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Turning Ideas into Engineering Projects

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1. Introduction

Ideas typically turn into engineering projects through a structured process that assesses their viability and gains formal authorization. This transformation occurs within the initiation phase of the project life cycle.

The following are common steps in the transformation process:

1. **Idea Generation**: Projects usually start as an initial thought, a business need, a problem to be solved, or an opportunity to be capitalized on. For example, a new technology is proposed to reduce frequent production failures.
2. **Feasibility Study**: The idea or opportunity is then analyzed to determine if it is viable. This assessment considers various factors including Technical, Economical, and Operational feasibility. Many ideas do not progress further due to being not viable, questionable, high risk, or lower priority.
3. **Go/No-Go Evaluation**: A Go/No-Go form is filled out based on the feasibility study results, and a decision is made to “Go” to next step if the idea or opportunity is deemed viable.
4. **Business Case**: If the idea is deemed viable, a formal business case is developed. This document uses the feasibility results to outline the problem or opportunity, the proposed solution, the benefits, the estimated costs, the timeline, and potential risks. It serves to justify the investment of resources.
5. **Stakeholder Approval**: The business case is presented to key stakeholders, such as senior management. Their review and approval are essential to secure the necessary funding and authority to move forward.
6. **Project Charter**: Upon approval, a project charter is created. This officially recognizes the existence of the project and provides the project manager with the authority to apply organizational resources to project activities. A project charter defines the high-level scope, objectives, and key stakeholders. Once the project charter is approved, the idea officially becomes a project, and the project manager can move into the planning phase to outline exactly how the objectives will be achieved.



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The above steps vary greatly by organization and industry. However, the general approaches and principles apply to nearly any application that results in the development of engineering projects.

This course covers the idea transformation process, as roughly outlined above. First, key definitions and background knowledge is presented to allow a better understanding and context for each step.



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2. What is a Project?

A project is a temporary endeavor with a beginning and an end, aiming to create a unique product, service, or result. An “engineering project” involves alterations to physical property with works of an engineering nature and often requires design input from more than one discipline or field. Engineering projects are often referred to as capital improvement projects.

Engineering projects are very different from other projects such as software development or business initiative projects. However, the project development process is surprisingly similar across all types of projects. The processes outlined in this course apply to both engineering and non-engineering projects.

The most widely accepted standard for project management principles is the *Guide to the Project Management Body of Knowledge* (PMBOK® Guide) and *The Standard for Project Management*. PMBOK is a registered mark of the Project Management Institute, Inc. (PMI). Fundamental recommendations are provided which are widely accepted across a variety of project types and delivery methods.

The PMBOK® Guide defines five process groups: Initiation, Planning, Execution, Monitoring and Controlling, and Closing. The Seventh Edition shifted from a process-oriented approach to one based on principles and performance domains, emphasizing adaptability and value delivery. The Initiation group directly relates to the content in this course, including a feasibility study, business case, stakeholder approval, and project charter.

Traditional linear and stage-gate management approaches are called waterfall methods. Adaptive and iterative management approaches are called Agile methods. A combination of the two is called a hybrid method.



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3. Portfolio vs Program vs Project

Most organizations manage a portfolio of multiple projects. Projects that are closely related can be grouped together to form a “program”. The management of the portfolio and the programs is just as important as the management of the projects, and together a well-managed portfolio has a big impact on achieving goals for an organization.

The following definitions help distinguish between portfolios, programs, and projects:

Portfolio management = Oversight of multiple projects and programs

Program management = Oversight of multiple related projects with overlapping schedules and common objectives

Project management = Management of a single project with specific objectives



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Example Portfolio

Figure 1 shows an example of an electronic parts production company with a portfolio of projects and two programs. The first program in **green** is for changes needed in the production of Product B, both to increase production efficiency and to add new features. There are two projects for this program, each at a different facility.

The second program in **orange** is to expand two facilities to allow for the production of a new item called Product C. There are currently two facilities to be upgraded: Plant 1 and Plant 2. Thus, the Product C program has two projects, one for Plant 1 and one for Plant 2. If an additional facility upgrade is needed in the future, a third project would be added to the Product C program.

The last project in **brown** is for an upgrade to the standby generator at Plant 1. Since there are no related projects, it is not considered part of a program. If the company had an initiative to assess and upgrade several standby generators, then together those projects could be considered a program.

A standalone improvement project that is broken into multiple stages (study, preliminary design, final design, bidding, construction) is NOT considered a program.

Note that each program is assigned a number, and the projects within that program have a related number. This makes document management easier.

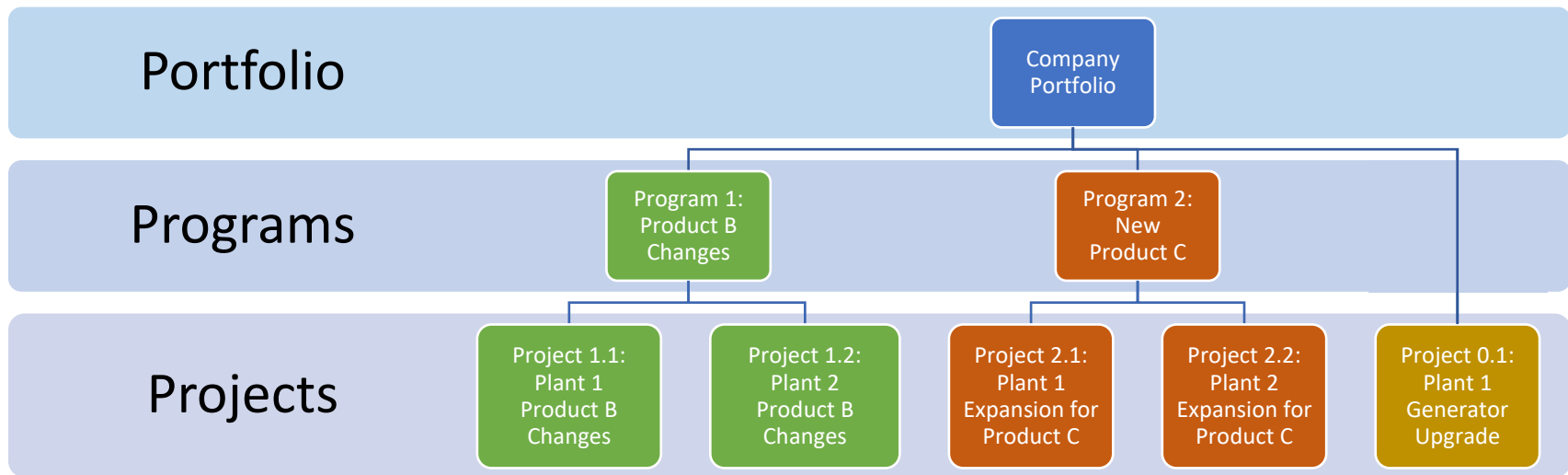


Figure 1: Depiction of a company with a portfolio of projects.
 The program in **green** has projects related to revisions needed for Product B.
 The program in **orange** has projects related to production of a new Product C.
 The project in **brown** is unrelated to all other active projects and so is not part of a program.

