: Flow-based estimating provide an estimate to complete a specific quantity of work. The estimates are developed by determining the cycle time and throughput. Cycle time is the total elapsed time it takes one unit to get through a process. Throughput is the number of items that can complete a process in a given amount of time.

Adjusting estimates for uncertainty: Estimates are inherently uncertain and therefore associated with risk. It is important to establish the range of uncertainty for various parameters.

Evolving Estimates and the Concept of Progressive Elaboration

Rough Order of Magnitude vs. Definitive Estimate

All project estimates involve assumptions, constraints, uncertainty and risk. Estimate confidence level is directly related to activity definition and available data therefore project estimation is an iterative and evolving process which aligns with the concept of progressive elaboration. As more information about the project becomes available the estimates are fine-tuned to higher levels of precision and confidence.

According to the PMBOK and the Practice Standard for Estimating, a project in the Start-up phase may have a rough order of magnitude (ROM) estimate with an accuracy in the range of -25% to +75%. As more information is known, the estimates could narrow to a range of -10% to +15 or to a definitive estimate with an accuracy range of -5% to +10%. Therefore the definitive estimate is determined in the course of the project when more information and resources for accurate estimates are available. Note that every industry is different and there are industry-specific types of estimates such as design and bid estimates in construction projects.

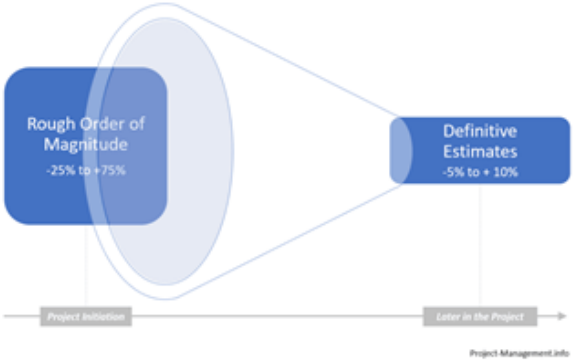

Exhibit 2.5: Rough order magnitude vs. definitive estimates

Types of Project Estimation Approaches – Estimating Techniques

The PMI Practice Standard for Estimating Projects identifies three estimating techniques categories:

Quantitative estimation are most likely applied to numerically estimate effort, duration and cost. This technique may not be applicable to all situations applicable data, experience or time may not be applicable.

Relative estimating techniques are high level estimating techniques that uses information that is currently available and known to the team doing the estimating work. This approach takes advantage of human capacity to compare things to other things and avoids comparisons with abstract concepts such as dollars and days.

Qualitative estimates rely on understanding of processes, behaviours and conditions as perceived by individuals or team. Qualitative estimation generate textual or non-numeric estimates and range from semi structured to unstructured techniques. Qualitative estimates are technique used where the project have elements that are difficult to quantify.

Note that it is important to consider the complexities of projects and the fact that activities vary. Some projects may apply one techniques or various techniques may be applied at different stages during the project life cycle. For example many agile teams adopt unique estimating techniques like planning poker, ideal hours, or story points to determine a numeric value for the task at hand.

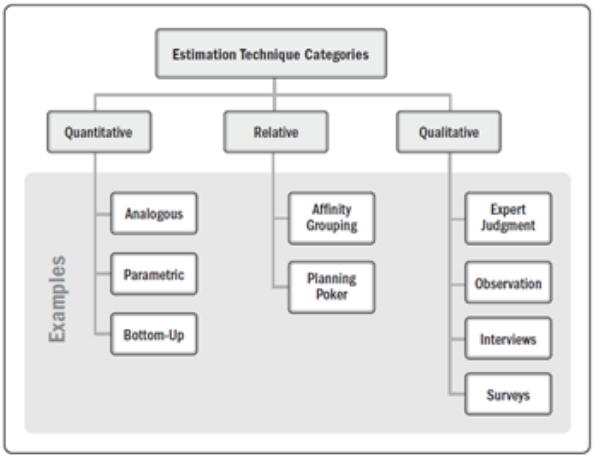

Exhibit 2.6: Estimation Technique Categories

Quantitative Estimation

Analogous Estimating (Top down Estimating)

Analogous estimating also refers to as Top-down Estimating uses observed cost figures and related values in previous projects. In order to be accurate, the type and nature of these reference activities must be comparable with the current project. This technique uses historical data in the form of values and parameters to determine the expected resource

requirements of a current project. The historic values are adopted for the current work and can be adjusted for differences in scope or complexity. In general, analogous estimates are used if a project has access to historical data on similar types of work while the details and resources for more accurate estimates in the current project, such as parametric or bottom-up estimating, are not available. It is important to make sure that projects are really comparable since projects that appear similar, such as road construction, can actually cost vastly different amounts depending on other factors — such as local landscapes and climates. Types of analogous estimation include: ratio and range estimations

With estimation by analogy in Agile, story sizes are compared with other stories. This relative sizing approach is helpful when making assumptions relevant to agile estimations. For effective Agile estimation using analogy, the triangulation method is widely used. According to the triangulation method, the user story is estimated against similar intent user stories that have already been estimated. Analogous Estimating in Agile uses cases:

- If retrospectives are a part of the process
- Among teams that have a good mutual understanding
- Among highly experienced teams

Parametric Estimating

Parametric estimating is a statistical approach to estimating resources. It is based on the assumed or proven relationship of parameters and values. Examples are the building cost per square foot in construction projects or the implementation cost per data field in IT projects.

Parametric estimates are often used in construction projects, e.g. to determine cost of the material. However, differences

between the current project and historical projects need to be taken into account when using parametric estimates.

Because of the fact that complexities of projects and activities vary certain adjustments may be required. For example, building a highway in a mountainous region will likely produces a higher cost per mile than in a flat area. Another example to consider is the project environment. Where an IT development projects is complex and requires a complex IT architectures, more resources will be required compared to a less complex environment.

Another consideration concerns the expertise and experience of the project team. If a previous project was delivered by highly skilled and experienced resources while the current team is just at the beginning of its learning curve, using unadjusted historic data may understate the estimated cost.

Similar to analogous estimates, adjustments can be made to adapt the parametric estimates to the current project.

Depending on the quality of the input data and its applicability to the current type of work, the parametric estimation technique can produce very accurate figures. However, the higher the accuracy desired the more resources are needed to perform the data gathering and statistical analyses.

Bottom-up Estimation

Bottom-up estimation refers to a technique that involves estimating the cost at a granular level of work units. The estimates for all components of a project are then aggregated in order to determine the overall project cost estimate. These estimates are often performed at the lowest level of the work breakdown structure (WBS), e.g. for work packages or even activities. Project team members who are operationally in charge of the respective work packages or activities are the

right people to estimate the work. This techniques comes with significantly higher accuracy than top-down estimations. However, obtaining and aggregating these granular estimates normally requires some resources and can potentially become political challenge, especially in large or complex projects.

Three-Point Estimating

As the name suggests, this technique requires determining three different duration estimates:

- an optimistic,
- a pessimistic, and
- a 'most likely' estimate.

It can be used as a range estimate or further processed, e.g. by calculating a final estimate using a triangular or PERT distribution. Expert judgment and analogous estimating are typically done without calculations.

Assuming a triangular distribution of the three estimates the calculation of the final estimate is:

$$E = (O + M + P) / 3$$

where:

E = Estimation using three-point estimation,
O = Optimistic duration estimate,
M = Most likely duration estimate,
P = Pessimistic duration estimate.

An alternative to this triangular calculation is the PERT method.

The PERT beta distribution takes into account the 'most likely' case is more likely to occur which is reflected in a multiplier for that estimate. The PMI methodology suggests this calculation as an alternative to the triangular distribution for cost estimates. In this method, the most likely estimate

receives a multiplier of 4 while the overall divisor is increased to 6. The formula is as follows:

$$E = (O + 4*M + P) / 6$$

where:

E = Expected amount of time or cost,

O = Optimistic estimate,

M = Most likely estimate,

P = Pessimistic estimate.

The Standard Deviation of the PERT distribution is calculated using the formula:

$$\text{Standard Deviation} = (P - O) / 6$$

Example of a Three-Point Estimate and PERT

A team of subject matter experts is estimating the time it takes to complete an activity. In this example, the duration of an activity is estimated using the three-point estimating technique. They come up with the following numbers:

Optimistic estimate	10 days
Pessimistic estimate	25 days
Most likely estimate	19 days

The values range from 10 days (optimistic) to 25 days (pessimistic). A duration of 19 days is deemed to be the most likely amount of time needed for the completion of the work.

Calculating the Expected Duration with a Triangular Distribution

The expected duration using a triangular distribution is calculated as follows:

Final Estimate = (10 + 25 + 19) / 3.

The resulting final estimate under this method is 18, which is basically the unweighted average of the 3 estimates.

Calculating the Expected Duration Using PERT Beta Distribution

The expected duration can also be calculated with the PERT method:

Final Estimate (expected value) = (10 + 4×19 + 25) / 6.

The resulting expected value is 18.5 days which is greater than the final estimate determined under the triangular method. This is due to the higher weight (i.e. the multiplier of 4) that is assigned to the 'most likely' estimate.

The standard deviation of this estimation is:

Standard Deviation = (25 – 10) / 6 = 2.5

Using the PERT method allows taking probabilities of value ranges into account. This is useful if the quality of estimates varies, e.g. if the difference between optimistic and pessimistic estimates is significantly deviating among different activities. In this case, using ranges and their probabilities will reflect the scattering and level of confidence of the underlying estimates.

The Three-Point Method and PERT method can be used in Agile when:

- The team is new to Agile estimation
- Running later-stage estimations

- There are highly prioritized backlogs

Relative Estimation Techniques

Estimating resources and in particular cost using agile development approach involves everyone on the team. Each team member brings a different perspective on the product and the work required to deliver a user story. Relative estimating is a method for creating estimates that are derived from performing a comparison against a similar body of work, taking effort, complexity, and uncertainty into consideration.

Affinity Grouping

Affinity Estimating is a technique many Agile teams use to quickly and easily estimate a large number of user stories in story points. This is a great technique starting a project with a backlog that has not been estimated yet.

Affinity grouping can be used as a collaborative prioritization activity. It works by having your group of participants brainstorm ideas and opportunities on Post-It Notes. The team then works to put the sticky notes into groups of similar items. Once the groups are created, the team votes on the groups to rank them.

Exhibit 2.7: Affinity Grouping

Affinity Mapping use cases:

- Estimating a long-term plan for a project
- Gaining mutual understanding in the team
- There are large backlogs to handle
- Running early-stage estimations

Planning Poker

Planning Poker is an agile estimating technique which is a consensus-based technique used to estimate the product backlogs by Agile teams. To estimate the Product Backlog, a customer or Product Owner reads the user stories or describes the features of the product to the estimators.

Number-coded playing cards are used to estimate an item. The cards are distributed across the team (sized 2-10), with each of the cards representing a valid estimate.

The reading on the cards could be something such as — 0, 1, 2, 3, 5, 8, 13, 20, 40, and 100. Now, the product owner or the analyst describes the user story to the team, and the team can ask any related queries.

Each team member secretly selects a card number for an estimate, which is revealed when all the cards are turned over. The card with the most voting is the finalized estimate for the item under discussion. In case of uneven estimates, meetings are held, and the next round of voting commences to come up with an estimate everyone agrees with

Exhibit 2.8: Estimates made easy with playing poker. Source

Planning Poker use cases:

- There are a small number of items
- Establishing mutual understanding among team members
- Running late-stage estimations
- The backlogs are highly prioritized

Qualitative Estimation Techniques

Expert judgement: Besides being an estimation technique on its own, expert judgment is inherent to the other estimation techniques such as bottom-up and top-down estimating. Its accuracy depends on the number and experience of the experts involved, the clarity of the planned activities and the type of project.

Observations, interviews and surveys are other types of qualitative techniques.

Other considerations include:

- **Labour costs:** The people who will be working on the project are often also the largest cost component of it. Taking the time to estimate the labour rates is important

and may require market analysis.

- **Vendor bid analysis:** Sometimes external organizations are required on the project. The project may send out RFQs (Request for Quotations) or RFPs (Request for Proposals). RFQs are used when the project team knows the required solution but is unable to provide it internally. RFPs are used when the project team does not know the required solution and requests proposals from organizations with relevant expertise. In both instances, the bids must be analyzed and evaluated in order to determine which is best for the project.
- **Cost of quality:** Many project teams overlook the costs associated with the quality-related tasks for a project. This includes measures to error-proof solutions, create checklists, and inspect deliverables before they are presented to stakeholders for review and sign-off. Since it is cheaper to identify flaws earlier than later in the project, there are always quality costs associated with everything a project produces. Cost of quality is a way of tracking the cost of those tasks. It is the amount of money it takes to assure that the project is executed efficiently.
- **Reserve analysis:** Is a method used to evaluate the amount of risk on the project and amount of schedule and budget reserve to determine whether the reserve is sufficient for the remaining risk. It is important to set aside some money for cost overruns. Higher-risk projects require more reserve than lower-risk projects. The reserve is intended to assist the project team with managing risks by putting mitigating strategies in place.

Additional Considerations

It is important to determine the level of detail needed to effectively manage the project. Large, complex projects require more coordination. The level of detail that can be achieved at the beginning of the project will depend on the clarity of the end outcome. In projects with clear outcomes (predictive/waterfall), it is possible to develop detailed estimates from the onset. In projects that do not have clear outcomes (agile), the detailed estimates can only be produced as the user requirements become clear.

There are two types of reserves:

- **Contingency reserves** are funds set aside to manage the identified risks. Because there is a chance that these funds will be required, the contingency reserve is incorporated into the project budget. If this fund is adequate to meet the project's unplanned expenses, then the project will be complete within the budget.
- **Management reserves** are funds set aside to manage situations that are not anticipated. These situations can be positive and negative. An example of a positive situation is the discovery of new technology that will revolutionize the way the project objectives are achieved. The necessary funds can be made available to take advantage of this opportunity at the project sponsor's discretion. If such an opportunity were pursued, it would result in a significant change in the project's scope, especially if the predictive/waterfall development methodology was used. Unlike contingency reserves, management reserves are unlikely to be spent and are not part of the project's cost baseline.

However, they may be included in the funding made available to the project.

Estimates can change over time and it is important to consider new information as it becomes available. In addition, it is also important to document the assumptions you make and the source of the supporting information used to make the assumptions. This makes it easier to analyze variances and revise projections as needed.

2.4 Understanding Budgets

Budgeting is an exercise in refining the focus of the project. As explain earlier progressive elaboration enables us to start with a wide-angle estimate, in which the details are necessarily fuzzy, and bit by bit zero in on a sharper picture of project costs. In some projects there is the attempt to nail down every figure in an early draft of a budget but in fact only develop a budget at the precision needed for current decisions since overall precision can and should advance as the project advances.

In the early stages of the budgeting process a percentage for uncertainty must be included. The percentage may initially be large but should gradually decrease as the project progresses and the level of uncertainty declines. For IT projects, which are notoriously difficult to estimate, adding an uncertainty percentage to every line item is good practice. Some items, such as hardware, might be easy to estimate. But other items, such as labor to create innovative technology, can be extremely difficult to estimate. These line item variances can influence the total estimate variance by a significant amount in many projects. Including a contingency fund, which is a percentage of the budget must be set aside for unforeseen costs.