Source: Author

The following table helps to compare portfolios, programs, and projects at a high-level.

Table 1: Comparing Portfolios, Programs, and Projects			
	Portfolio	Program	Project
Definition	A portfolio is a collection of projects and programs managed as a group to achieve common goals.	A program is a group of related projects that are managed together and have some common goals.	A project is a temporary endeavor with a beginning and an end, aiming to create a unique product, service, or result.
Responsible	Portfolio Director	Program Manager	Project Manager
Management	Portfolio managers may manage or coordinate portfolio management staff, or program and project staff that may have reporting responsibilities into the aggregate portfolio.	Programs are managed by program managers who ensure that program benefits are delivered as expected, by coordinating the activities of a program's components.	Project managers manage the project team to meet the project objectives.
Scope	High-level scope that changes with the strategic objectives of the organization. Also, the sum of the program and project scopes.	Sum of the scopes of program components. Subject to changes within projects.	Initial requirements defined. Written scope is progressively elaborated and changed throughout the project life cycle.
Planning	Portfolio managers are elected to create and maintain necessary processes and communication relative to the aggregate portfolio.	Programs are managed using high-level plans that track the interdependencies and progress of program components. Program plans are also used to guide planning at the component level.	Project managers progressively elaborate high-level information into detailed plans throughout the project life cycle. A work breakdown structure (WBS) helps to manage tasks.
Management Plan	A portfolio management plan is sometimes created. Often a PMO will issue guidelines and define processes and procedures.	A program management plan is sometimes developed, with reference to project management plans.	A project management plan is typically developed, with sections on scope, budget, schedule, risk, communication, etc.
Changes and Adding Components	Portfolio managers continuously monitor changes in the broader internal and external environments.	Programs are managed in a manner that accepts and adapts to change as necessary to optimize the delivery of benefits as the program's components deliver outcomes and/or outputs.	Project managers expect change and implement processes to keep change managed and controlled.
Monitoring	Portfolio managers monitor strategic changes, resource allocation, performance results, and risks for the overall portfolio.	Program managers monitor the progress of program components to ensure the overall goals, schedules, budget, and benefits will be met.	Project managers monitor and control the work of producing the agreed deliverables within schedule and budget constraints.
Achieving Goals	Success is measured in terms of the performance and benefit realization of the overall portfolio.	Success is measured by the program's ability to deliver its intended benefits to an organization, and by the program's efficiency and effectiveness.	Success is measured by deliverable quality, timeliness, budget compliance, and degree of customer/client/user satisfaction.
Benefits to Organization	Portfolios provide strategic alignment, resource optimization, improved decision making, efficiency, and risk management.	Programs help ensure that the component outcomes are delivered in a coordinated and complementary manner.	Projects have defined objectives and defined benefits to the organization, per the business case.

Example Portfolios

Large companies often have multiple portfolios of projects such as in different departments or divisions. A corporate project management office (PMO) gives guidance to all portfolios.

Examples of portfolios include:

- An engineering company has three portfolios:
 - Urban planning projects (15 active)
 - Civil projects (24 active)
 - Building projects (10 active)
 - Utilities projects (8 active)

- A construction company has two portfolios:
 - General contractor projects (30 active)
 - Electrical contractor projects (12 projects)
 - Internal improvement projects (5 active)

- A consulting company has three portfolios:
 - Internal projects (4 active)
 - Public projects (46 active)
 - Private projects (31 active)

- A pharmaceutical manufacturer has four portfolios:
 - Internal processes projects (2 active)
 - Facility improvement projects (3 active)
 - Drug development projects (6 active)
 - Clinical trial projects (4 active)

- A vehicle manufacturer has five portfolios:
 - Strategic improvement projects (8 active)
 - Facility improvement projects (12 active)
 - Sudan design projects (8 active)
 - SUV design projects (12 active)
 - Truck design projects (4 active)

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4. PMO vs PPMO

A Project Management Office (PMO) is a department or group that defines, maintains, and promotes project management standards and best practices across the business/organization, often including multiple portfolios. A PMO provides guidance, documentation, and tracks metrics. The goal is to empower project managers and program managers with tools, training, and procedures that help bring about success in projects.

A Project Portfolio Management Office (PPMO) helps manage a single portfolio by selecting, assessing, and prioritizing the projects and programs in a portfolio. The PPMO maintains alignment with an organization's objectives by making project adjustments. Although the term PPMO is rare in industry, portfolios always have some form of leadership and oversight.

Note that PMOs and PPMO normally don't directly participate in the formulation and selection of new projects. However, they do influence the initiation process for new projects.



Figure 2: Leadership concept. Both the PMO and PPMO provide leadership and direction that helps bring about success to portfolios, programs, and projects.

Source: commons.wikimedia.org/wiki/File:3D_Team_Leadership_Arrow_Concept.jpg, lumaxart, CC-BY-SA-2.0



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5. Value Delivery Systems

Projects are developed and executed within a project delivery system, also called a value delivery system. A value delivery system creates deliverables used to produce outcomes, which ultimately results in benefits (something of worth, importance, or usefulness) to the organization.

Figure 3 shows an example value delivery system with regular flow of information back and forth between groups. Senior leadership determine the business strategy, high-level initiatives, and long-term goals (top orange arrow). These drive the creation of new ideas that become new programs projects in the portfolios (middle orange arrow). The creation of new projects is an important part of an efficient delivery system.

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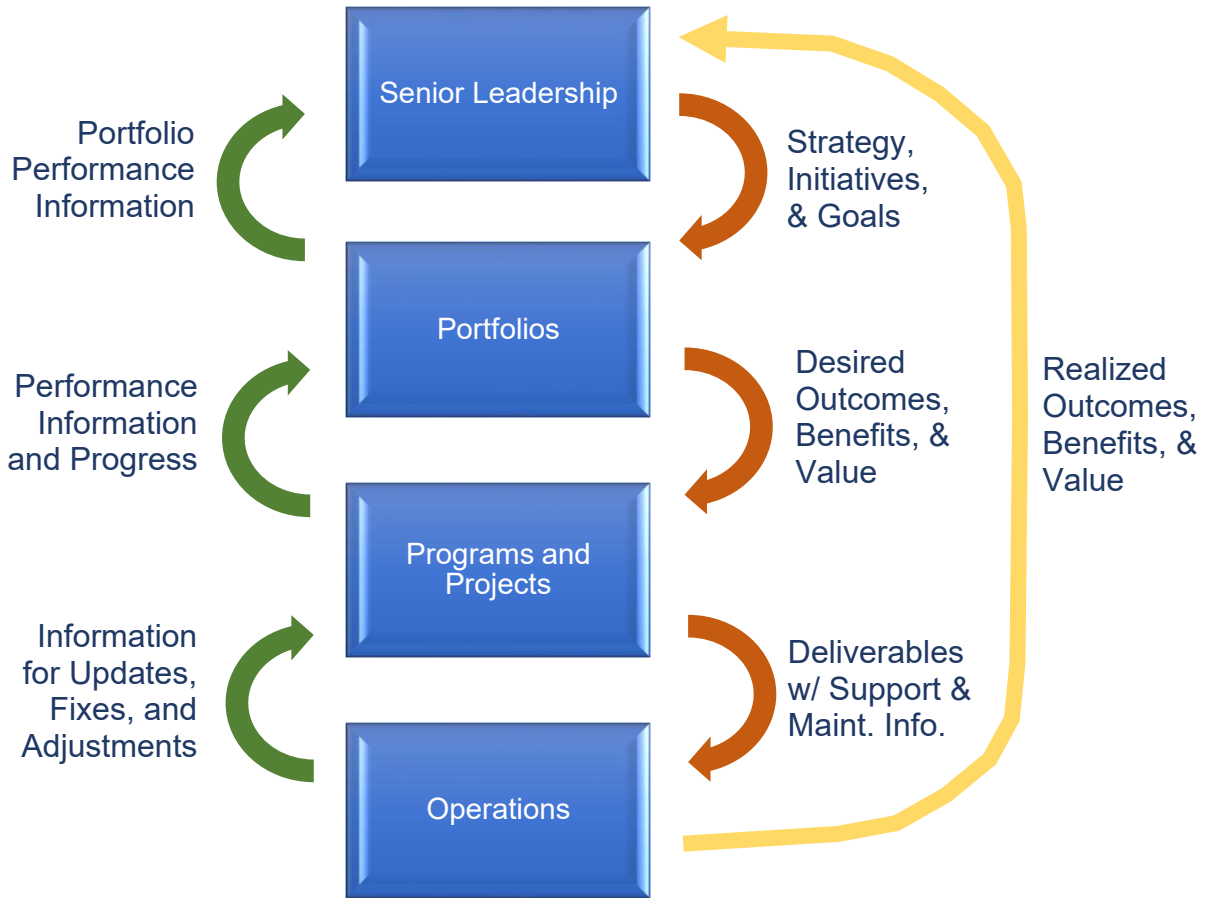


Figure 3: Example value delivery system structure with relevant information flows between groups. The strategy directives from senior leadership are used to generate ideas and evaluate if they should become projects.

Source: Author



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6. Business Strategy and Initiatives

Business strategy

Business strategy is the comprehensive, high-level outline that defines an organization's long-term goals. For example, where it wants to compete and how it will gain a competitive advantage in the market. It serves as a guiding framework that helps leaders make informed decisions, allocate resources efficiently, and aligns all departments toward a common vision.

An organization may have a corporate strategy which is updated annually. In addition, there are often strategies for each department or division within the organization. And there may be Functional-Level Strategies with more practical goals. Examples include:

- Marketing Strategy
- Operational Strategy
- Financial Strategy
- Human Resources Strategy

Specific goals, often called strategic metrics are also common. For example:

Strategic Metrics	Target
Small & Minority Business Participation	20%
Projects with Environmental, Social, and Governance (ESG) scope	100% growth
Engineering talent base	1,000 staff
Total revenue from consulting, data & technology solutions and products	30% growth

The various business strategies usually require programs and projects in order to achieve the objectives. When a project idea is first developed, it is helpful to review the various business strategies and identify if the idea helps achieve any of the goals. This will help to justify the idea and build a business case for the project.



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Business initiatives

Business initiatives are specific tasks (including projects) undertaken to execute the business strategy. Initiatives translate abstract strategic direction into tangible results. Initiatives start as ideas that are evaluated and only enacted upon with proper agreement. See Figure 4 shows example initiatives that align with cooperate strategy.

A. Governance			
22. Movement Charter			G. Environmental Sustainability
23. Interim Global Council			8. Support Environmental Sustainability Practices
24. Global Council	B. Improve User Experience	D. Hubs	H. Identify Topics for Impact
B. Improve User Experience	14. Cross-wiki Tools	25. Regional and thematic hubs	36(a). Identify impact of Wikimedia projects
9(a). Platform UX methodology	C. Skills and Leadership Development	E. Funding	36(b). Identify and track high impact topics
9(b). Community engagement for UX	31. Global approach for local skills development	2. Funding for underrepresented communities	36(c). Misinformation
9(c). Adaptable UX for various devices	32. Leadership development plan	F. Awareness	37. Bridge content gaps
11. Newcomer resources	33. Skills development infrastructure	3. Increased awareness about the movement	38. Initiatives for underrepresented communities

Figure 4: List of proposed business initiatives (light green) grouped by topic (dark green). These draft initiatives (ideas) can lead to the creation of new projects.

Source: commons.wikimedia.org/wiki/File:Strategy_initiatives_for_implementation.svg, Abbad (WMF), CC-BY-SA-4.0

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7. Project Selection Process

An idea must provide a demonstrated value in order for it to become a project. There are several techniques to demonstrate beyond a reasonable doubt that the intended value will be realized. Most organizations have a standard process in which these techniques are applied, reviewed, and approved. The process is specific to each organization; however, general steps are as follows.

The following are examples steps for idea assessment, review, and approval:

1. Idea Generation
2. Feasibility Study
3. Go/No-Go Form
4. Business Case
5. Stakeholder Approval
6. Project Charter

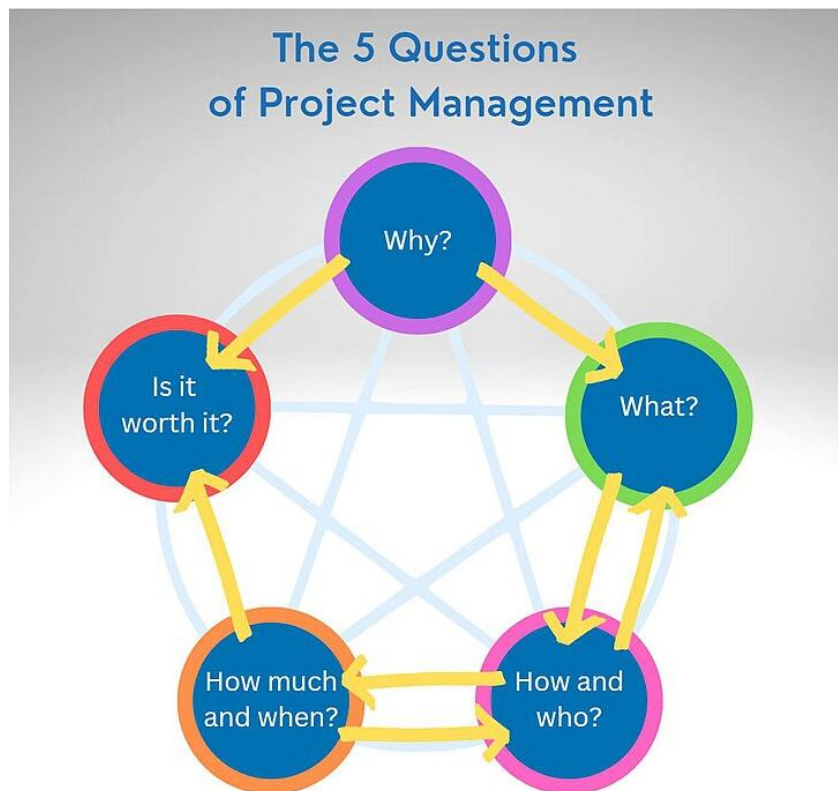


Figure 5: Questions to ask when considering a new project.