Successful project managers use the budgeting process as a way to create stakeholder buy-in regarding the use of available resources to achieve the intended outcome. By being as transparent as possible about costs and resource availability helps with building trust among stakeholders. By taking care to use the right kinds of contracts—for example, contracts that do not penalize stakeholders for escalating prices caused by a changing economy—may can create incentives that keep

all stakeholders focused on delivering the project value, rather than merely trying to protect their own interests.

Cost Budgeting

The main goal of the cost budgeting process is to produce a **cost baseline**. This baseline is a time-phased budget that can be used to measure and monitor cost performance after it has been approved by the key project stakeholders. The aggregated budget is integrated with the project schedule to produce the time-phased budget. Costs are associated with tasks, and since each task has a start date and a duration period, it is possible to calculate how much money will be spent by any date during the project. Recognizing that all the money required to deliver the project is not needed upfront, allows the cash flow needs of the project to be effectively managed.

For smaller organizations facing cash flow challenges, this can result in significant savings as the money required to pay for resources can be transferred to the project account shortly before it is needed. These transfers must be timed so that the money is there to pay for each task without causing a delay in the start of the task. If the money is transferred too far in advance, the organization will lose the opportunity to use the money somewhere else, or they will have to pay unnecessary interest charges if the money is borrowed.

Managing Cash Flow

If the total amount spent on a project is equal to or less than the amount budgeted, the project can still be in trouble if the funding for the project is not available when it is needed. There is a natural tension between the financial people in an

organization, who do not want to pay for the use of money that is just sitting in a checking account, and the project manager, who wants to be sure that there is enough money available to pay for project expenses. The financial people prefer to keep the company's money working in other investments until the last moment before transferring it to the project account. The contractors and vendors have similar concerns, and they want to get paid as soon as possible so they can put the money to work in their own organizations. The project manager would like to have as much cash available as possible to use if activities exceed budget expectations.

Managing the Budget

A key aspect of ongoing cost management is monitoring cost estimates. Baseline budgets often change after they have been approved. Successful project leaders understand that estimates are just that, estimates. As new information and real experience occur, it may be necessary to revise an estimate. In some cases, the revision is minor and does not impact the achievement of the project's total budget. In other instances, the necessary revisions are significant, and a new baseline needs to be created.

It is important for project managers to discuss the ongoing management of the schedule with key stakeholders to understand their expectations of when/how they are informed of changes that need to be made. Large complex projects may document stakeholders' expectations for ongoing cost management in a formal Cost Management Plan. In addition, there are several tools and techniques that help project leaders monitor and control project budgets.

Example of Budget 1

Project Budget Template									
Summary Cost of Project		**Amount in $**			**Details of Project**				
Total budget cost during the					Name of Company				
Total Actual Cost during period					Project Name or ID				
Total Variance during period					Project Lead				
					Start Date				
S. No	**Particulars**	**Materials**		**Labour**		**Fixed Cost**	**Misc. in $**	**Budgeted in $**	**Actual in $**	**Variance in $**
		Units	**Cost**	**Hours**	**Cost per Hour**					
	Task 1									
1	Subtask 1									
2	Subtask 2									
3	Subtask 3									
4	Subtask 4									
5	Subtask 5									
(A)	Total Task 1									
	Task 2									
1	Subtask 1									
2	Sub task 2									
3	Sub task 3									
(B)	Total Task 2									
	Task 3									
1	Subtask 1									
2	Subtask 2									
3	Subtask 3									
4	Subtask 4									
(C)	Total Task 3									
(D)	**Total of Project (A+B+C)**									

Example of Budget 2

Activity	Budget Direct Costs	Budget Overhead	Budget Total Cost	Actual Cost	Variance	Comments
Survey						
Design						
Clear site						
Foundation						
Framing						
Plumb and Wire						

Example of Budget 3

Months

Activity	Jan $	Feb $	March $	April $	May $	Total Cost $
Survey						
Design						
Clear Site						
Foundation						
Framing						
Plumb & Wiring						
Monthly Planned						
Cumulative						

2.5 Agile Estimation

Agile estimation is the process for estimating the effort required to complete a prioritized task in the product backlog. This effort is usually measured with respect to the time it will take to complete that task, which, in turn, leads to accurate sprint planning. Agile estimations are essential for:

- Making teams accountable for deliverables
- Inducing discipline across the Agile team
- Predicting the approximate time it will take to finish a project
- Enabling better sprint management
- Improving team productivity

Consider the following in Agile estimation:

Collaborating with the product owner: Estimation process in an agile development begins with questions about requirements and user stories. These questions help the entire team understand the task fully. For product owners specifically, breaking down work items into smaller pieces and estimates via story points helps them prioritize all and potentially hidden areas of the work and once estimates have been provided from the development team, it is not uncommon for a product owner to reorder items on the backlog.

Agile estimation is a team effort: Estimating resources and in particular cost using agile development approach involves everyone on the team. Each team member brings a unique perspective on the product and the work required to deliver a user story.

It is important to include all team members in the estimation

process. Leaving team members out may create lower quality estimates, lower morale and compromises the quality of the product.

Story points vs. hours: Traditional project teams give estimates in a time format: days, weeks, months. Many agile teams, however, have transitioned to story points. Story points are units of measure for expressing an estimate of the overall effort required to fully implement a product backlog item or any other piece of work. Teams assign story points relative to work complexity, the amount of work, and risk or uncertainty. Values are assigned to break down work more effectively into smaller pieces, so they can address uncertainty. Over time, this helps teams understand how much they can achieve in a period and builds consensus and commitment to the solution. It may sound counter-intuitive, but this abstraction is helpful because it pushes the team to make tougher decisions around the difficulty of work. Here are few reasons for using story points:

- Dates do not account for the non-project related work that inevitably creeps into our days: emails, meetings, and interviews that a team member may be involved in.
- Dates have an emotional attachment to them. Relative estimation removes the emotional attachment.
- Each team will estimate work on a slightly different scale, which means their velocity (measured in points) will naturally be different. This, in turn, makes it impossible to play politics using **velocity** as a weapon.
- Once you agree on the relative effort of each story point value, you can assign points quickly without much debate.
- Story points reward team members for solving problems based on difficulty, not time spent. This keeps team members focused on shipping value, not spending time.

Story points go wrong when they are used to judge people,

assign detailed timelines and resources, and when they are mistaken for a measure of productivity. Instead, teams should use story points to understand the size of the work and the prioritization of the work.

Story points and planning poker: Teams starting out with story points use planning poker. The team will take an item from the backlog, discuss it briefly, and each member will mentally formulate an estimate. Then everyone holds up a card with the number that reflects their estimate. If everyone agrees, great! If not, take some time (but not too much time–just couple minutes) to understand the rationale behind different estimates. Remember though, estimation should be a high level activity. If the team is too far into the weeds, take a breath, and up-level the discussion.

Estimate smarter, not harder: Spending so much time estimating work that is likely to shift is a waste of time. Providing the product owner with an estimate that can be used to prioritize the product roadmap appropriately is the best approach. By the time the team begins to work on items, the requirements may have changed, and any estimates will be inaccurate.

Learning from past estimates: Retrospectives are a time for the team to incorporate insights from past iterations–including the accuracy of their estimates. Many agile tools track story points, which makes reflecting on and re-calibrating estimates a lot easier.

2.6 Earned Value Management

Earned value management (EVM) is a project management methodology that integrates schedule, costs, and scope to measure project performance. Based on planned and actual values, EVM predicts the future and enables project managers to adjust accordingly.

Monitoring enables the project manager and team to identify unplanned impacts on scope, cost, schedule, resource, performance, and value. The project manager must regularly compare the amount of money spent with the budgeted amount and report this information to managers and stakeholders. It is necessary to establish an understanding of how this progress will be measured and reported.

Measuring the actual data against the project plan requires information from the project team. As work on the project progresses, the project manager can update the plan with the actual start and finish dates, actual work, actual and remaining duration, and percent of work complete.

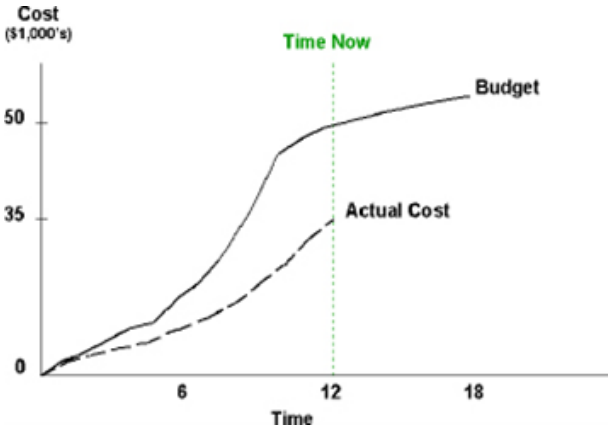

Exhibit 2.9: Budget and Actual Cost

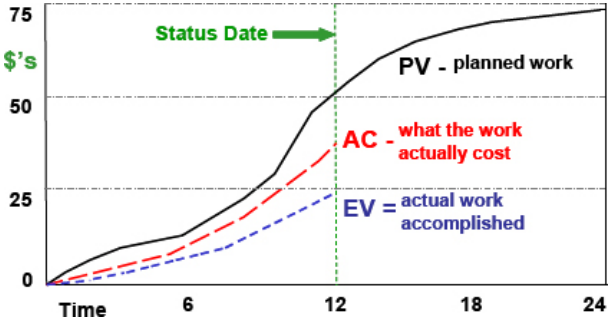

Exhibit 2.10: Earned Value Analysis

Estimation Variances

Variance Analysis is a method for determining the cause and degree of differences between the baseline and actual performance.

The differences between the original and the adjusted estimates are called variances. It is important to track and record these variances and examine their causes. Using the concept of progressive elaboration, variances should become smaller throughout the project. Variances between estimated and actual cost, resources, effort, and duration are normal in any project and occur for several reasons based on the specific project life cycles are summarized below:

Predictive Life Cycle	Adaptive Life Cycle
Evolution of requirements.	Rough order of magnitude (ROM) variances
The duration of the project	One-point estimating variances
Approved change request	Relative estimation
Operational problems or changing assumptions	Velocity
Faulty estimating	
Padding	

During the project, analyzing variances and taking corrective actions is an important activity that must be completed by the project team and manager. Taking appropriate corrective actions and updating project plans and documentations are required. All issues should be examined and communicated to relevant stakeholders and any issues should be resolved. Any changes in the budget, schedule, and resources should be identified and communicated to the stakeholders and all corrective actions should be addressed and lessons learned documented.

As you read think of examples of factors that may cause deviations from Project Plans for the following factors and provide reasons:

Factors	Reasons for deviations from the Project Plans
Scope	
Cost	
Schedule	
Resources	
Performance	
Value	

Earned Value Analysis (EVA)

Earned Value Analysis (EVA) uses a set of measures associated with scope, schedule, and cost to determine the cost and schedule performance of a project. EVA indicates how much of the budget should have been spent, in view of the amount of work done so far and the baseline cost for the task or resources. The project manager should generate and review status reports on the information of a project. Each team must also prepare and share the progress reports of each project with the stakeholders.

EVA uses “work in progress” to indicate the future of a project. EVA examines actual cost at any period during the progress of a project. This provides project managers greater insight into potential risk areas and allows them to plan with risk mitigation plans based on actual cost, schedule, and other elements of the work.

EVA helps answer many questions about project progress and performance and indicates the performance measurements for costs and schedule.

The table below provides a summary of the key terms, their meanings, and formulae to help calculate EVAs.

Cost Term	In Short	What is it?	Formula
Planned Value	PV	Sum of estimates for work planned to be done up to the present	
Earned Value	EV	Sum of estimates for work done up to the present	
Actual Cost	AC	Sum of actual costs up to the present	
Budget at Completion	BAC	Total approved budget for the project when the scope of the project is completed (includes contingencies).	
Estimate to Complete	ETC	Budget to complete taking into account work done to date and work remaining – in the context of cost performance	ETC = (BAC – EV) / (CPI)
Estimate at Completion	EAC	Budget at completion considering actual cost incurred.	EAC = AC + ETC
Cost Variance	CV	Difference between earned value and actual cost	CV = EV – AC
Cost Performance Index	CPI	Ratio of Earned Value to Actual Cost	CPI = EV/AC
Schedule Variance	SV	Difference between Earned Value and Planned Value	SV= EV – PV
Schedule Performance Index	SPI	Ratio of Earned Value to Planned Value	SPI = EV/PV

Variances and Performance Indices Interpretations	
Schedule Variance	**Cost Variance**
Variances are deviations from the expectations – difference between planned and actual progress: ***SV=EV-PV*** • Positive value: project is ahead of schedule • Zero: project is on-time • Negative: project is behind schedule	The difference between the earned value and the actual cost is the cost variance: ***CV=EV-AC*** • If positive, you are achieving more than you predicted for the money • If zero, you are right on the plan • If negative, you are achieving less than you predicted for the money
Schedule Performance Index	**Cost Performance Index**
Compares progress on the scope to spending: **SPI = EV/PV** • SPI less than one indicates the project is behind schedule • SPI of one is right on schedule • SPI greater than one the project is ahead of schedule	Compares the budget spent to date with progress to date: **CPI=EV/AC** • A value greater than one: under budget • Equal to one: on budget • Less than one: overspending the budget

Example – SeaCo, Inc.

SeaCo, Inc., a media and entertainment company is interested in purchasing and installing a new server. The company estimates an activity of a major project

for scalability of company offerings to last a week and a cost $20,000, including hardware, software, and installation. The $20,000 is the baseline budgeted cost of the project which is the budget at completion (BAC). SeaCo, Inc., wants to monitor the progress of this project. It finds out that at the end of the second day of a five-day week, 20 percent of the work is completed and $9,000 has been spent. The planned activity had 30 percent completion at the end of the second day.

Solution – SeaCo, Inc.

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Earned value is the most effective technique for providing information on project performance. It communicates scope, schedule, and cost status information to project stakeholders. Earned value is a flexible process that provides timely

information on the project's health. It is important to note that effective use of earned value concepts can provide a competitive edge in successfully delivering projects.

2.7 Reporting Progress

Project managers use the monitoring and controlling processes to translate project execution data from information into knowledge and this knowledge is then used to make the right management decisions and to take the right actions at the right time. According to the PMBOK Guide – Monitoring and Controlling activities include:

- Comparing planned results with actual results
- Reporting performance
- Determining if action is needed, and what the right action is
- Ensuring deliverables are correct based on the previously approved definitions and/or requirements
- Acquiring sign-off on deliverables by authorized stakeholders
- Assessing the overall project performance
- Managing risks
- Managing contracts and vendors

Project status reporting is a regular, formalized report on project progress against the project plan. It keeps project stakeholders informed of critical aspects of project health such as schedule, issues, scope, resources, cost, etc. and allows management to take action to address project issues and risks.

There are several types of project reports and may be prepared daily, weekly, monthly, or quarterly. They simplify the process of gathering and disseminating information about key information on the project.

Performance reports indicate the physical progress to date. The report might include information about procurement, delivery, and usage.

Trends reports shows performance over time.