Source: commons.wikimedia.org/wiki/File:The_5_Questions_of_Project_Management.jpg, Leanpm, CC-BY-SA-4.0

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8. Idea Generation

Ideas for new engineering projects usually start as a strategic goal, a business need, business initiative, a problem to be solved, or an opportunity to be capitalized on. For example, if the business goal is to double the production of a product, ideas need to be generated to determine how that will be obtained. A physical expansion of the production system may be needed, which requires one or more engineering projects.

Ideas can come from a variety of sources:

- Organizational workshops
- Brainstorming sessions (see Figure 6)
- Role reversal activities focused on specific issues
- Virtual suggestion boxes
- Innovation challenges (see Figure 7)
- Rewards offered for best ideas
- Internal channels focused on business areas with posts/comments encouraged
- Specific requests for ideas from individuals or groups
- Employee feedback requests
- Focus group meetings (see Figure 8)



Figure 6: Brainstorming session to generate ideas.

Source: commons.wikimedia.org/wiki/File:BlueWhite_Coworking_Brainstorming_room.jpg, Mohkermani, CC-BY-SA-4.0

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Figure 7: Winners of an innovation challenge presenting their new idea.
 Source: commons.wikimedia.org/wiki/File:MINO_Team_-_Innovation_Challenge_(36061201910).jpg, p.d.



Figure 8: A virtual focus group meeting to discuss solutions to a business need.
 Source: commons.wikimedia.org/wiki/File:Mike_Thompson_-_5.1.20.jpg, p.d.



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9. Feasibility Study

A feasibility study is a formal assessment designed to determine if an idea (proposed project) is viable and worth undertaking. The primary goal is to analyze the project's viability from various angles before committing significant resources to its development and to identify potential obstacles or risks that might prevent its success.

A comprehensive feasibility study examines several critical areas:

- **Technical Feasibility**: Can the project be successfully completed with existing or acquirable technology and technical expertise?
- **Economic and Financial Feasibility**: Will the project be cost-effective and provide a positive return on investment (ROI)? Is the payback period reasonable? This involves a cost-benefit analysis, estimating development or construction costs, operating expenses, and projected revenues/benefits.
- **Operational Feasibility**: Will the proposed solution work within the organization's existing environment, culture, and processes? It determines if the project's outcomes can be realistically integrated into daily operations.
- **Schedule Feasibility**: Is the project timeline realistic and achievable? This assesses whether the project can be completed within any required deadlines and whether the proposed timeline meets market needs or regulatory requirements.
- **Legal and Regulatory Feasibility**: Does the project comply with all applicable laws, regulations, permits, and contractual obligations? Are there any significant insurance or contractual concerns? This ensures the project will not lead to legal issues.
- **Risk Assessment**: Systematically evaluate potential threats that could impact the project's success. The goal is to proactively identify and mitigate risks.



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Example Detailed Feasibility Study Table of Contents

1. Executive Summary
 - A. Background
 - B. Project Description
 - C. Project Goals & Vision
 - D. Guiding Principles
 - E. Site Drivers
 - F. Building Design
 - a. Description
 - b. Rationale
 - c. Alternatives
 - G. Cost & Timeline

2. Process Overview
 - A. Project Kickoff
 - B. Visioning
 - C. Discovery
 - D. Project Workshops
 - E. Stakeholder Involvement
 - F. Analysis of Existing Conditions
 - G. Alternatives Development
 - H. Consensus Building
 - I. Refinement of Preferred Concept Design
 - J. Final Deliverable Development
 - K. Proposed Study Schedule with Benchmark Sates

3. Existing Facilities & Conditions
 - A. Building Condition Assessment
 - B. Facilities Condition Index
 - C. Current Conditions
 - D. Stakeholder Assessment
 - E. Photographs of Existing Conditions
 - F. Health, Safety, Accessibility, Code Issues
 - G. Results of Destructive Testing
 - H. Current & Projected Occupancy
 - I. Alignment with Long-range Framework Plan
 - J. References to Previous Studies



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4. Proposed Architectural Program
 - A. Program Overview
 - B. Program Requirements
 - C. Program Distribution
 - D. Distribution by Space Type (Instructional, Research, Office, etc.)
 - E. Distribution by Program and Department
 - F. Program Space List
 - G. Graphic Representation
 - H. Tabular Schedule of Spaces
 - I. Customer and Stakeholder Approval
 - J. Planning Design & Construction Approval

5. Site Analysis and Site Selection
 - A. Site Analysis
 - a. Utilities
 - b. Topography
 - c. Access
 - d. Climate & Orientation
 - e. Cultural Resource Assessment
 - f. Relationship Alignment to Long-range Framework Plan
 - g. Adjacent Structures and Landowners
 - B. Site Selection
 - a. Site Options
 - b. Site Utility Requirements
 - c. Preferred Site

6. Concept Design
 - A. Massing Studies
 - B. Site Plan
 - C. Plan Diagrams
 - D. Section Perspective
 - E. Axonometric Projections
 - F. Concept Images
 - G. 3D Renderings
 - H. Chart of Spaces showing programmed SF and as-designed SF



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7. Proposed Concept Building Design Guidelines
 - A. Mechanical Narrative
 - B. Electrical Narrative
 - C. Plumbing Narrative
 - D. Fire Protection System Narrative
 - E. Structural Narrative
 - F. Utility Controls
 - G. Code Summary
 - H. Computing & Information Technology
 - I. Network Cabling, Pathways, and IT Closets
 - J. Audio-Visual Overview
 - K. Equipment Needs
 - L. Interior Design Narrative
 - M. Security, Access Control
 - N. Card Access
 - O. Security Cameras
 - P. Utilities & Maintenance
 - Q. Sustainability Goals
 - R. Pathway to Net Zero

8. Conceptual Cost Estimate & Project Schedule
 - A. Construction Cost Summary
 - B. Estimate Approach
 - C. Construction Cost per Unit Area
 - D. Cost Estimates by Project Element
 - E. Total Project Cost Estimate
 - F. Schedule Inputs
 - G. Schedule Milestones
 - H. Schedule Assumptions
 - I. Proposed Project Schedule

9. Implementation Information
 - A. Funding Sources
 - B. Estimated Operating Costs
 - C. Maintenance
 - D. Assumed Utility Rates
 - E. Grants

10. Final Approval
 - A. Finance Review and Approval
 - B. Operations Review and Approval
 - C. Final Stakeholder Approvals



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11. Appendices

- A. Project Cost Estimate – Detailed Estimate
- B. Site Plan
- C. Infrastructure Plan
- D. Project Directory
- E. Study Participant Details
- F. Program Stakeholder Register
- G. Risk Register
- H. Meeting Minutes
- I. Photographs of Existing Conditions
- J. References to Previous and Related Studies



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10. Lifecycle Costs

Lifecycle cost (LCC) refers to the total cost of ownership over the life of an asset, including development, construction, raw materials, maintenance, energy usage, operation labor, chemical use, waste disposal, and demolition. Most new projects add systems and processes that require significant ongoing operations and maintenance costs which need to be taken into account. The LCC is often considered when doing an economic feasibility study, business case, and for making a go/no-go decision.

LCC is calculated as the sum of the lifecycle costs for the project. Often a time period of 20 years is used for a lifecycle analysis.

Present Worth LCC

The lifecycle cost can be calculated using the present worth approach. The formula is as follows:

$$\text{Lifecycle Cost} = \text{Capital Cost} + \text{Annual O\&M} * \text{PWF} - \text{Salvage Value}$$

where: *Annual O&M* = annual operations and maintenance costs

$$\text{PWF} = \text{Present Worth Factor} = \frac{(1+i)^T - 1}{i * (1+i)^T}$$

i = interest rate (or discount rate)

T = number of years

Simplified LCC

Given the high variability in cost estimates at the business case stage, it is common to ignore PWF and salvage value, and use this simplified LCC formula:

$$\text{Lifecycle Cost} = \text{Capital Cost} + \text{Annual O\&M} * \text{Years}$$

The simplified LCC approach is also common if inflation is high or similar to interest rates, or if discount rates are low, since the present worth factor (PWF) will be similar to the “number of years”.



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Example Problem 1

Given the following, calculate the 20-year lifecycle cost with the simplified approach:

- Capital Cost = \$10M
- Annual O&M = \$100,000

Solution:

Using the simplified LCC formula:

$$\textit{Lifecycle Cost} = \textit{Capital Cost} + \textit{Annual O\&M} * \textit{Years}$$

$$\textit{Lifecycle Cost} = \$10,000,000 + \$100,000 * 20 = \mathbf{\$12,000,000}$$



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11. Return on Investment

Return on Investment (ROI) is a measure of profitability by comparing the anticipated profit to the program cost. ROI applies when profit or cost savings is a factor which doesn't apply to some potential projects.

A common ROI formula for a program is as follows:

$$ROI = \left(\frac{\text{Revenue} - \text{Project Cost}}{\text{Project Cost}} \right) * 100 = \left(\frac{\text{Net Profit}}{\text{Project Cost}} \right) * 100$$

The above formula requires an assumption on the time period (number of years) for the revenue and doesn't include operations and maintenance costs over that time period. Therefore, the following ROI formula is more comprehensive and applicable to most projects.

$$ROI = \left(\frac{\text{Annual Revenue} * \text{Years} - \text{Lifecycle Cost}}{\text{Lifecycle Cost}} \right) * 100$$

See the previous section for more details on calculating lifecycle costs.

Some projects provide cost savings instead of revenue/profit. For example, a new digester and biogas generator would produce electricity and heat which results in energy bill savings but not revenue. In such cases, the ROI formula is as follows:

$$ROI = \left(\frac{\text{Annual Savings} * \text{Years} - \text{Lifecycle Cost}}{\text{Lifecycle Cost}} \right) * 100$$

Often a high and low range are calculated since the estimated cost and revenue are very rough at the feasibility study stage. ROI should be updated whenever there are scope changes or external influences that impact the anticipated revenue.

ROI can also be calculated for multiple potential projects and compared, to prioritize projects that provide the best financial return.



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Example Problem 2

A solar power upgrade is estimated to save \$200,000 a year in electricity costs. The project has a 20-year lifecycle cost of \$1,500,000. What is the ROI for a 20-year period?

Solution:

Use the following ROI formula:

$$ROI = \left(\frac{\text{Annual Savings} * \text{Years} - \text{Lifecycle Cost}}{\text{Lifecycle Cost}} \right) * 100$$

$$\text{Annual Savings} = \$200,000/\text{yr}$$

$$\text{Years} = 20 \text{ yr}$$

$$\text{Lifecycle cost} = \$1,500,000$$

$$ROI = \left(\frac{\frac{\$200,000}{\text{yr}} * 20 \text{ yr} - \$1,500,000}{\$1,500,000} \right) * 100 = \left(\frac{\$2,500,000}{\$1,500,000} \right) * 100 = \mathbf{167\%}$$



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12. Payback Period

The payback period is the time it takes to recover capital cost and start to generate a net profit or net savings. The following is a common formula for a project:

$$\text{Payback Period} = \frac{\text{Project Cost}}{\text{Annual Revenue} - \text{Annual Costs}}$$

Or, if a project results in savings instead of profit:

$$\text{Payback Period} = \frac{\text{Project Cost}}{\text{Annual Savings} - \text{Annual Costs}}$$

Example Problem 3

What is the payback period for a project with the following:

- Project Cost = \$2,000,000
- Annual O&M Costs = \$50,000
- Annual Savings = \$300,000

Solution:

The following formula is used:

$$\begin{aligned} \text{Payback Period} &= \frac{\text{Project Cost}}{\text{Annual Savings} - \text{Annual O\&M Costs}} \\ &= \frac{\$2,000,000}{\$300,000 - \$50,000} = \mathbf{8 \text{ years}} \end{aligned}$$



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13. Risk Assessment

Risks are potential events that would have a negative impact on the project or organization. When evaluating an idea, it is important to assess the risks as follows:

1. Identify potential risks
2. Estimate the likelihood of each risk
3. Estimate the impact of each risk
4. Identify potential avoidance or mitigation strategies
5. Estimate overall risk exposure

Risk Register

A risk register is a table with a list of identified risks. It helpful to identify major risks earlier, before the idea becomes a project. The register is continued through the life of the project.

Normally, there are columns for risk description, probability (aka likelihood), cost & schedule impact (aka severity or consequence), priority (aka rank), mitigation strategy, response, and status. See Table 2 for an example.