Status reports identify where we are today – they are generally referred to as static reports because they relate to the moment in time. They may use the information from the performance reports to calculate Schedule Variances (SV) and Cost Variances (CV).

Projection or Forecasting reports provide forward-looking projections and emphasize where the project will end up.

Variance Analysis reports compares project actual and budgeted results.

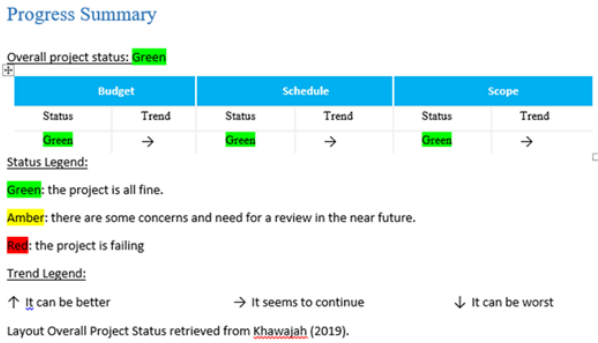
Exception reports identify exceptions, problems, or situations that exceed the threshold limits on such items as variances, cash flows, resources assigned etc.

A convenient format used in status reporting is the color chart where the "health" of a project is characterized by a color. Usually, Green and Blue signify satisfactory and excellent performance while Yellow, Orange and Red depict increasing levels of difficulty.

Red: Serious issues and the project will be delayed or have significant budget overrun

Yellow: Potential issues with schedule or budget, but both can be saved with corrective actions.

Green: On schedule, on budget, all good.



Progress Summary

Overall project status: Green

Budget		Schedule		Scope	
Status	Trend	Status	Trend	Status	Trend
Green	→	Green	→	Green	→

Status Legend:

Green: the project is all fine.

Amber: there are some concerns and need for a review in the near future.

Red: the project is failing

Trend Legend:

↑ It can be better → It seems to continue ↓ It can be worst

Layout Overall Project Status retrieved from Khawajah (2019).

Exhibit 2.11: Status Reporting

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Key Takeaways

- Project budget has the potential of impacting every facet of the project, making it one of the most critical responsibilities of a project manager.
- Extra money is allocated in a contingency fund to deal with activities where costs exceed estimates. Funds are allocated in a management reserve in case a significant opportunity or challenge occurs that requires change of scope, but funds are needed immediately before a scope change can typically be negotiated.
- Schedule variance is the difference between the part of the budget that has been done so far (EV) versus the part that was planned to be completed by now (PV). Similarly, the cost variance is the difference between the EV and the actual cost (AC).
- The schedule performance index (SPI) is the ratio of the earned value and the planned value.
- The cost performance index (CPI) is the ratio of

the earned value (EV) to the actual cost (AC).

- The formula used to calculate the amount of money needed to complete the project (ETC) depends on whether the cost variance to this point is expected to continue (typical) or not (atypical). If the cost variance is atypical, the ETC is simply the original total budget (BAC) minus the earned value (EV). If they are typical of future cost variances, the ETC is adjusted by dividing the difference between BAC and EV by the CPI.
- The final budget is the actual cost (AC) to this point plus the estimate to complete (ETC).

3.0 PLANNING AND MANAGING PROJECT RISK

Learning Objectives

By the end of this session, you will be able to:

- Explain the importance of navigating uncertainty to improve the ability to anticipate situations, make good decisions, plan and solve problems.
- Explain the purpose and role of project risk management in project management.

- Examine the principles and concepts including stakeholders risk attitudes, communications, responsibility for project risk management and project manager's role for project risk management.
- Apply and evaluate all elements of the project risk management processes.

    1. Plan Risk Management
    2. Identify Risks
    3. Perform Qualitative Risk Analysis
    4. Perform Quantitative Risk Analysis
    5. Plan Risk Responses
    6. Monitor and Control Risks
    7. Analyze all Critical Success Factors

Introduction

Project environments are constantly changing with varying degrees of uncertainty. Uncertainty represents threats and opportunities that project teams explore, assesses and decide how to handle. According to PMBOK 7th edition, the Uncertainty Performance Domain, addresses activities and functions associated with risk and uncertainty. Uncertainty is about a state of not knowing or unpredictability and there are many degrees of uncertainty:

- **Risk:** Associated with not knowing future events.
- **Ambiguity:** Associated with not being aware of current or future conditions.
- **Complexities:** Associated with dynamic systems having

unpredictable outcomes.
- **Volatility:** Associated with rapid and unpredictable change.

Successful navigating uncertainty begins with understanding the larger environment within which the project is operating. Aspects of the environment that contributes to project uncertainty include and not limited to:

- Economic factors such as volatility in prices, availability of resources, ability to borrow funds, and inflation/deflation
- Technical consideration such as new or emerging technology, complexity associated with systems, and interfaces.
- Legal or legislative constraints and requirements
- Physical environment as it pertains to safety, weather, and working conditions
- Ambiguity associated with current and future conditions
- Social and market influences shaped by opinion and media
- Political influences, either external or internal to the organization.

There are hardly any uncertainty free projects since there are multiple events that can influence the project so risk management is about identifying, analyzing, minimizing and managing risk.

PMI Practice Standard for Project Risk Management purpose is to:

- Define Project Risk
- Explain Principles and Concepts
- Identify Risk Management Processes

SHOW WHAT YOU KNOW!

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3.1 Project Risk

Risks are the uncertainties that exist in all projects. A risk can be positive or negative. Some uncertainties, such as the potential of finding an easier way to do a task and/or lower prices for certain materials, can make it easier to achieve a project's objectives. When this type of uncertain happens, the risk is positive and is therefore referred to as an **opportunity**. Negative risks are threats to the project – examples of negative risks are the potential for technology to fail and/or a vendor missing an important delivery.

Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, procurement and quality. It may impact each phase of the life cycle.

A risk may have:

- one or more causes (probability – likelihood of occurrence)
- one or more impacts (effects on project objectives)

When risk event occur, it ceases to become uncertain and the threats and benefits requires project management actions.

It is important to consider individual risks and overall project risk.

An individual risk are specific events or conditions that might affect project objectives, elements or task. The effect may be negative or positive and understanding individual risk assist in determining how to apply effort and resources to enhance the chances of project success.

Overall project risk represents the effect of uncertainty on the project as a whole. Overall project risk is more than the sum of individual risks on a project, since it applies to the whole project rather than to individual elements or tasks. It is an important

component of strategic decision-making, program and portfolio management and project governance where investment decisions are made and priorities are set.

In this video David explains how the right understanding of risk appetite can help us take the right risks safely.

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More Risk-Related Terms

Threat: Is a potential hazard, a threat is not in itself a risk. A risk is the probability that the threat will be realized times the consequences.

Issues: Known potential problems that the project team will definitely have to keep an eye on.

Known risk: Known risks can be identified, analyzed & planned in advance

Unknown risk: Unknown risks are unable to anticipate and describe.

Residual risk: Is the risk that remains after considering the mitigating effects of all options to reduce risk.

Tolerable risk: Is the level of risk people are willing to accept to secure and enjoy certain benefits.

Risk capacity: The maximum amount of risk an organization can bear.

Risk appetite: The maximum amount of risk an organization is willing to assume.

3.2 Stakeholder Risk Attitudes

Risk attitudes of the stakeholders determine the extent to which an individual risk or overall risk matters. Wide range of factors influence risk attitude and this include: Scale of the project, strength of public commitments, stakeholders sensitivity to issues (environmental, industrial relations, etc.). Stakeholders risk attitudes are strongly influenced by an organizations culture and impacts how risk can be applied.

Note that your tolerance of risk is partly a matter of personality and attitude. This article describes a range of attitudes toward risk, ranging from “risk paranoid” to “risk addicted”: Article

Table 3-1 compares issues, threats, and risks on different projects.

Project	Issue	Threat	Risk
Developing a new cell phone	The phone must be released on schedule or consumers will consider it obsolete.	Introduction of new features in a competing product, which would necessitate adding the same feature to your product.	The probability that a competitor will introduce a new feature times the consequences in time and money required to remain competitive.
Constructing a sea wall	The sea wall must be resilient even if exposed to the most severe storm surge that can be anticipated given our current knowledge.	Rising sea levels caused by climate change make it hard to predict the future meaning of the words "the most severe storm surge."	The probability of sea levels rising higher than the sea wall times the monetary and safety consequences of flooding.
Constructing an addition to a clinic	Cost of capital has significant impact on capital project decision-making.	The Federal Reserve raises interest rates, increasing the cost of borrowing money for the project.	The probability of rising interest rates times the increase to overall project cost if interest rates do go up.

3.3 How Team Members Perceive Risk

The role of the project management team is to understand the types and severity of risks on the project, and then develop and implement plans in response to these risks. The type and severity of risk vary by industry, project complexity, and project phase. The human tolerance for risk varies significantly from one person or organization to another. Due to this, it can be difficult for project team members to reach a consensus on the riskiness of an activity and overall project. Understanding the risk tolerance of a project's stakeholders is a critical success factor in risk management.

The role team members play in a project can hugely affect their perception of risk. According to David Hillson, a consultant and author of many books on risk, a project sponsor (upper management or the customer) and the project manager perceive things very differently:

The project manager is accountable for delivery of the project objectives, and therefore needs to be aware of any risks that could affect that delivery, either positively or negatively. Her scope of interest is focused on specific sources of uncertainty within the project. These sources are likely to be particular future events or sets of circumstances or conditions which are uncertain to a greater or lesser extent, and which would have some degree of impact on the project if they occurred. The project manager asks, "What are the risks in my project?"....

The project sponsor, on the other hand, is interested in risk at a different level. He is less interested in specific risks within the project, and more in the overall picture. Their question is "How risky is my project?".... Instead of wanting to know about

specific risks, the project sponsor is concerned about the overall risk of the project. This represents her exposure to the effects of uncertainty across the project as a whole.

These two different perspectives reveal an important dichotomy in the nature of risk in the context of projects. A project manager is interested in "risks" while the sponsor wants to know about "risk." While the project manager looks at the risks in the project, the project sponsor looks at the risk of the project (Hillson 2009, 17-18).

Even when you think you understand a particular stakeholder's attitude toward risk that person's risk tolerance can change. For example, a high-level manager's tolerance for risk when your organization is doing well financially might be profoundly different from the same manager's tolerance for risk in an economic downturn. Take care to monitor the risk tolerance of all project stakeholders—including yourself. Recognize that everyone's risk tolerances can change throughout the life of the project based on a wide range of factors.

3.4 Project Risk Management

Risk management focuses on identifying and assessing the risks to the project and managing those risks to minimize the impact on the project. Successful project managers manage the differing perceptions of risk, and the widespread confusion about its very nature, by engaging in systematic risk management. According to the Practice Standards on Risk Management the following are important considerations around risk management success.

Exhibit 3.1: Critical success factors for Project Risk Management.

Case Scenario

Imagine there are three similar projects. They are to develop the work safety program for different small to medium sized organizations. Assume all three organizations produce the same product or service. While every project is unique, these three projects at first glance seem the same. However, after investigating, there are subtle but significant differences. For example:

The first organization does not have a significant amount of cash. Cost is the highest priority for this project. While the project manager wants high-quality and for everything to be finished on time, he will never overspend in order to achieve these goals.

The second organization has recently suffered a serious workplace accident. The initial budget is the same as the first organization, however managing director of the organization has already said that if more money needs to be spent in order to get the best quality work health and safety system available, they will find the money from somewhere. In other words, quality is the highest priority.

The third organization is trying to implement the work of safety system, in a work culture actively resists change. The greatest challenge to this project will be the competing influences of different stakeholders. The highest priority for this project will be to achieve a successful outcome in an environment that has not yet recognize there is benefit in the project being proposed.

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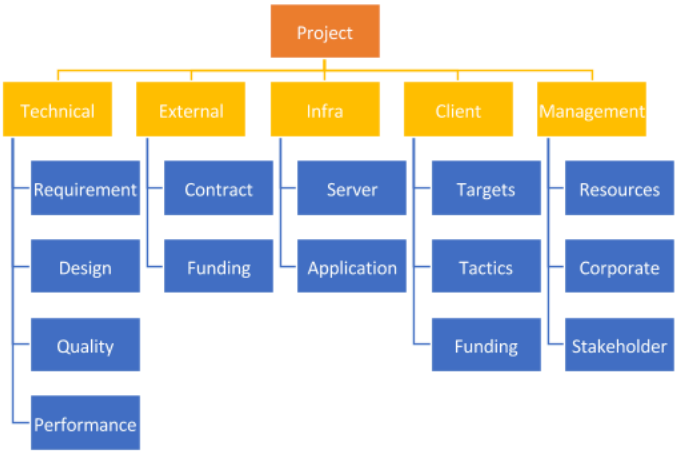
H5P Reference

3.5 Risk Management Processes

Information (Inputs) that is needed to plan how risks is to be managed is found in the; project management plan; the project charter and; the stakeholder register. The project's environment (internal and external environmental factors) also need to be considered. The environment includes but is not limited to the risk attitude of the organization, how risks are categorized; definition and terms; templates and formats that direct how risks are documented and roles, responsibilities and decision-making authority.

A Risk Breakdown Structure enables risk categories to be more easily remembered. For example:



According to the Practice Standard for Risk Management there are six steps in the risk management processes:

1. **Planning Risk Management Process**

    - The objectives of the Plan Risk Management process are to develop the overall risk management strategy for the project, to decide how the risk management processes will be executed, and to integrate project risk management with all other project management activities.

2. **Identifying the Risks**

    - Some uncertainties are easy to identify, such as the potential for a damaging storm in the Caribbean, while others are less obvious, such as the potential for a project team to experience poor health. Many industries or companies have risk checklists developed from past experience. The value of a checklist is the stimulation of discussion and thought among team members about the potential risks of a particular project.

3. **Perform Qualitative Risk Assessment**

    - Assess and analyze each identified risk by estimating its likelihood (probability of occurrence) and impact on project goals. The outcome from this process is a prioritized list of project risks with values (e.g. high, medium, low) that represent the likelihood and potential impact. The probability/impact matrix is a key tool in risk assessment and assist in ranking risks.

4. **Perform Quantitative Risk Assessment**

- Quantitative risk analysis is a numeric estimate of the overall effect of risk on the project objectives such as cost and schedule objectives. The results provide insight into the likelihood of project success and is used to develop contingency reserves.

5. **Developing Risk Responses**

    - Accept the risk (do nothing to prevent it from happening), eliminate it (change something in the project to avoid its occurrence), transfer it (to a third party by purchasing insurance), or mitigate it (reduce its likelihood and/or impact).

6. **Monitoring and Control Risks**

    - After selecting the appropriate response for a particular risk, the project team must balance the cost of the response against the anticipated benefit for the project. Monitoring is important because new risks emerge and understanding the effectiveness of implemented risk response strategies ensures project risks are effectively managed throughout the project's lifecycle.

Let us examine each aspect of effective risk management processes in more detail.

Risk Management Plan

By the time a risk turns into an issue on a project, it is often too late to effectively respond to it. The **risk management plan** allows the project team to reduce the likelihood of negative surprises, proactively take advantage of positive risks

(opportunities), and ensure risk management is considered when schedules, budgets, and other management plans are developed. Creating and maintaining a risk management plan significantly increases the likelihood of project success.