Risk No.	Risk Description	Likelihood	Impact		Mitigation Strategy	Status
			Cost	Schedule		
1	Add parking spaces due to building occupancy change	High	\$100,000	12 weeks	Apply for zoning variance	Active
2	Market changes due to new technology by competition	Medium	\$50,000 / yr	N/A	Monitor marketplace	Active
3	Key engineer retiring in 3 months and need their input	High	\$20,000	N/A	Start project earlier; meet w/ engineer to gain direction	Mitigated

Normally, impact is considered more important than likelihood.



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14. Go/No-Go Evaluation

After performing feasibility calculations and assessments, the results can be used to perform a Go/No-Go evaluation. This involves completing a “Go/No-Go Form” or “Go/No-Go Checklist”, which is a structured list of criteria used to determine a "Go" or "No-Go" status.

Contractors, consultants, and suppliers often use a Go/No-Go Form to help decide if the opportunity is worth investing resources to prepare an official proposal or bid.

The following Table 3 is a generic Go/No-Go Form. Many organizations add a scoring system within the form to provide a more visual and quantitative basis for the final decision.



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Table 3: Example #1 Project Go/No-Go Form		
Criteria	Yes/No	Comments
Strategic Alignment		
Does the project align with our core business strategy and goals?		
Is there a clear justification and a defined return on investment (ROI)?		
Scope and Client		
Is the project scope clearly defined, documented, and agreed upon by all stakeholders?		
Have we successfully performed work for this client?		
Have we successfully performed similar scope?		
Resources and Capacity		
Are all required personnel (staff, contractors) available and committed to the project?		
Is the project team adequately skilled and trained to complete the work?		
Are necessary tools, technology, and materials available?		
Are subcontractors required? If so, what percent of cost?		
Budget and Financials		
Is the project within its allocated budget parameters?		
Is the funding certain for the next phase/entire project life cycle?		
Are the projected profit margins or financial benefits acceptable?		
Risk and Compliance		
Have all major risks been identified, assessed, and documented in a risk log?		
Does the project meet all regulatory and internal governance standards?		



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EXAMPLE #2 PROPOSAL GO/NO GO CHECKLIST

This checklist helps you decide whether your company should proceed with a proposal for an opportunity.

Project	Click or tap here to enter text.	Client					
Location	Click or tap here to enter text.	Type	<input type="checkbox"/> RFI	<input type="checkbox"/> RFP	<input type="checkbox"/> RFQ	<input type="checkbox"/> RFT	<input type="checkbox"/> SO
Scope of Work or Service		Click or tap here to enter text.					
Submission Deadline	Click or tap to enter a date.	Questions Deadline	Click or tap to enter a date.	Site Visit Date	Click or tap to enter a date.		
Why are we interested?			Choose an item.				
Have we read the entire RFP or at least its highlights to get an accurate understanding of what is sought?					<input type="checkbox"/> Yes <input type="checkbox"/> No		
Do we need to follow-up with the issuer to get clarification/further information?					<input type="checkbox"/> Yes <input type="checkbox"/> No		

A. CAPABILITY		
<input type="checkbox"/>	Can we meet the mandatory requirements?	
<input type="checkbox"/>	Can we provide the sought solution?	
	<input type="checkbox"/> The solution is our core competency	<input type="checkbox"/> We've done parts of the solution
	<input type="checkbox"/> We have personnel who've done the solution	<input type="checkbox"/> Our partners have done the solution
	<input type="checkbox"/> We have the skills to provide the solution despite no prior experience	
<input type="checkbox"/>	Do we have the exact experience the issuer is seeking? If not, is the issuer willing to consider "mix 'n match" responses?	
<input type="checkbox"/>	Can we have a representative attend any mandatory site visit?	
<input type="checkbox"/>	Do we have the right certifications/accreditations?	
B. FINANCIAL		
<input type="checkbox"/>	Is the proper corporate approval secured, including Board approval if necessary?	
<input type="checkbox"/>	Are we financially able to pursue the opportunity and execute it if we win?	
	<input type="checkbox"/> The estimated cost/size of the opportunity is within the company's financial threshold. If above the dollar limit:	
	<input type="checkbox"/> A joint venture (JV) agreement is in place	<input type="checkbox"/> A teaming agreement as a subcontractor is in place
<input type="checkbox"/>	Can we meet the bonding and insurance requirements?	
<input type="checkbox"/>	Do we have the budget for the level of effort needed to respond to the opportunity?	
<input type="checkbox"/>	Given what is known about the opportunity and the level of effort to pursue it; if won, will it be within the company's profitability margin expectations? (e.g., 10%; 12%) Note: Winning a pursuit but taking a financial loss is only acceptable for legitimate strategic reasons that requires approvals from the highest levels.	
C. EXPERIENCE/CREDIBILITY		



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<input type="checkbox"/>	Does our company/joint venture meet the required work experience?
<input type="checkbox"/>	Do our proposed key personnel possess the required work experience?
<input type="checkbox"/>	Do we have a good relationship with the client or its decision makers, or at the very least, not a bad relationship?
<input type="checkbox"/>	If required, do we have the WCB recognition letter?
<input type="checkbox"/>	If required, do we have the Health, Safety, and Environmental (HSE) historical performance?
D. COMPETITION	
<input type="checkbox"/>	If competitors are known, can we be competitive in price, quality, and schedule?
<input type="checkbox"/>	Is the playing field level – that is, no peer competitor has an advantage due to currently being on site, is local, or is an incumbent that the client is happy with?
<input type="checkbox"/>	If known, is the issuer unhappy with the current incumbent or provider?
<input type="checkbox"/>	Is the number of competitors small such as due to a prequalification process, large financial requirements to the vendors, or remote location? If not, do we have an advantage that a “mom and pop” local provider cannot match?
<input type="checkbox"/>	Do we have an advantage that we can leverage that would cause the client to select us even if our price was slightly higher than a competitor?
E. RESOURCE LIMITATIONS	
<input type="checkbox"/>	Can our internal resources provide a proper response by the submission deadline? This includes no scheduling conflicts with another more preferred opportunity.
<input type="checkbox"/>	Can we use external resources to help provide a proper response by the submission deadline? (outsourced writers or other departments)
<input type="checkbox"/>	If we win, do we have the proper resources and equipment during the opportunity’s execution period to deliver the required solution or are they committed elsewhere?

Note: Any item in the Go/No Go checklist that is not checked off signifies that is it likely not in the company’s best interest to pursue the opportunity unless other factors override the gaps. Serious thought is required before consuming company funds and internal/external resources that may be better spent elsewhere.



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15. Business Case

If the idea or opportunity is deemed feasible, and a “Go” decision has been made, a formal business case is developed. This document outlines the problem, the proposed solution, the benefits, the estimated costs and timelines, and potential risks. It serves to justify the investment of resources.

Note that a business case is usually done by (or on behalf of) the owner or entity that is driving the potential project. Engineering consultants that prepare proposals for opportunities would not normally develop business cases for those proposals and awarded projects. However, a consultant may assist the owner in preparing business cases and supporting documents for their projects.