The risk management plan identifies the processes and procedures to be used in managing risk throughout the life of the project. It includes a number of key sections: project description, methodology, risk management organization, stakeholder risk tolerance, risk sources, categories, assessment, definitions (e.g. very high to very low), probability/impact assessment (matrix), roles and responsibilities, budget and schedule estimates for risk-related activities, criteria for success, tools and guidelines for use, risk communication plan, RBS, and the risk register. The risk management plan is integrated into the project management plan (or, in the absence of this plan, into the execution approach for the project) and the response strategies are assigned to the appropriate individuals in the organization.

A risk register is a key tool that helps project teams keep track of the status of risks, ensure response plans are effectively implemented, and new risks are managed. The register is often created during the initiation phase of a project's life and it is maintained throughout the remaining phases.

Risk Identification

Since risks are uncertainties, a good place to start in identifying risks is the assumptions that have been made in the project justification document and project charter. Project teams hope the proposed assumptions will materialize, but this is not certain. Often, these assumptions represent significant risks.

Another important method for identifying project risks is the project team itself. The individuals responsible for specific components of the work are in the best position to identify

the risks and opportunities associated with the task(s). Risk management should be a standing agenda item during project status meetings

The third source of risk is risk checklists developed from past projects. These checklists can be helpful to the project team in identifying specific risks on the checklist and expanding the thinking of the team. Some industries publish their own risk management checklists that, when feasible, should be utilized. Checklists are often organized by risk category. The categories themselves can add helpful insights during brainstorming sessions. Examples of common risk categories include:

- Technical (related to technology and equipment)
- Cost (specific labour and non-labour estimates)
- Schedule (activity durations and methods of completing work)
- Client/Customer (their willingness to use a new product/service)
- Procurement (vendor performance)
- Weather (adverse weather can impede progress)
- Financial (related to funding sources)
- Environmental (new/changing government regulations)
- Resources (skills, availability, and effectiveness of teamwork on the project)
- Stakeholders (fulfilling expectations of specific stakeholders)
- Communications (related to its effectiveness)

Notice that the categories are broad. Successful project delivery is a multi-disciplinary approach.

Risks can also be categorized according to the deliverables of the work breakdown structure (WBS). This is commonly referred to as a risk breakdown structure (RBS). Using the RBS approach helps the project team identify known risks but it may prevent the team from thinking beyond the list to

creatively identify unknown risks that are not easily found inside the WBS. It is important to document all relevant information available for each identified risk.

Tools and Techniques for Identifying Risks

- Expert Judgement
- Assumptions and constraints
- Brainstorming
- Cause and Effect
- Checklists
- Documentation Reviews
- Force Field analysis
- Interviews
- Meetings
- Prompt List
- Questionnaire
- Risk Breakdown Structure
- Root-Cause Analysis
- SWOT analysis

Qualitative Risk Assessment

A qualitative risk analysis prioritizes the identified project risks using a pre-defined rating scale. Risks will be scored based on their probability or likelihood of occurring and the impact on project objectives should they occur.

After the potential risks have been identified, the project team evaluates each risk based on the probability that the risk event will occur and the potential impact (cost/benefit) associated with it. Not all risks are equal. Some risk events are more likely to happen than others and the cost/benefit of a risk can vary greatly. Having criteria to determine high-impact risks can help narrow the focus on a few critical risks that require responses.

For example, suppose high-impact risks are those that could increase the project costs by 5% or more. Similarly, high-probability risk events are those that carry a likelihood of occurrence of 50% or more. Only a few potential risk events are likely to be high-impact *and* high-probability. These risks become the “critical few” and, therefore, promptly identifying the risks within this category is helpful in deciding early on

where the funds and time should be allocated for risk-related activities. See *Exhibit 3.2*.

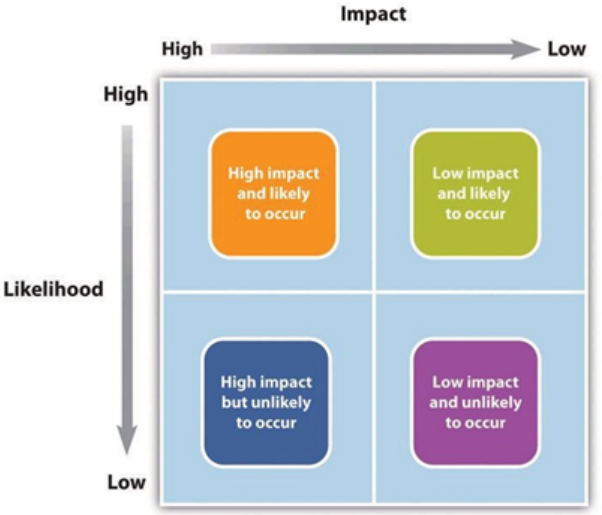


Exhibit 3.2: Risk and Impact Matrix Project Management from Simple to Complex

	Negligible	Marginal	Critical	Catastrophic
Certain	High	High	Extreme	Extreme
Likely	Moderate	High	High	Extreme
Possible	Low	Moderate	High	Extreme
Unlikely	Low	Low	Moderate	Extreme
Rare	Low	Low	Moderate	High

Exhibit 3.3 Risk Matrix – Probability and Impact

Qualitative risk assessment must be performed always and the exercise is usually quick and subjective.

There is a positive correlation between project complexity and project risk. This means that both variables increase or decrease together. A project with new and emerging technology will have a high complexity rating and a

correspondingly high project risk. The project management team will assign the appropriate resources to the technology managers to ensure the accomplishment of project goals. The more complex the technology, the more resources the technology manager typically needs to meet project goals, and each of those resources could face unexpected problems.

On projects with a low-complexity profile, the project leader may informally track items with risk potential. On more complex projects, the project management team may develop a list of items perceived to be higher risk and track them during project reviews. On projects of even greater complexity, the process for evaluating risk is more formal with risk assessment meetings occurring throughout the project's lifecycle to assess relevant risks during different project phases. On highly complex projects, an outside expert may be included in the risk assessment process, leading to the risk assessment plan taking a more prominent place in the project implementation plan.

Quantitative Risk Assessment

Individual risks are evaluated in the qualitative risk assessment and analysis, however, quantitative assessment and analysis allows us to evaluate the overall project risk from the individual risks plus other sources of risks. For more critical decisions, quantitative risk analysis provides more objective information and data than the qualitative analysis. Quantitative risk assessment can be considered for large and complex projects, projects that requires a large contingency reserve and projects where upper management wants more detail about the probability of completing the project on schedule and within budget.

Tools used in quantitative analysis include Three Point Estimate, Decision Tree Analysis, Expected Monetary Value (EMV), Sensitivity Analysis and Fault Tree Analysis (FMEA).

In addition, statistical models are sometimes used to evaluate risk because there may be too many possible combinations of risks to calculate them one at a time. One example of the statistical model used on highly complex projects is the Monte Carlo simulation, which simulates a possible range of outcomes by evaluating many different combinations of risks based on their likelihood. The output from a Monte Carlo simulation provides the project team with the probability of a risk event successively occurring with other combinations of risk events.

For example, the typical output from a Monte Carlo simulation may indicate a 10% chance that a key piece of equipment will be late *and* that the weather will be unusually bad upon equipment arrival. Quantitative risk analysis relies on accurate statistical data to produce actionable insights. High-risk industries in such as — mining, oil and gas, or construction rely heavily on quantitative risk analysis which is a legal requirement.

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Risk Responses

Negative Risks

After the risks have been identified and assessed, the project

team develops appropriate risk responses. As previously mentioned, the project team responds to negative risks in various ways:

- Risk avoidance
- Risk mitigation
- Risk transfer
- Risk acceptance

Each of these responses can be an effective tool in reducing individual risks as well as the overall risk profile of the project. The risk response plan captures the risk management approach for each identified risk event and actions the project management team will take to manage the risk.

Risk avoidance usually involves developing an alternative strategy with a higher probability of success, but, usually, the associated cost of task completion also becomes higher. A common risk avoidance technique is using proven and existing technologies rather than adopting new techniques, even though the new techniques may show promise of better performance and/or lower costs. A project team may choose a vendor with a proven track record over a new vendor that is providing significant price incentives to avoid the risk of working with a new vendor. Alternatively, a project team that requires drug testing for team members is practicing risk avoidance by attempting to evade damage done by someone under the influence.

Risk mitigation is a response to a risk that cannot be avoided or if it is unwise to avoid it (due to risk avoidance strategies being too expensive, too time-consuming, etc.). In this case, the project team is attempting to reduce the likelihood and impact of a risk. For instance, assigning highly skilled resources to an activity reduces the likelihood and impact of errors occurring.

Risk transfer is a risk reduction method that shifts the risk from the project to another party. The purchase of insurance

on certain items is a risk-transfer method. The risk is transferred from the project to the insurance company. A construction project in the Caribbean may purchase hurricane insurance that would cover the cost of a hurricane damaging the construction site. The purchase of insurance is usually connected to risks that can significantly impact the project while being out of the project team's control, such as weather, political unrest, and labour strikes.

Risk acceptance involves doing nothing in response to the risk. The acceptance response is a good one when the likelihood and impact of a risk are low. In some cases, little else can be done about the risk, leading to acceptance being the only feasible option. When this response is chosen, many project leaders have developed a strategy to deal with the risk if it does materialize. This often involves setting aside funds (contingency reserves) in the project budget.

Positive Risks

As previously mentioned, positive risks (opportunities) are uncertainties that, if materialized, will have a positive impact on the project. Project teams have other alternatives to deal with opportunities:

Risk sharing involves partnering with others to share responsibility for the risk. Partnering with another company to share the risk associated with a portion of the project is advantageous when the other company has the expertise and experience that the project team lacks. This increases the likelihood of the opportunity materializing and, if it does, both organizations share the gains.

Risk exploitation attempts to eliminate the uncertainty and ensure the occurrence of the opportunity. An example of this could be pursuing a bonus that is available only if an activity is completed early. In this case, the project team will reallocate

resources in order to ensure the activity finishes early and the bonus is obtained.

Risk enhancement attempts to increase the probability of the opportunity materializing but it does not seek to *ensure* its occurrence. This requires less investment than the exploitation response and is appropriate when the positive impact is not as great.

Risk acceptance involves doing nothing in response to the risk. This acceptance response is a good one when the likelihood and impact of a risk is low.

Monitoring and Controlling

The objectives of risk monitoring and controlling are to track identified risk, monitor residual risk, identify new risks, ensure that risk response plans are executed at the appropriate time, and evaluate their effectiveness.

Understanding where or when risks occur in a project is important information for managing the project's contingency funds. Most organizations develop a plan for financing the project from the existing organizational resources, including financing the project through a variety of financial instruments. In most cases, there is a cost to the organization to keep these funds, including the contingency budget, available to the project. As the risks decrease over the length of the project, if the contingency is not been used, then the funds set aside by the organization can be allocated for other purposes.

3.6 Project Risk by Phases

Another effective way to manage risks is to consider the project lifecycle. Risk management techniques can vary by project phase. In the simplest of terms, the initiation phase usually involves simply assessing overall project risk by identifying the key risks. During the planning phase, the team is able to identify, assess, and respond to many more risks. During the implementation phase, previously identified response strategies require modification if they have been deemed ineffective or significant new risks emerge. During the closure stage, contractual arrangements related to risk management are terminated and risk management documentation is updated.

Initiating Phase: Risk is associated with the unknown. More things are unknown at the beginning of a project than at any other phase. When overall project risk is considered in the initiation phase, it is weighed against the potential benefit of the project's success in order to decide if the project should be chosen.

Planning Phase: Once the project is approved and it moves into the planning phase, additional risks are identified. Moreover, the list of initial risks identified during the initiation phase is considered in greater detail.

Implementing, Monitoring and Controlling Phases: As more information becomes available to the team and tasks are performed without loss, the overall project risk typically reduces. As the project progresses, the risk management plan must be updated with new information and risks related to the completed tasks must be checked off.

As the project's progress is monitored, the need to make

changes may arise. Sometimes, these changes occur as a result of risk management strategies that have been pursued in response to newly identified risks. In some situations, the project timeline may need to be extended or the project budget may need to be increased (or the timeline/budget may need to be reduced if an opportunity has been discovered!).

Closing Phase: During the closing phase, agreements for risk-sharing and risk transfer must be concluded and the risk management plan must be examined to ensure all the risk events have been effectively managed. If a risk register was used to track risks and their respective response strategies, a final update should be composed in order to ensure the register can be shared with and easily understood by future project teams in order to improve their likelihood of success. Similarly, identifying how much of the contingency funds were required is an important project closure step. This allows future teams to understand how much funds they may have to set aside to manage similar risks on their projects. Lastly, if a Monte Carlo simulation was done, the predicted result can be compared to the realized result.

Risk is not allocated evenly over the life of the project. On projects with a high degree of new technology, the majority of the risks may be in the early phases of the project. On projects with a large equipment budget, the majority of the risks may be during the procurement of the equipment. On global projects with a large amount of political risk, the majority of the risks may be toward the implementation and closure of the project.

3.7 Contingency Plan

Contingency funds are set aside by the project team to address unforeseen events that cause an increase in project costs. Projects with a high-risk profile will typically have a large contingency budget. The amount of contingency allocated in the project budget is often a function of the risks identified in the risk analysis process. It is possible to allocate contingency to specific activities. However, contingency can also be managed as a “one-line item” in the project budget when risks are difficult to assign to specific activities.

Contingency plans are often reviewed during the life of the project. This review evaluates the effectiveness of the risk responses and whether there is a need for additional contingency.

3.8 Risk in IT and Agile Project Management

The IT world faces a slew of risks related to the complexity of the products and services it provides. As a result, IT projects are notoriously susceptible to failure. In fact, a recent survey reported a failure rate of over 50% (Florentine 2016). This figure probably under reports the issue because it focuses on the success rate for IT projects in the short run—for example, whether or not developers can get their software up and running. But as software companies rely more and more on a subscription-based business model, the long-term life cycle of IT products becomes more important.

Indeed, in a world where software applications require constant updates, it can seem that some IT projects never end. This in turn, raises more risks, with obsolescence an increasing concern. Add to this the difficulties of estimating in IT projects and the cascading negative effects of mistakes made upfront in designing software architecture, and you have the clear potential for risk overload.

By focusing on providing immediate value, Agile helps minimize risk in software development because the process allows stakeholders to spot problems quickly. Time is fixed (in preordained sprints), so money and scope can be adjusted. This prevents schedule overruns. If the product owner wants more software, she can decide this bit-by-bit, at the end of each sprint.

In a blog post about the risk-minimizing benefits of Agile, Robert Sfeir (2015) writes,

"Agile exposes and provides the opportunity to recognize and mitigate risk early. Risk mitigation is achieved through cross-functional teams, sustainable and predictable delivery pace, continuous feedback, and good engineering practices. Transparency at all levels of an enterprise is also key. Agile tries to answer questions to determine risk in the following areas, which I will discuss in more detail in a future post:

- Business: Do we know the scope? Is there a market? Can we deliver it for an appropriate cost?
- Technical: Is it a new technology? Does our Architecture support it? Does our team have the skills?
- Feedback (verification & validation): Can we get effective feedback to highlight when we should address the risks?
- Organizational: Do we have what we need (people, equipment, other) to deliver the product?