Business Case Outline

Typical sections of a business case are as follows:

1. Executive Summary
2. Introduction/Background
3. Problem Statement & Objectives
4. Options Analysis
5. Preferred Option & Benefits
6. Financial Analysis & Affordability
7. Risk Assessment
8. Implementation Plan & Governance
9. Recommendations & Next Steps

Five Case Model

The Five Case Model is a methodology for preparing a business case. It comprises of evaluating and documenting the following five key dimensions:

1. Strategic Case
 - Is there a compelling case for change?
 - Demonstrate the fit with business strategy and goals.
2. Economic Case
 - Does the investment offer value for money?
 - Show that idea is worth the cost, such as a cost-benefit analysis.
3. Commercial Case
 - Is the proposed investment commercially viable?

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- Outline the procurement strategy, assess market interest, and identify key deals or partnerships needed
- 4. Financial Case
 - Is the proposed investment affordable?
 - Identify financial projections, funding sources, and lifecycle costs
- 5. Management Case
 - How will the project be delivered successfully?
 - Details key strategies for the project's governance, resources, risk management, outcomes, and benefits realization

SMART Goal Setting

A popular approach to defining the goals of a potential project is to follow the SMART technique. SMART is an acronym for the following:

- **Specific:** Clear and detailed
- **Measurable:** Quantifiable and tangible deliverables
- **Achievable:** Realistic and attainable
- **Relevant:** Aligned with business objectives
- **Time-bound:** Specific timeframe



Figure 9: Illustration of SMART goal setting.

Source: commons.wikimedia.org/wiki/File:SMART-goals.png, Dungdm93, CC-BY-SA-4.0

Example #1 - Business Case Table of Contents

Executive Summary	2
Background	3
Problem / Opportunity.....	3
Current Situation.....	3
Project Description	4
Project Description.....	4
Objectives.....	4
Scope.....	4
Out of Scope.....	4
Anticipated Outcomes.....	4
Stakeholders.....	5
Strategic Alignment	6
Environment Analysis	7
Alternatives	8
Business & Operational Impacts	9
Project Risk Assessment	10
Risk of Project and each Viable Alternative (Not including Status Quo.....	10
Risk of Not Proceeding with Project (Status Quo).....	11
Cost/Benefit Analysis	12
Quantitative Analysis – Financial Cost & Benefit:.....	12
Qualitative Analysis – Non-Financial Benefits & Costs:.....	14
Assumptions.....	14
Conclusions & Recommendations	15
Conclusions	15
Recommendations.....	15
Project Responsibility.....	15
Project Accountability.....	15
Implementation Strategy	16
Review & Approval Process	17
Review Process.....	17
Approval Process.....	17
Business Case Signoff.....	18



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1. BACKGROUND3

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3. PURPOSE OF THE BUSINESS CASE3

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4.3 Strategic Alignment4

4.4 Promotes ICT plan (three-year plan).....4

4.5 Business Case Criteria.....5

4.6 Motivation.....5

4.7 Situational Analysis.....5

4.7.1 *Current Situation*.....5

4.7.2 *Future Situation*5

4.7.3 *Gap Analysis*.....6

4.8 Alternatives Considered.....6

4.9 Resource requirement.....6

4.10 Critical Success Factors7

4.11 Stakeholders7

4.12 Role Players7

4.13 Business Benefits.....7

4.13.1 *Tangible Benefits*.....7

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4.14 Risks.....8

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4.16 Decisions Required8

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Example #3 - Business Case Table of Contents

Purpose	4
Strategic Case	4
Economic Case	6
Commercial Case	8
Financial Case	8
Management Case	9
Next Steps	9

16. Stakeholder Approval

The business case is presented to key stakeholders, such as senior management, investors, and partners. Their review and approval are essential to secure the necessary funding and authority to move forward. Typically, the authorized staff will sign either a hardcopy or digital version of the business plan to officially document the acceptance.

It is helpful to have the business case presented to stakeholders, through a PowerPoint presentation or similar. This is in addition to providing the written business case. The presentation should cover the same topics as the business case, with highlights on important findings that impact a decision for approval.



Figure 10: Depiction of a business case presentation to senior leaders.

Source: commons.wikimedia.org/wiki/File:Business_presentation_byVectorOpenStock.jpg, Vector Open Stock, CC-BY-SA-3.0



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17. Project Charter

Upon approval of the business case, a project charter can be created. A project charter is a formal document officially recognizing the existence of the project and providing the project manager with the authority to apply organizational resources to project activities. It also defines the initial scope, objectives, and key stakeholders.

Note that a project charter is usually done by (or on behalf of) the owner or entity that is driving the project. Engineering consultants that are awarded projects would not normally develop a charter for those projects since the signed agreement provides the authority to proceed and a project plan provides many of the elements in a project charter. However, a consultant may assist the owner in preparing project charters for their projects.

A typical project charter often has the following sections:

1. Project Title & Information
2. Executive Summary
3. Business Need / Problem Statement
4. Project Objectives & Goals (see SMART goals in Figure 9)
5. High-Level Scope
6. Key Deliverables
7. Key Milestones
8. Budget & Funding
9. Risks
10. Key Assumptions & Constraints
11. Key Stakeholders & Roles
12. Approvals & Sign-off



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Example Project Charter Template

Project Name	<i>Project name</i>		
Project Manager	<i>Project manager name</i>	Organization	<i>Organization name</i>
Sponsor	<i>Sponsor name</i>	Organization	<i>Organization name</i>
Executive Committee Sponsor	<i>Executive Committee that is responsible for the project</i>		
Document Version and Date	<i>Version number and date of this document.</i>		

Document Change Control			
Revision Number	Date of Issue	Author(s)	Brief Description of Change

Project Scope	
Business Need	<i>Provide a brief overview and background information about the project. Explain at a high level what the project is to accomplish, who initiated the project and expected benefits (both tangible and intangible).</i>
Project Goals	<i>Identify the key project goals.</i>
Product Description	<i>Describe the product or service that the project is to deliver.</i>
In Scope/Out of Scope	<i>The scope sets the boundaries of the project. Enter those key items that are a part of the project and those major items that will not be worked on as part of this project. This is a high level description of what is in and what is out of the boundaries of the project.</i>
Critical Success Factors	<i>Identify the critical success factors for the project. Critical success factors are outcomes that must be achieved in order for the project to be considered a success.</i>



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Project Assumptions	<i>List any assumptions made in defining the project. Assumptions can affect any area of the project including scope, stakeholders, business objectives and functional requirements.</i>
Project Constraints	<i>Summarize the key constraints that will serve as limitations and boundaries for the project team in their decision making.</i>
Project Deliverables	<i>List the key deliverables of the project with a short description of each.</i>

Requirements
<i>Identify the functional requirements here. Functional requirements describe what characteristics the proposed product or service must have and provides a list of the minimum features that must be in place when the project is complete.</i>



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High-Level Milestones and Timeline	
<p>Milestones are deliverables or major events that may be readily identified as completed or not completed on a specified date. Project Milestones are 'how are we doing' thresholds that indicate whether a project is on track to finish as expected.</p> <p>Enter the project's key milestones with an estimated date for the completion of the milestone.</p>	
Milestone/Task	Estimated Completion Date

Enter the roles and project responsibility for each role required for the project. Enter the skills required of the role. Enter the preliminary FTE estimates for resource commitment for the fiscal year. Enter a total of the FTE for the fiscal year. Enter the planned or recommended source for acquiring the resource. Example: Contractor or the name of the organization that might provide the resource.