Dependency: What outside events need to take place to deliver the project? Do I have a plan to manage dependencies?"

Keep in mind that in all industries, simply identifying threats is only the first step in risk management. Lots of time and money could be lost by failing to understand probabilities and

consequences, causing your team to place undue management focus on threats that have a low probability of occurrence, or that may have minimal impact.

3.9 Risk Reporting

The risk report will inform key stakeholders of the consequence of the risks, the likelihood of occurrence, and the mitigation strategy to be adopted in the event the risks occur. A well-developed and maintained risk register can serve as the risk report, if it includes not only negative risks but also opportunities, a supporting risk treatment plan, a work performance data review, project progress, and the status of all deliverables. The following should be considered when developing a risk report:

Number of serious risks: A project can be declared a high-risk project once it has a high number of risks (e.g., it has nine or more serious risks). Conversely, a project with a small number of risks can be considered a low risk.

Cumulative schedule risks: Cumulative risks can be calculated by adding the individual schedule risks during the project life cycle. It is imperative to understand that, in reality, much of the schedule risk acts concurrently, which makes the value of this risk a qualitative sign only. The cumulative schedule risk is considered high risk if it is above 25%, and low if it is below 15%.

Cost risks: This kind of risk is the total cost risk for an entire project. Again, cost risk has its own indicator where it can be considered low risk if it is below 5% of the total cost of the project, and high if it is more than 10%.

Threat factor: This is a qualitative calculation of the level of risk within the project itself. Basically, it calculates the average risk ruthlessness for the highest 20 threats. Therefore, any figure that is below 15 will be considered low risk, while any figure above 25 is considered high risk. The impact of the threat factor depends on the number of occurrences. For example, 100 occurrences may mean all risks would have a major impact

on the project, but occurrences of less than 100 may mean the impact is insignificant.

Expected risks: Expected risks is the position that all risk should be ended. This is based on the project manager's response plans and expectations.

In addition to the above, each risk must be assigned a tracking number and identify the risk owners. Each risk should be prioritized based on the likelihood of occurrence or severity of impact and its potential impact on the project's outcome (cost, quality, and schedule). It should also include documentation of indicators that will trigger the risk, risk mitigation strategies, and any other information that the project team deems helpful. If all goes as planned, the risk report will assist the project management team in making key decisions without delay.

3.10 Risk Framework

A risk framework outlines the organization's:

- risk management approach
- risk appetite
- risk tolerance
- accountabilities and responsibilities for managing risk.

In today's world organizations should constantly reassess and update their framework – as frequently as weekly, or even daily. Organizations that are proactively managing their risk, controls and compliance activities will potentially be better positioned to respond to change e.g. businesses fast-tracked their digitization process in 2020, to enable effective remote working and ecommerce.

The hallmarks of a good risk management framework are: pragmatism, flexibility, informed decision-making and ecosystem connectedness.

Key Takeaways

- Uncertainty is about a state of not knowing or unpredictability and there are many degrees of uncertainty:
    - Risk – Associated with not knowing future events.
    - Ambiguity – Associated with not being

aware of current or future conditions.
    - Complexities- Associated with dynamic systems having unpredictable outcomes.
    - Volatility – Associated with rapid and unpredictable change.

- Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, procurement and quality.
- An individual risk are specific events or conditions that might affect project objectives, elements or task.
- Overall project risk represents the effect of uncertainty on the project as a whole.
- Risk attitudes of the stakeholders determine the extent to which an individual risk or overall risk matters.
- Risk management focuses on identifying and assessing the risks to the project and managing those risks to minimize the impact on the project.
- Risk Management Processes has six steps in the process:

    - Planning Risk Management Process
    - Identifying the Risks
    - Perform Qualitative Risk Assessment
    - Perform Quantitative Risk Assessment
    - Developing Risk Responses
    - Monitoring and Control Risks

- The risk management plan identifies the processes and procedures to be used in

managing risk throughout the life of the project.

- A risk breakdown structure (RBS) can follow the work breakdown structure (WBS) to identify risk by activity.
- Contingency planning is the development of alternative plans to respond to the occurrence of a risk event.

4.0 PLANNING AND MANAGING PROJECT PROCUREMENT

Learning Objectives

By the end of this section, you will be able to:

- Describe the procurement management processes
- Discuss the significance of procurement planning
- Examine procurement approaches and strategies

- Create procurement plans in a predictive and agile approaches
- Apply the concept of make or buy analysis to decision making
- Conduct Procurement – Create vendor list and select a vendor
- Create procurement contracts and manage contracts through the project life cycle
- Manage procurement contracts including types of contracts.
- Discuss current trends in procurement management
- Apply appropriate models, artifacts, and methods for enabling project outcomes

Introduction

To achieve the objectives of the project, the project team will purchase goods and some services. The process of obtaining goods and services from providers who are outside of the organization is procurement. The process for selecting the work that will be procured and the different methods and processes for procuring resources such as equipment, materials, and services for the project requires procurement planning and management.

SHOW WHAT YOU KNOW

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=35#h5p-14

4.1 Procurement Management

The procurement effort on projects varies widely and depends on the type of project. Procurement can happen anytime during the project; however, planning helps set expectations to ensure that the procurement process is performed smoothly. Procurement covers everything from material, capital equipment and supplies to solutions, labor, and services. The "procurement cycle" reflects all procurement-related activities from when the decision is made to outsource equipment all the way through to the payment of bills and closing of procurement contracts.

In less complex projects, the project team performs the work associated with procurement management. This includes:

- Identifying the required materials, equipment, and supplies
- Identifying the potential vendors
- Preparing requests for quotes (RFQs) and requests for proposals (RFPs), which include product/service specifications and a detailed delivery schedule
- Evaluating RFQs and RFPs to select the most suitable vendors
- Awarding and signing contracts
- Administering the contract and monitoring vendors' performance
- Managing contract changes
- Closing out the contract upon work completion

Procurement Cycle

Exhibit 4.1: Procurement Cycle

On more complex projects, procurement professionals may be assigned to assist the team throughout the project's lifetime.

Procurement management follows a logical order. First, determine what the project needs to contract; then plan to do it. Next, send out contract requirements (solution specifications and timeline requirements) to potential vendors. These vendors bid for the chance to work on the project. The project team selects the best vendor and then signs a contract to formalize acceptance of the terms. Once the work begins, the supplier's performance is monitored to ensure that the contract is being followed. When the work is done, the contract is closed out.

PMI identifies the following three major procurement processes:

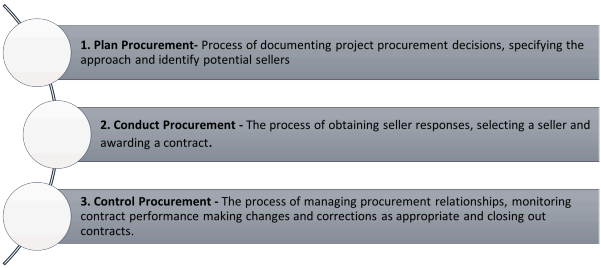

Exhibit 4.2: Major Procurement Processes

Corporate Procurement and Project Procurement Strategies

Corporate procurement is the relationship of specific procurement actions to the corporate strategy, e.g. centralized procurement.

Project procurement is the relationship of specific procurement actions to the operating environment of a project.

E.g. when the project manager is allowed to perform sole source procurement without necessarily involving the centralized procurement group (such as purchasing one ounce of a special chemical for an R&D project).

Project procurement strategy can differ from corporate procurement strategies because of:

- constraints
- availability of critical resources
- specific customer requirements.

Corporate procurement strategies might promote purchasing small quantities from several qualified vendors, whereas project procurement strategies may dictate sole-source procurement.

4.2 Plan Procurement

When planning procurement, there is numerous consideration that involves the following primary objectives:

- Procure all goods/services from a single source.
- Procure all goods/services from multiple sources.
- Procure only a small portion of the goods/services.
- Procure none of the goods/services.

Also, it is important to consider the internal and external environments in which procurement must take place.

Procurement Management Plan

It is important to start with the plan for the whole project. Before doing anything else, consider all work that needs to be contracted out for the project. Ensure the project's needs are closely examined to confirm if contracting is even necessary.

A procurement management plan is used in projects with high complexity as it details how the procurement process will be managed. It includes the following information:

- Roles and responsibilities of the project team and procurement professionals
- Vendor selection criteria and the selection process
- The identification of prequalified sellers (if known)
- The types of contracts to use and any metrics that will be used to measure the vendors' performance
- The requirements and specifications of the necessary products, services, and equipment
- The planned delivery dates for the work or products being

contracted
- The company's standard documents to be used on the project
- The number of vendors involved and how they will be managed
- How purchasing may impact the constraints and assumptions of the project management plan
- The coordination of purchasing lead times with the development of the project schedule
- Closing contracts

Depending on the project's complexity level, procurement management plans can take hours or weeks to complete. The activities involved in procurement management are included in the project's schedule and budget. The time involved in the procurement cycle can influence the scheduling of critical activities, including the decision to self-perform the work or contract the work to others. The delivery dates for equipment and materials and the work completion dates for contracted works are placed on the project schedule.

Any procurement activities that create a project delay or fall on the project critical path may require special attention. Procurement planning must address the risks on the contract as well as the risks with procurement. Some companies have project management manuals with sections that specifically address procurement risks using templates.

Like all other management plans, the procurement management plan becomes a subsidiary of the project management plan.

Let us explore some key activities, tools, and techniques used in the procurement management process. Feasible procurement alternatives include:

- Make-or-Buy analysis
- Lease-or-Buy analysis

- Buy-or-Rent analysis
- Lease-or-Rent analysis

Example 1: Lease-or-Buy analysis

Lease-or-Buy analysis is a technique used to determine if needed equipment should be purchased or leased on a project. This can apply to all kinds of equipment, including information technology.

Some of the key questions answered include:

1. How long does the organization need to use the equipment for the project?
2. What will the organization do with the equipment after the project is complete?
3. How will this decision affect the scope of the project?
4. How will it affect the project schedule?
5. How will it affect the stakeholders' expectations of quality?

A simple example will help illustrate how this analysis is performed. Let us assume a project team needs a 3-D printer. The printer would cost about $15,000 to purchase and require about $200 per month to maintain. Alternatively, the project could lease the printer for $600 a month. The monthly lease rate includes all associated expenses like maintenance.

The first step is to determine when the cost to buy becomes equal to the cost to lease. This can be expressed mathematically as follows:

Cost to lease = Cost to purchase

Assume M is the number of months.

$600 x M = $15,000 + ($200 x M)

($600 – $200) x M = $15,000

$400 x M = $15,000

M = $15,000 ÷ $400 **= 37.5**

If the project is considerably longer than 37.5 months, it makes sense to buy the equipment. The organization could

choose to reassign the printer to future projects or sell it using a very low-cost online alternative. Conversely, if the project is considerably less than 37.5 months, it makes more sense to lease the equipment. If the project's duration is very close to 37.5 months, this becomes a judgement call, and the project leader may wish to consult with others in the organization to determine if there is a need for this type of equipment in other areas.

Example 2: Make-or-Buy analysis (Using Expected Monetary Value)

Another technique used is to consider the **Expected Monetary Value** (EMV); some of the questions to consider may include:

- How much does it cost to build it as opposed to buying it?
- How will this decision affect the scope of your project?
- How will it affect the project schedule?
- Do you have time to do the work and still meet your commitments?
- EVM – Expected Monetary Value (EMV) = Probability * Impact

Assuming you have two scenarios 1 and 2, and you have been provided with data for probabilities of receiving and losing a certain amount of money. You can use the EMV to determine the best option see below. The best option will be the scenario with the largest EMV.

Scenario 1

Best case provides a 20% probability of making $180,000	BC = 20% X $180,000= $36,000
Worst case provides a 15% probability of losing [-$20,000]	WC = 15% X (-$20,000) = (-$3,000)
Most likely case provides a 65% probability of making $ 75,000	MLC = 65% X $75,000 = $48,750

Total Expected Monetary Value 100% $81,750

Scenario 2

Best case provides a 15% probability of making $200,000	BC=15% X $200,000 =$30,000
Worst case provides a 25% probability of making $15,000	WC= 25% X $ 15,000 = $ 3,750
Most likely case provides a 60% probability of making $45,000	MLC=60% X $45,000 = $27,000

Total Expected Monetary Value 100% $60,750

4.3 The Bid Process

The bid process includes developing and publicizing bid documents, bidder conferences, and letting a bidder.

After the analysis is complete, the project team will be able to determine the nature of the contractual relationship needed with a vendor. It is then time to identify potential vendors. Once the potential vendors have been identified, the project team will move on to bid solicitation. Once the bids come in, they are evaluated. Once the successful vendor has been selected, a contract is awarded. Let us look at each of these steps more closely.

Qualifying Bidders

Potential bidders are people or organizations capable of providing the materials or performing the outsourced work required for the project. On smaller, less complex projects, the parent company typically has a list of suppliers and vendors that have successfully provided goods and services in the past. The project has access to the performance records of companies on that list. On unique projects where no supplier list exists, the project team develops a list of potential suppliers and then qualifies them to become eligible to bid on project work. Eligible bidders are placed on the bidder's list and provided with a schedule of when work on the project will be put out for bid.

The eligibility of a vendor is determined by the ability to perform the work in a way that meets project requirements and demonstrates financial stability. The ability to perform the work includes the ability to meet quality specifications and the project schedule. During times when economic activity

is high in a region, many suppliers become busy and stretch their resources. Before they are included on the bidder's list, the project team investigates the potential suppliers to ensure they have the capacity and track record to meet deadlines and quality expectations.

The potential supplier must also be financially stable to be included on the bidder's list. A credit check or a financial report from a reputable credit rating agency (e.g. Dun and Bradstreet, Equifax) will provide the project team with information about the potential bidder's financial status.

Solicitation

A **solicitation** is a process of requesting a price and supporting information from bidders. The solicitation usually takes the form of either a **Request for Information** (RFI), a **Request for Quotation** (RFQ) or a **Request for Proposal** (RFP).

An RFI is used to gather more information from the market prior to sending out bid documents to a set of selected vendors.

An RFQ focuses on price. The product, service, and/or materials are well-defined and can be obtained from several sources. The bidder that can meet the project quality and schedule requirements usually wins the contract by quoting the lowest price.

An RFP is issued when the project team does not know the required solution. The RFP is intended to solicit ideas on how to fulfill the project's objective with specific solutions. This approach is used in projects utilizing the predictive (waterfall) and adaptive (agile) methodology. For instance, consider a project with the objective of streamlining a service process. The project will involve the introduction of a new service request application. In addition, since the existing desktop computers are too old to run the new application, the project team must

upgrade all desktop computers. Since the project team does not know which desktop computer is most appropriate, they issue an RPP to three companies. This project could be following a predictive or an adaptive methodology.

The key is that the project team needed assistance in defining an aspect of the full solution. The RFP considers price, but it focuses more on meeting the project's objective by selecting the appropriate solution. If several vendors have submitted proposals that successfully illustrate how they would support the project's objective, the price can become one of the deciding factors. The process of developing a proposal in response to an RFP can be very time-consuming and expensive for the bidder, and the project team should not issue an RFP to a company that is not eligible to win the bid.

Invitation for Bid (IFB) – some companies utilize an invitation for bid (IFB) process where only selected companies are allowed to bid. Either all or part of the companies on the buyer's preferred contractor list may be allowed to bid. IFBs are used in sealed bidding procurements for government agencies. These IFBs contain all the necessary technical documents, specifications, and drawings needed for a bidder to develop a priced offer. In sealed bid procurement, there are no discussions or negotiations, and the contract is always awarded to the lowest acceptable offer using a firm fixed-priced contract.

Also, **Statement of Work** (SOW) which is a narrative description of the work to be accomplished and/or the resources of work to be supplied, including terms and conditions, are included in the documents. **Statements of Objectives** (SOOs) for projects that are designed as "performance-based" efforts describe the project end objectives. SOOs include specifications such as design, performance, and functional. Performance-based projects are now the preference in the federal government procurements.

In response to a solicitation containing a SOO, the potential

contractors develop and propose their own SOW that provides detailed specifics on how they intend to perform the work. The source selection process entails comparing the various contractor-developed SOWs, each contractor applying its own unique technologies, capabilities, and expertise to the project effort.

A final consideration is logistics. Equipment and materials that are purchased for use on the project must be transported, inventoried, warehoused, and often secured. This area of expertise is called logistics. The logistics for the project can be managed in many different ways. It can be managed within the project team if they have the needed expertise and access to the required facilities. On larger, more complex projects, a member of the organization's procurement department may assume accountability for logistics. Lastly, if the organization does not have the required skills and facilities, it will be managed externally and potentially part of the RFP or RFQ process.

Evaluating Bids

Evaluation of bids in response to RFQs for commodity items (e.g. office supplies) is heavily weighted toward price. In many cases, the lowest total price will win the contract. This is because the vendors have already confirmed they are able to meet the specifications and delivery timelines, so price becomes the determining factor. The total price will include the costs of the goods or services, any shipping or delivery costs, the value of any warranties, and any additional service that adds value to the project. Evaluation of bids for non-commodity items (e.g. services) often considers the vendors' past performance (obtained from reference checks of existing/past clients).

The evaluation of bids based on RFPs is more complex. The

evaluation of proposals includes the price and an evaluation of the technical approach chosen by the bidder. The project team evaluating the proposal must include people with the expertise to understand the technical aspects of the various proposed approaches and the value of each approach to the project. On more complex projects, the administrative part of the proposal is evaluated and scored by one team, and another team evaluates the technical aspect of the proposal. The project team combines the two scores to determine the best proposal for the project. Quite often, the two scores are not weighted equally.

Vendor selection is another great example of how the weighted scoring model is used as an effective decision-making tool in project management. Once the bid documents are distributed, the buyer generally has a bidder conference to respond to bidder questions and provide clarifying information. The bidders develop their own responses and deliver them to the buyer by the date specified in the bid document.

Awarding the Contract

After the project team has selected the bidder that provides the best value for the project, a project representative reviews the contract terms with the successful vendor. Depending on the nature of the product/service to be purchased, some negotiation may occur. Negotiation typically does not occur on less complex awards, such as contracts for standard office supplies. More complex projects require a detailed discussion of the goals, the potential barriers to accomplishing those goals, the project schedule and critical dates, the processes for resolving conflicts and improving work processes, and any penalty clauses. Contracts have a penalty clause if the work is not performed according to the contract.

For example, suppose the new software is not completed in

time to support the implementation of the training. In that case, the contract might penalize the software company a daily amount of money for every day the software is late. This type of penalty is often used when the software is critical to the project, and the delay will cost the project significant money.

In awarding the contract, strategies that may be considered are:

1. **Price-based award strategy** – used when the contract will be awarded to the lowest-priced, technically acceptable proposal
2. **Best-value award strategy** – used when:

    - the contract may be awarded to either the lowest-priced, technically acceptable offer or
    - a higher-priced proposal offering a higher level of performance.
    - the procuring organization conducts trade-offs among price, performance, and other nonprice factors to select the proposal that offers the overall best value to the buyer.

Once a vendor is selected, the project plans and documents are updated to incorporate vendor dates, resources, costs, quality requirements, risks etc. The vendor then becomes a project stakeholder. Information in the Stakeholder Performance Domain and Measurement Performance Domain will apply to the vendor throughout the project.

Bidder conferences are also held as part of debriefing sessions whereby the bidders are informed as to why their bids did not win the contract. Bidders who feel that their bid or proposal was not evaluated correctly can submit a "bid protest." A bid protest is not necessarily a complaint that the wrong company won the contract but that their proposal was not evaluated correctly.

4.4 Contract Types

There are three primary types of contracts – fixed price, cost reimbursable, and time and materials. The objective is to select the type that creates the fairest and most workable deal for both parties – the project team (client) and the contractor (vendor).

Fixed-Price Contracts

In a fixed price contract, no matter how much time or effort goes into the project, the project always pays the same. As displayed in *Exhibit 4.2*, the cost to the client remains unchanged while the profit to the vendor decreases as more effort is exerted.

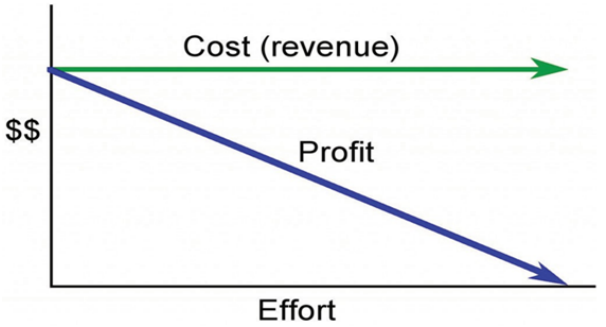

Exhibit 4.3: In a fixed-price contract, the cost to the project is constant regardless of effort applied or delivery date. Project Management for Scientists and Engineers

The **fixed-price contract** is a legal agreement between a client

(the organization leading the project) and a vendor (person or company) that will provide goods or services for the project at an agreed-on price. The vendor is responsible for incorporating all costs, including profit, into the agreed-on price. The vendor also assumes the risks for unexpected increases in labour and materials needed to provide the service or materials and in the materials and timeliness required.

The contract usually details the quality of the goods or services, timing needed to support the project, and price for delivering goods or services. There are several variations of the fixed-price contract. The fixed-price contract offers a predictable cost for commodities, goods, and services where the scope of work is evident and unlikely to change. The responsibility for managing the work to meet the needs of the project is focused on the vendor. The project team tracks the quality and schedule progress to ensure the vendor(s) will meet the project needs. Contracts carry a degree of risk. For fixed-price contracts, the risks are the costs associated with project change. If a change occurs on the project that requires a change order from the vendor, the price of the change is typically very high.

Fixed-price contracts require the availability of vendors with appropriate qualifications and performance histories to ensure that the project's needs can be met. The other requirement is a scope of work that is most likely not going to change—developing a clear scope of work based on good information, creating a list of highly qualified bidders, and developing a clear contract that reflects that scope of work is critical aspects of a good fixed-priced contract. As a result, solutions developed in an iterative fashion (like agile) are generally more challenging to manage with fixed-price contracts.

The **fixed-price contract with price adjustmen**t is used for unusually long projects that span years. The main difference is that it considers inflation-adjusted prices. In some countries,

the value of its local currency can vary significantly in a few months, which affects the cost of local materials and labour. In periods of high inflation, the contract price is adjusted accordingly. If the adjustment is determined upfront and included in the fixed price, the project accepts the risk that the actual inflation rate is lower than stipulated in the contract, and the vendor runs the risk that the actual inflation is higher than stipulated. The volatility of certain commodities can also be accounted for in a price adjustment contract. For example, if the price of oil significantly affects the project's costs, the contract can allow for an adjustment based on a change in the price of oil.

The **fixed-price contract with incentive fee** provides an incentive for performing better than stipulated in the contract. A common example is delivering ahead of schedule.

If the service or materials can be measured in standard units, but the amount needed is not known accurately, the price per unit can be fixed—a **fixed-unit-price contract**. The project team assumes the responsibility of estimating the number of units used. If the estimate is inaccurate, the contract does not need to be changed, but the project will exceed the budgeted cost.

Type	Known Scope	Share of Risk	Incentive for Meeting Milestones	Predictability of Cost
Fixed total cost	Very High	All vendor	Low	Very high
Fixed unit price	High	Mostly project	Low	Medium
Fixed price with incentive fee	High	All vendor	High	Medium-high
Fixed fee with price adjustment	High	Depends on how the adjustment will occur *(before or after the trigger for adjustment arises)*	Low	Medium

Cost-Reimbursable Contracts

Cost reimbursable contracts are also called **cost-plus contracts**. This is where the vendor charges you for the cost of doing the work plus some negotiated fee or rate. *Exhibit 4.4* illustrates this by showing that as efforts increase, costs to the client also increase while the vendor's profits stay the same.

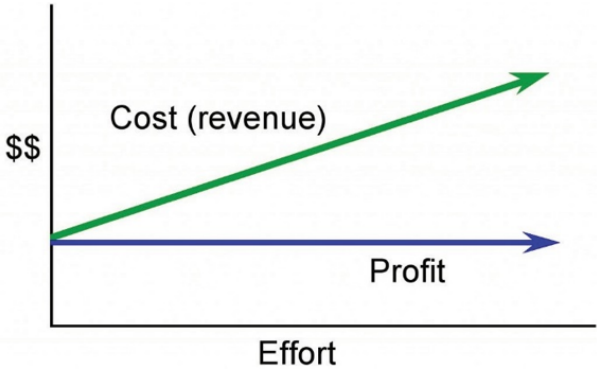

Exhibit 4.4: The vendor is guaranteed a profit in a cost-reimbursable or cost-plus contract, but the project's costs can increase based on effort. Project Management for Scientists and Engineers

In a **cost-reimbursable contract**, also known as **cost-plus contracts**, the organization agrees to pay the vendor for the cost of performing the service or providing the goods. Cost-reimbursable contracts are most often used when the scope of work or the costs for performing the work are not well known.

The project uses a cost-reimbursable contract to pay the contractor for allowable expenses related to performing the work. Since the cost of the project is reimbursable, the vendor has much less risk associated with cost increases. When the costs of the work are not well known, a cost-reimbursable contract reduces the amount of contingency the bidders place in their bid to account for the risk associated with potential increases in costs. This type of contract is often well-suited to projects using the agile development methodology.

This is quite different from fixed-price contracts, where vendors try to include as much contingency as possible in their bids to protect their profit margin. In these types of contracts, the vendor is less motivated to find ways to reduce the cost

of the project as there is no incentive to do so – the client will reimburse costs incurred by the vendor, even if they are unnecessarily high, as the work is completed. One way to limit excessive costs imposed by vendors is to include incentives for supporting the accomplishment of project goals.

Cost-reimbursable contracts require good documentation of the costs that occurred on the project to ensure that the vendor receives payment for all the work performed *and* that the organization is not paying for something that was not completed. The vendor is also guaranteed a profit over and above cost reimbursement. There are several ways to compensate the vendor:

- A **cost-reimbursable contract with a fixed fee** provides the vendor with a profit amount, often referred to as a fee, determined at the beginning of the contract and does not change.
- A **cost-reimbursable contract with a percentage fee** provides the vendor with a percentage of the allowable costs as profit. For instance, the fee could be 5% of total allowable costs. The vendor is reimbursed for allowable costs and is compensated with a fee that changes as the costs change.
- A **cost-reimbursable contract with an incentive fee** is used to encourage performance in areas critical to the project. Often the contract attempts to motivate vendors to save or reduce project costs. For instance, besides being reimbursed for allowable costs, the vendor (a talent scout) receives a predetermined bonus fee for each musician who signs on with the record label at a very attractive price.
- A **cost-reimbursable contract with award fee** reimburses the vendor for all allowable costs plus a fee based on performance criteria. The fee is typically based on goals or objectives that are more subjective. An amount of money

is set aside for the vendor to earn through excellent performance, and the decision on how much to pay the vendor is left to the judgment of the project team. The amount is sufficient to motivate excellent performance. For instance, besides being reimbursed for allowable costs, a music producer receives an award fee from the record label based on the album's rating.

Cost Reimbursable (CR)	**Known Scope**
CR with fixed fee	Medium
CR with percentage fee	Medium
CR with incentive fee	Medium
CR with award fee	Medium
Time and Materials	Low

Time and Material Contracts

In a time and materials contract, the client pays a rate for the time spent working on the project and pays for all the materials used to do the work. *Exhibit 4.5* demonstrates that as costs to the client increase, so does the profit for the vendor.

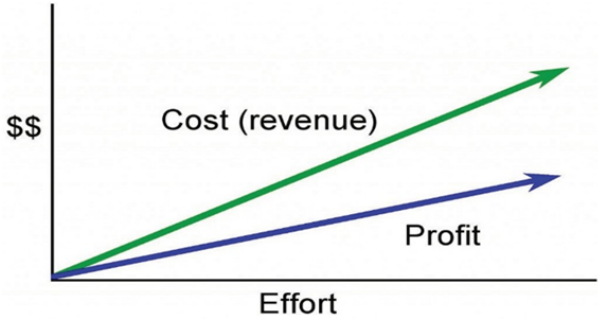

Exhibit 4.5: In a time-and-materials contract, the profit to the vendor increases with increased effort, as do the costs to the project. Project Management for Scientists and Engineers

For project activities with a high level of uncertainty, the vendor might charge an hourly rate for labour, the cost of materials, plus a percentage of the total costs. This type of contract is called **time and materials** (T&M). Time is usually contracted on an hourly rate, and the vendor would often be required to submit timesheets and receipts for items purchased for the project. The project reimburses the vendor for the time spent at the agreed-on rate and the actual cost of the materials. The fee, which becomes the vendor's profit margin, is typically a percentage of the total cost.

T&M contracts are used on projects for work that is smaller in scope and has uncertainty or risk. This is often well suited to projects following the agile development methodology. The project, rather than the vendor, assumes all the risk. However, this can be particularly challenging if there are no limits to the amount of effort and materials that can be applied.

To minimize the risk to the project, the vendor typically includes a not-to-exceed amount, which means the contract can only charge up to the agreed amount. The T&M contract

allows the project to adjust the contract as more information about the project's end solution becomes available. The final cost of the work is not known until sufficient information is available to complete a more accurate estimate.

Since there are numerous contract-type alternatives, deciding which type is appropriate for any given project can be challenging. The following considerations can help project teams identify the best alternative for the project:

1. Is the required work or materials a commodity, customized product or service, or unique skill or relationship?
2. How well-known is the scope of work?
3. What are the risks, and which party should assume which types of risk?
4. Does the procurement of the service or goods affect activities on the project schedule's critical path, and how much float is there on those activities?
5. How important is it to be sure of the cost in advance?

4.5 Control Procurement

Progress Payments and Change Management

Vendors usually require payments during the life of the contract. On contracts that last several months, the vendor will incur significant costs and will want the project to pay for these costs as early as possible. Rather than wait until the end of the contract, a schedule of payments is typically developed as part of the contract and is connected to the completion of a defined amount of work or project milestones. These payments made before the end of the project and based on the progress of the work are called progress payments.

For example, the contract might develop a payment schedule that pays for the design of the solution, then the development of the solution, and then a final payment is made when the solution is completed and accepted. In this case, there would be three payments made. There is a defined amount of work to be accomplished, a time frame for accomplishing that work, and a quality standard the work must achieve before the vendor is paid for their work.

Just as the project has a scope of work that defines what work will be done by the project team and what will be outsourced, vendors and suppliers have a scope of work that defines what they will produce or supply to the company. Often changes occur on the project that requires adjustments to the vendor's scope of work. How these changes will be managed during the life of the project is typically documented in the contract.

Capturing these changes early, documenting what changed and how the change impacted the contract, and developing a change order (a change to the contract) is important to maintaining the project's progress. Conflict among team members may arise when changes are not documented or when the team cannot agree on the change. Developing and implementing an effective change management process for vendors will minimize this conflict and the potential negative effect on the project.

Managing the Contracts

The contract type determines the level of effort and the skills needed to manage the contract. The individual responsible for managing the contracts develops detailed specifications and ensures compliance with these specifications. They track the vendor's performance against the project needs, as outlined in measurable performance evaluation criteria, supplying support and direction when needed.

Items that take a long time to acquire—long-lead items—receive early attention from the project team. An example of a long-lead item is equipment that must be designed and built specifically for the project. The equipment might require weeks, months, or years to develop and complete.

Occasionally, vendors do not perform to project expectations. Some project leaders will refer to the contract and impose penalties in an attempt to persuade the vendor to improve performance. Other project leaders will first brainstorm ways that the vendor could improve performance and meet project requirements before penalties are imposed. Both approaches to deal with non-performing vendors can work, and the project team must assess what method is most likely to work in each situation.

Managing vendor performance on a project is as important to the overall project outcomes as the work performed by the project team.

Procurement Management

Monitoring procurement includes ensuring the vendors' performance meets the agreed-upon, often contractual, requirements. The complexity of the project determines the number and type of vendors procured. This, in turn, determines the nature of the monitored activities. For instance, projects that only require supplies to be purchased externally will have much simpler vendor management processes than projects that had to outsource the completion of some of the work to external consultants. Key tools and techniques used in procurement management include inspections, audits, formal change control methods, vendor-produced performance reports, payment systems, and contract administration.

4.6 Traditional and Agile Procurement

Traditional procurement works on legacy systems and frameworks. Decisions are slow. Much time is taken with each procurement stage – identifying the needs, outlining the procurement plan, selecting suppliers, issuing RFQ, tender evaluation, contract terms & conditions, and supply chain management.

With agile procurement, on the other hand, time and speed are of the essence, so some steps are combined– for example – contract negotiations can be entered upon during the sourcing process.

Where traditional procurement employs a large team of professionals, agile procurement may opt for a select handful of people to form a cross-functional team. Individuals are chosen from the stakeholders – and may include procurement professionals, IT, legal, customer representatives, suppliers, and finance experts.

Agile procurement provides greater efficiency, is more effective, and has a faster time (speed) to market compared to traditional procurement. The simple, agile procurement definition states that "agile procurement is a type of procurement approach that is less strict, less orthodox, and more open and collaborative" (CPO Rising Report).

Agile procurement is not promoted as an alternative to contemporary procurement. It is simply an ally, an aide to strengthen current procurement strategies, i.e. complimentary. For example, agile procurement is a favored model because of its lean and fast approach in IT industries.

Reflective Exercise

- What criteria will you use to select a contractor?
- Why is developing your negotiation skills important in procurement management?

Key Takeaways

- The procurement plan includes determining the category of materials or services, choosing the type of contractual relationship, soliciting bids, selecting bidders, managing the work, and closing the contracts.
- The decisions made when selecting the type of contract are based on whether the materials can be provided by suppliers, vendors, or partners; how well defined the work is; how the risk will be shared; the importance of the task to the schedule; and the need for certainty of the cost.
- Companies that bid on contracts are evaluated on past performance and current financial status. RFQs and RFPs are sent to those companies. RFQs are evaluated on price and RFPs are evaluated on price and method.
- As part of the procurement process, long lead

time items are identified and monitored. Items that are critical to the schedule or delayed are assigned to an expediter. The logistics of handling delivery, storage, and transportation are determined. Work and materials are inspected for quality.

Additional Information

Low-Code Platform and Apps – Use the link to read more about Low-Code Platform and Apps to Modernize Police Operations.

5.0 PLANNING AND MANAGING PROJECT QUALITY

Learning Objectives

By the end of this section, you will be able to:

- Define Quality, Quality Management, Quality Control, and Cost Effectiveness
- Discuss the concept of cost of quality and why it is important
- Apply techniques and tools for managing project quality including plan quality, manage

quality, and control quality

- Discuss how integral quality is to all aspects of project management and performance domains
- Discuss the project manager's responsibility in quality management
- Apply appropriate models, artifacts, and methods for enabling project outcomes

Introduction

Quality management is all about identifying and following quality requirements, auditing the results of quality control measurements, and using quality measurements to control quality and recommending project changes if necessary. It is about ensuring that the client and stakeholders are satisfied with the deliverables of the project. Quality requirements may be reflected in the completion criteria, Definition of Done (DOD), which is a checklist of all the criteria required to be met so that a deliverable can be considered ready for customers, Statement of Work (SOW) or requirement documentation.

It is important to know at the onset of any project on what acceptable rate the quality is and how it will be measured on the project. This process of performing Quality Management process helps avoid many issues at a later stage of the project.

SHOW WHAT YOU KNOW

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=56#h5p-1

5.1 Quality Management

Ensuring that the project is done on time, on budget, and within scope is important, but there is more to project success. Project success also involves delivering the right solution that accomplishes the project's objective and satisfies stakeholders' expectations. This is the role of quality management. According to PMI PMBOK 7th edition, "quality is the degree to which a set of inherent characteristics fulfills requirements."

The requirements of a product or process can be categorized or given a grade that will provide a basis for comparison. The quality is determined by how well something meets the requirements of its grade. For most people, the term quality also implies good value—getting your money's worth. For example, even low-grade products should still work as expected, be safe to use, and last a reasonable amount of time. Project Quality Management includes the processes and activities that determine quality policies, objectives, and responsibilities to ensure that the project satisfies the needs for which it is undertaken.

Project Quality Management is composed of the following processes:

- Plan Quality Management
- Manage Quality
- Control Quality

High quality is achieved by planning for it rather than by reacting to problems after they are identified. Standards are chosen, and processes are put in place to achieve those standards. Similar to the triple constraints (scope, cost, and

schedule), quality is managed on a project by setting goals and taking measurements. It is important to understand the quality levels stakeholders believe are acceptable and ensure that the project meets those targets.

When the project team gathers requirements for the solution, they identify all of the specifications that stakeholders want in the product, so they know how to define and measure quality. "Fitness to use" ensures the product has the best design possible to fit the customer/client's needs. For example, you could pound in a nail with a screwdriver, but a hammer is a better fit for the job. Conformance to requirements is the core of customer satisfaction and fitness and measures how well the solution meets expectations. Above all, the solution must fulfill the requirements established by the users.

On large complex projects, a formal quality management plan is necessary. This plan should be developed with key stakeholders, including the end-user community. The plan will identify the quality expectations and the work required to ensure these expectations are fulfilled. Just as the project budget and completion dates may change over the life of a project, the project specifications may also change. The approach to managing change is dependent on the development methodology chosen. When the requirements for the solution are being defined upfront, as is the case with the predictive/waterfall methodology, formal change control processes are important as commitments regarding project duration and/or project cost have likely already been established.

Formally assessing changes in quality specifications allows the team to understand the impact on the commitments. In these situations, the impacts are communicated, and approvals are sought before implementation occurs. In projects using an adaptive/agile approach, the end solution cannot be clearly defined. The quality expectations will be defined when the capabilities, features, and user stories are

developed in cycles. Quality processes are conducted throughout the project.

Project management organizations that execute several similar types of projects may find process improvement tools helpful in identifying and improving the baseline processes used on their projects. Process improvement tools may also help identify cost and schedule improvement opportunities. Students wishing to learn more about these tools can begin by reading about Lean Six Sigma practices for products and their applicability to service organizations.

Ideally, opportunities for improvement are to be quickly identified in order to influence project performance. This is particularly true when the predictive/waterfall development methodology is used since planning is completed upfront. During later project stages, as pressures to meet project schedule goals increase, the culture of the project is less conducive to making changes in work processes. Many organizations have a quality policy that states how it measures quality across the organization. When planning quality in the project, project leaders must ensure that the project follows the company policy and any government rules or regulations.

Part of good quality planning includes identifying the tasks that need to be performed in order to measure the quality of the project's solution. These specific tasks will be part of the scope and considered when schedules and budgets are developed.

5.2 Tools and Techniques for Planning and Controlling Quality of Projects

Several different tools and techniques are available for planning and controlling the quality of a project. The extent to which these tools are used is determined by the project complexity and the organization's quality management program.

The following represents some of the quality planning tools in use today:

- **Cost-benefit analysis** looks at how much the quality activities will cost versus how much will be gained from doing them. Typical cost considerations include the effort and resources required to carry out the quality activities. Typical benefit considerations include greater user satisfaction, less reworking, and greater productivity.
- **Benchmarking** is using the results of quality planning from other projects to set goals for the current project. If the last project in the organization had 20% fewer defects than the one before it, the project team should learn from a project like that and put in practice any of the ideas the previous project used to make such a great improvement. Benchmarks can serve as reference points for evaluating a project before the work begins.
- **Design of experiments** is the list of the array of tests to be

run on the product. It might list all the kinds of test procedures, the approaches to be taken, and even the tests themselves. (In the software world, this is called *test planning*.)

- **Cost of quality** is obtained by adding up the cost of all the prevention and inspection activities to be performed on the project. This includes many different activities, such as testing, time spent writing standards, reviewing documents, meeting to analyze the root causes of defects, and reworking to fix defects identified by the team... in other words, absolutely everything that is done to ensure quality on the project. The cost of quality can be compared from one project to another to identify innovative ideas and best practices. The cost of quality model identifies four categories of cost associated with quality. Think of some examples of each:
    - **Prevention**: Prevention costs are incurred to keep defects and failures out of a product. They are planned and incurred before actual operations. E.g. Quality Assurance
    - **Appraisal:** Appraisal costs are associated with measuring and monitoring activities related to quality. E.g. Quality audits
    - **Internal Failure:** Internal failure costs are associated with finding and correcting defects before the customer receives the product. E.g. Wastes
    - **External Failure**: External failure costs are associated with defects found after the customer has the product and with remediation. E.g. Warranty claims
- **Control charts** can be used to define acceptable limits. If some of the functions of a project are repetitive, statistical process controls can be used to identify trends and keep the processes within control limits. Part of the planning for controlling the quality of repetitive processes is to determine what the control limits are and how the

process will be sampled.

- **Cause-and-effect diagrams** can help in discovering problems. When control charts indicate an assignable cause for a variation, it is not always easy to identify the cause of a problem. Discussions intended to discover the cause can be facilitated using a cause-and-effect, or **fishbone diagram**, where participants are encouraged to identify possible causes of a defect.

Example: Diagramming Quality Problems

A small manufacturing firm tries to identify the assignable causes of variations in its manufacturing line. They assemble a team that identifies six possibilities:

- Low-quality raw materials
- Power fluctuation
- Ambient temperature
- Worker absenteeism
- Poor training
- Old equipment

Each of these possibilities is organized into a fishbone diagram below.

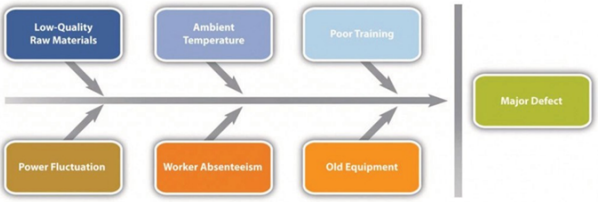

Exhibit 5.1: Cause-and-effect (fishbone) diagram.

Then, each branch of the diagram can be expanded to break down a category into more specific causes. An engineer and an electrician work on one of the branches to consider possible causes of power fluctuation. They identify:

- Utility reliability
- Personal space heaters and large motor start-up leading to overloaded circuits
- Lighting

Those items are added to their part of the fishbone diagram, as shown below.

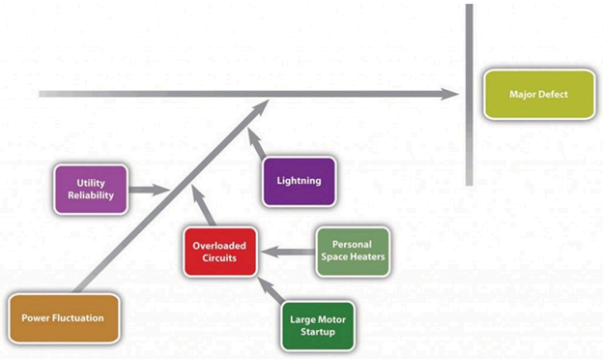

Exhibit 5.2: Cause-and-effect (fishbone) diagram expanded.

Check sheets, histograms, and Pareto charts are also used to solve several quality problems. When a quality-control issue occurs, a project leader must choose which problem to address first. One way to prioritize quality problems is to determine which ones occur most frequently. These data can be collected using a **check sheet**, a basic form on which the user can check in the appropriate box each time a problem occurs, or by automating the data collection process using the appropriate technology.

Motor Assembly Check Sheet

Name of Data Recorder: Lester B. Rapp

Location: Rochester, New York

Data Collection Dates: 1/17 - 1/23

Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Supplied parts rusted		8	5	4	2			20
Misaligned weld			3			2		5
Improper test procedure								0
Wrong part issued		1		2				3
Film on parts								0
Voids in casting				4	2			6
Incorrect dimensions						2		2
Adhesive failure								0
Masking insufficient					1			1
Spray failure			5					5
TOTAL		10	13	10	5	4		

Exhibit 5.3: Example of a check sheet. DanielPenfield, Wikimedia

Once the data are collected, they can be analyzed by creating a type of frequency distribution chart called a **histogram**. A true histogram is a column chart where the widths of the columns fill the available space on the *x*-axis axis and are proportional to the category values displayed on that axis, while the height of the columns is proportional to the frequency of occurrences. Most histograms use one column width to represent a category, while the vertical axis represents the frequency of occurrences.

A variation on the histogram is a frequency distribution chart invented by economist Vilfredo Pareto known as a **Pareto chart**. The columns are arranged in decreasing order, with the most common on the left and a line added that shows the cumulative total. The combination of columns and a line allows the user to tell at a glance which problems are most frequent and what fraction of the total they represent. For instance, in *Exhibit 5.4*, there are six reasons why travelers arrive late at the airport. Traffic is the number one reason, and 55 participants reported it. Approximately 154 people participated in this study.

Traffic represents approximately 36% of the total late arrivals (55/154). The second highest cause, child care issues, represents

26% of the total. Cumulatively, traffic and child care issues represent 62% of the total. The third cause, public transportation issues brings the cumulative total to approximately 80% of the total. Understanding what causes the majority of the issues allows a team to prioritize and focus on these key factors. In this case, if the airport wanted to reduce the number of late arrivals, they could focus on traffic, childcare, and public transportation issues.

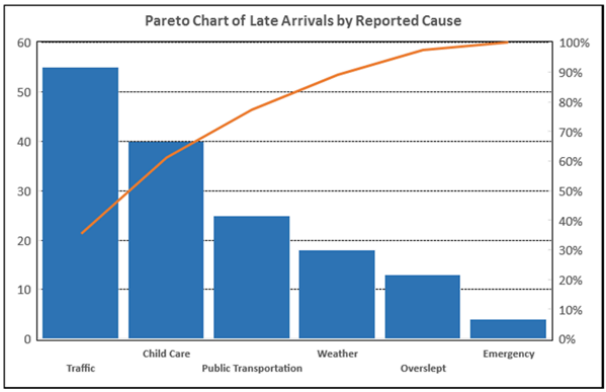

Exhibit 5.4: Example of Pareto chart. Dense2013, Wikimedia

Other tools include:

- Surveys and Questionnaires
- Meetings
- Brainstorming
- Affinity diagrams
- Nominal group techniques
- Matrix diagrams
- Prioritization matrices
- Force field analysis

5.3 Measurement Terminology

During implementation, services and products are sampled and measured to determine if the quality is within control limits for the requirements and to analyze possible causes for any quality variations. A separate quality control group often does this evaluation, and knowledge of a few process measurement terms is necessary to understand their reports. Several of these terms are similar, and it is valuable to know the distinction between them.

Project teams can identify the control limits of the product or process. The size of the range between those limits is the **tolerance**. Tolerances are often written as the mean value, plus or minus (±) the tolerance.

Tools are selected that can measure the samples closely enough to determine if the measurements are within control limits and whether any trends emerge. Each measurement tool has its own tolerances.

The choice of tolerance directly affects the cost of quality (COQ). In general, it costs more to produce and measure products that have small tolerances. The costs associated with making products with small tolerances for variation can be very high and not proportional to the gains. For example, suppose the cost of evaluating each screen as it is created in an online tutorial is greater than delivering the product and fixing any issues after the fact. In that case, the COQ may be too high, and the instructional designer will tolerate more defects in the design.

Statistics

Determining how well products meet grade requirements is done by taking and interpreting measurements. **Statistics**, the mathematical interpretation of numerical data, are useful when interpreting large numbers of measurements to determine how well the product meets a specification (when the same product is being made repeatedly). Measurements made on product samples must be within **control limits**, which are the upper and lower extremes of allowable variation. It is up to the project team to design a process that will consistently produce products between those limits.

Suppose a process is designed to produce a product of a certain size or another measured characteristic. In that case, it is impossible to control all the small factors that can cause the product to differ slightly from the desired measurement. Some of these factors will produce products with larger measurements than desired, and some will have the opposite effect. If several random factors affect the process, they tend to offset each other, and the most common results are near the middle of the range; this phenomenon is called the **central limit theorem**.

If the range of possible measurement values is divided equally into subdivisions, referred to as **bins**, the measurements can be sorted, and the number of measurements that fall into each bin can be counted. The result is a **frequency distribution** that shows how many measurements fall into each bin. If the effects causing the differences are random and tend to offset each other, the frequency distribution is called a **normal distribution**, which resembles the shape of a bell with edges that flare out. The edges of a theoretical normal distribution curve get very close to zero but do not reach zero.

Quality Assurance

The purpose of quality assurance is to create confidence that the quality plan and controls are working correctly. Time must be allocated to review the original quality plan and compare that plan to how quality is ensured during the project's implementation.

Process Analysis

The flowcharts of quality processes are compared to the processes followed during actual operations. If the plan was not followed, the process is analyzed, and corrective action is taken. The corrective action could be to educate the people involved on how to follow the quality plan, or it could be to revise the plan.

The experiments that sample products/processes and collect data are examined to see if they are following statistically valid sampling techniques and that the measurement methods have small enough tolerances to detect variation within control limits.

Because projects are temporary, there are fewer opportunities to learn and improve within a project, especially if it has a short duration. But even in short projects, the quality manager should have a way to learn from experience and change the process for the next project of a similar complexity profile.

Quality assurance: Aims to build confidence in the user that quality standards and procedures are being followed. This is done by an internal review of the plan, testing, and revision policies. Or by an audit of the same items performed by an external group or agency.

Quality audits: A quality audit reviews the quality plan to

determine whether the project activities comply with organizational and project policies, processes, and procedures.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.bccampus.ca/projectcostsrisksqualityprocurement/?p=65#oembed-1

Quality reviews: A formal procedure for reviewing a product, system or service against quality criteria set forth by the project organization. Quality reviews are planned and documented inspections of the project. They represent a significant effort in terms of required resources. If the reviews identify errors, the cost of quality becomes less since the earlier an error is identified, the better the project's success. Examples of quality reviews include:

- Expert reviews
- Peer reviews
- Team reviews
- Walk-through reviews
- Formal reviews
- Management reviews
- Process reviews

Inspections: An inspection is a formal evaluation involving measurements and tests. Quality must be plan in and prevented, and not inspected.

Gold Plating

Gold plating is all about giving the customer extra value to the product (more functionality, higher-quality parts, more scope than required, higher performance). Some organizations have a policy that promotes adding value to customers and going beyond to fulfill their requests, although advanced quality thinkers and PMI do not recommend it. The team's impression of what is valued by the customer and what the customer does not want is often called gold plating. Gold plating can be done on certain projects and may not be done on certain others. This creates a gap in customers' expectations, and hence gold plating is not recommended.

Continuous Improvement

Continuous Improvement is about continuously looking for small improvements in the process. The term "Continuous Improvement" also means Kaizen in Japanese, where Kai means Change and Zen means for the better.

Quality reports: A quality report includes quality management issues, recommendations for corrective actions, and a summary of findings from quality control activities. It may consist of recommendations for processes, projects, and product improvement.

Just In Time (JIT)

The concept of JIT involves having the suppliers deliver raw materials just when they are needed, thus reducing inventory to close to zero. JIT has supplemented reduction in high inventory costs, which is unnecessary.

Total Quality Management (TQM)

This philosophy encourages companies and their employees to focus on continuously improving the quality of their products and business practices at every level of the organization.

Responsibility For Quality

The ultimate responsibility of the product or project quality lies with the project manager and project team members. However, the organization has a responsibility relating to quality.

Reflective Exercise

- What is the impact of inferior quality?

Agile projects often use quality development techniques

Agile projects often use quality development techniques, many of which originated in Extreme Programming (XP) and were used in software projects. These techniques are now being adapted for use in other project types. Some of these techniques are *Test-driven development (TDD)*, *Pair programming, Peer review, Collective code ownership*, and *Continuous integration*.

Key Takeaways

- Managing project quality enables you to go from identifying customer needs to achieving customer satisfaction
- Effective quality management is consistent with effective project management.
- Managing project quality is tightly connected with:
    - Managing requirements/scope
    - Managing stakeholder/customer expectations
    - Managing risks
    - Provide clear communications
    - Provide clear completion/acceptance criteria.

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Chapter 1

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Introduction to the Project Management Environment

Team Formation, Team Management, and Project Leadership

Background of Agile

Selecting Projects

Non – financial /Financial Selection/Cost Benefit Analysis

Working with Indigenous Peoples

7 Tips on Building Relationships with Indigenous Peoples

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Chapter 5

Glossary

The terms are consistent with PBMOK 7th edition.

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Glossary

Actual Cost (AC)

The realized cost incurred for the work performed on an activity during a specific time period.

Affinity Grouping

The process of classifying items into similar categories or collections on the basis of their likeness.

Agile

A term used to describe a mindset of values and principles as set forth in the Agile Manifesto.

Ambiguity

A state of being unclear, having difficulty in identifying the cause of events, or having multiple options from which to choose.

Baseline

The approved version of a work product, used as a basis for comparison to actual results.

Benchmarking

The comparison of actual or planned products, processes, and practices to those of comparable organizations to identify best practices, generate ideas for improvement, and provide a basis for measuring performance.

Bid Documents

All documents used to solicit information, quotations, or proposals from prospective sellers.

Budget

The approved estimate for the project or any work breakdown structure (WBS) component or any schedule activity.

Budget at Completion (BAC)

The sum of all budgets established for the work to be performed.

Complexity

A characteristic of a program or project or its environment that is difficult to manage due to human behavior, system behavior, and ambiguity.

Contingency

An event or occurrence that could affect the execution of the project, which may be accounted for with a reserve.

Contingency Reserve

Time or money allocated in the schedule or cost baseline for known risks with active response strategies.

Contract

A mutually binding agreement that obligates the seller to provide the specified product, service, or result and obligates the buyer to pay for it.

Control

The process of comparing actual performance with planned performance, analyzing variances, assessing trends to effect process improvements, evaluating possible alternatives, and recommending appropriate corrective action as needed.

Control Chart

A graphic display of process data over time and against established control limits, which has a centerline that assists in detecting a trend of plotted values toward either control limit.

Cost Baseline

The approved version of the time-phased project budget, excluding any management reserves, which can be changed only through formal change control procedures and is used as a basis for comparison to actual results.

Cost Estimation

The process of estimating all of the costs associated with completing a project within scope and according to its timeline.

Cost of Quality (COQ)

All costs incurred over the life of the product by investment in preventing nonconformance to requirements, appraisal of the product or service for conformance to requirements, and failure to meet requirements.

Cost Performance Index (CPI)

A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost.

Cost Plus Award Fee Contract (CPAF)

A category of contract that involves payments to the seller for all legitimate actual costs incurred for completed work, plus an award fee representing seller profit.

Cost Plus Fixed Fee Contract (CPFF)

A type of cost-reimbursable contract where the buyer reimburses the seller for the seller's allowable costs (allowable costs are defined by the contract) plus a fixed amount of profit (fee).

Cost Plus Incentive Fee Contract (CPIF)

A type of cost-reimbursable contract where the buyer reimburses the seller for the seller's allowable costs (allowable costs are defined by the contract), and the seller earns its profit if it meets defined performance criteria.

Cost-Benefit Analysis

A financial analysis method used to determine the benefits provided by a project against its costs.

Cost-Reimbursable Contract

A type of contract involving payment to the seller for the seller's actual costs, plus a fee typically representing the seller's profit.

Definition of Done (DoD)

A checklist of all the criteria required to be met so that a deliverable can be considered ready for customer use.

Digital Transformation

Changing the way business gets done and, in some cases, creating entirely new classes of businesses.

Digitalization

The use of digital data to simplify the way work is done.

Digitization

The process of converting information from analog to digital.

Discounted Cash Flow

A valuation method used to estimate the value of an investment based on its expected future cash flows.

Earned Value (EV)

The measure of work performed expressed in terms of the budget authorized for that work.

Estimate

A quantitative assessment of the likely amount or outcome of a variable, such as project costs, resources, effort, or durations.

Estimate at Completion (EAC)

The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete.

Estimate to Complete (ETC)

The expected cost to finish all the remaining project work.

Expected Monetary Value (EMV)

The estimated value of an outcome expressed in monetary terms.

Firm Fixed Price Contract (FFP)

A type of fixed-price contract where the buyer pays the seller a set amount (as defined by the contract), regardless of the seller's costs.

Fixed Price Incentive Fee Contract (FPIF)

A type of contract where the buyer pays the seller a set amount (as defined by the contract), and the seller can earn an additional amount if the seller meets defined performance criteria.

Fixed-Price Contract

An agreement that sets the fee that will be paid for a defined scope of work regardless of the cost or effort to deliver it.

Governance

The framework for directing and enabling an organization through its established policies, practices, and other relevant documentation.

Histogram

A bar chart that shows the graphical representation of numerical data.

Internal Rate of Return (IRR)

The annualized effective compounded return rate OR the discount rate that makes the net present value of all cash

flows (both positive and negative) from a particular investment equal to zero.

Leadership

Using one's interpersonal skills in order to guide, motivate and direct a team.

Lease-or-Buy Analysis

A technique used to determine if needed equipment should be purchased or leased on a project.

Make-or-Buy Analysis

The process of gathering and organizing data about product requirements and analyzing them against available alternatives including the purchase or internal manufacture of the product.

Management Reserve

An amount of the project budget or project schedule held outside of the performance measurement baseline for management control purposes that is reserved for unforeseen work that is within the project scope.

Monte Carlo Simulation

A method of identifying the potential impacts of risk and uncertainty using multiple iterations of a computer model to develop a probability distribution of a range of outcomes that could result from a decision or course of action.

Net Present Value

The difference between the project's current value of cash inflow and the current value of cash outflow.

Opportunity

A risk that would have a positive effect on one or more project objectives.

Opportunity Cost

The cost that is given up when selecting another project.

Organization Environment

Represents the organization governance, policies, organizational culture and supporting practices of the organization that are created to support OPM and organizational strategy delivery and the system must be set up for value delivery.

Payback Period

The ratio of the total cash to the average per period cash.

Planned Value (PV)

The authorized budget assigned to scheduled work.

Portfolio

Projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives.

Principle

A norm, rule, value or fundamental truth which serve as a guide for behaviour or action.

Procurement Management Plan

A component of the project or program management plan that describes how a project team will acquire goods and services from outside of the performing organization.

Product

An artifact that is produced, is quantifiable, and can be either an end item in itself or a component item.

Program

Related projects, subsidiary programs, and program activities that are managed in a coordinated manner to obtain benefits not available from managing them individually.

Project

A temporary endeavour undertaken to create a unique product, service, or result.

Project Governance

The framework, functions, and processes that guide project management activities in order to create a unique product, service, or result to meet organizational, strategic, and operational goals.

Project Management Body of Knowledge (PMBOK)

A term that describes the knowledge within the profession of project management.

Project Management Office (PMO)

A management structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques.

Project Management Process Group

A logical grouping of project management inputs, tools and techniques, and outputs. The Project Management

Process Groups include Initiating processes, Planning processes, Executing processes, Monitoring and Controlling processes, and Closing processes.

Psychological safety

A shared belief held by members of a team that the team is safe for interpersonal risk taking.

Quality

The degree to which a set of inherent characteristics fulfills requirements.

Risk

An uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives.

Risk Acceptance

A risk response strategy whereby the project team decides to acknowledge the risk and not take any action unless the risk occurs.

Risk Avoidance

A risk response strategy whereby the project team acts to eliminate the threat or protect the project from its impact.

Risk Breakdown Structure

A hierarchical representation of potential sources of risks.

Risk Enhancement

A risk response strategy whereby the project team acts to increase the probability of occurrence or impact of an opportunity.

Risk Exploitation

A risk response strategy whereby the project team acts to ensure that an opportunity occurs.

Risk Management Plan

A component of the project, program, or portfolio management plan that describes how risk management activities will be structured and performed.

Risk Mitigation

A risk response strategy whereby the project team acts to decrease the probability of occurrence or impact of a threat.

Risk Sharing

A risk response strategy whereby the project team allocates ownership of an opportunity to a third party who is best able to capture the benefit of that opportunity.

Risk Transference

A risk response strategy whereby the project team shifts the impact of a threat to a third party, together with ownership of the response.

Self-Organizing Team

A cross-functional team in which people assume leadership as needed to achieve the team's objectives.

Stakeholder

An individual, group, or organization that may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio.

Volatility

The possibility for rapid and unpredictable change.