High-Level Roles				
Role	Project Responsibility	Skills Required	FTE FY yy-yy	Recommended Source
Total				

Enter the preliminary budget information needed to support the project. Include costs for labor, material and other expense items. If the on-going maintenance and support costs are required by your project add this information to the high-level budget. The preliminary budget can also be broken down by major phases or key deliverables/milestones of the project.



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High-Level Budget			
Cost Type	FY yy-yy	FY yy-yy	Total
Total Budget			

Communications Strategy
<p><i>The communications strategy provides guidance in how to meet the ultimate end of project communication. Develop a high-level statement of the general approach to communications for key items:</i></p> <p><i>Project Communication Objectives</i> <i>Key Communication Message</i> <i>Key Audiences</i></p>

Change Management Strategy
<p><i>The change management strategy is a high-level statement of the general approach to change management issues for these key items:</i></p> <ul style="list-style-type: none"> • <i>Anticipated change management challenges</i> • <i>Key project constraints</i> • <i>Key customer practices for managing change</i> • <i>A concise statement of change management practices</i>



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Risk Management Strategy
<p><u>Risk areas</u> <i>Describe at a high level the most significant areas of risk for this project.</i></p> <p><u>Critical stakeholder risk tolerances and thresholds</u> <i>Include this block if the stakeholders have identified areas of risk where either risk cannot be tolerated at all or for which the risk threshold is very low</i></p> <p><u>Risk management objectives</u> <i>Identify the project's overall objectives for managing risk.</i></p> <p><u>High-level risk management process</u> <i>Identify at a high level the process to be followed for assuring risk management objectives are met throughout the project life cycle.</i></p> <p><u>Risk decision makers</u> <i>Identify the roles for assuring risk management objectives are met throughout the project life cycle.</i></p>

Project Charter Approval Signatures
<p>Project Manager</p> <p>_____ (Signature) _____ (Date)</p> <p>Name Position Organization</p>
<p>Project Sponsor</p> <p>_____ (Signature) _____ (Date)</p> <p>Name Position Organization</p>



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18. CIP Project Selection Process

Public and private organizations with considerable infrastructure, such as utility companies, typically have a capital improvement program (CIP), although it may go by a different name. The goal of such program is to systematically plan and execute projects that maintain and upgrade physical infrastructure to better meet current needs and future goals. There is typically an ongoing stream of projects with no end in sight.

CIPs are often managed as a portfolio since the projects sometimes have little relation to one another. Within a CIP “portfolio”, there may be programs (or sub-programs) such as roads, parking, security fencing and gates, water supply, wastewater collection, stormwater, pipelines, pump stations, treatment systems, etc. These programs have annual budgets and are managed like an ongoing program that is always in the Delivery Phase since there are always one or more active projects in design, bidding, construction, or commissioning. And there is a regular CIP planning process to add new projects to the program(s).

CIPs issue annual reports which present the status of the program and projections for the upcoming year. Master Plans are more technical in nature, presenting the engineering status of the infrastructure and recommended improvements for future project selection. It is common for CIP programs to spend 1 to 5% of the total asset value each year on improvement projects to avoid excessive failures.

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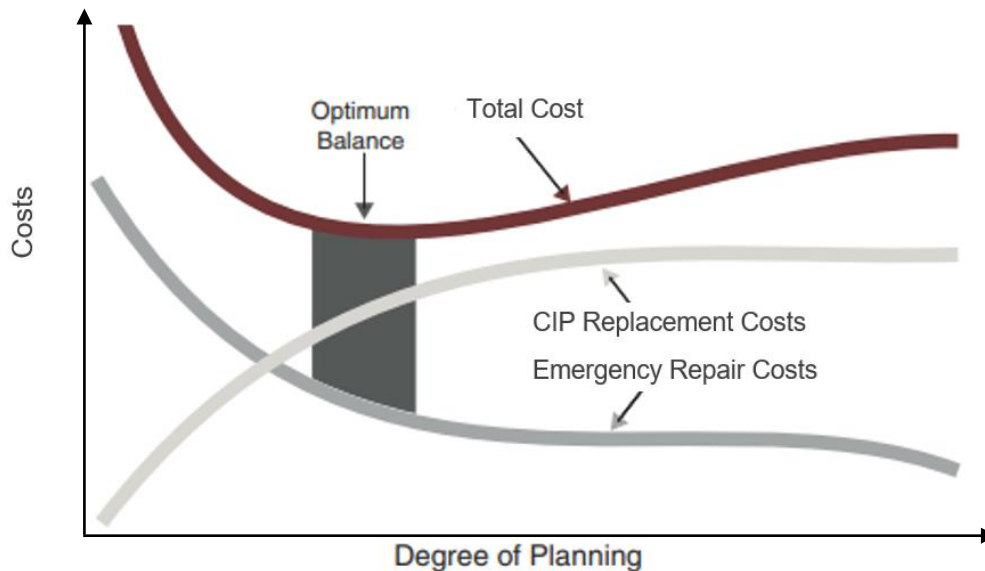


Figure 11: Chart showing the optimum balance where just enough CIP projects are being done to minimize failure risks and optimize total asset management cost.

Source: www.epa.gov/sites/default/files/2015-10/documents/assetmanagement.pdf, modified, p.d.

CIP Planning

A CIP needs to undergo regular planning to assess the budget, modify program goals to align with business strategy, and identify new initiatives and projects. Often CIP planning is done once a year and documented in an annual report. Sometimes an updated Master Plan.

The following are common steps in CIP planning:

1. Review program budget and schedule status
2. Review existing condition assessments
3. Review performance assessments
4. Review risk assessments and risk rankings
5. Review and update the Master Plan
6. Make new project selections
7. Create annual report



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Plant No. 1, Plant No. 2, and Joint Projects

Project No.	Project Name	Status	Project Budget
P1-105	Headworks Rehabilitation at Plant 1	Construction	\$340,000,000
P1-126	Primary Sedimentation Basins No. 3-5 Replacement at Plant No. 1	Preliminary Design	\$183,000,000
P1-128A	Headquarters Complex at Plant No. 1	Construction	\$167,819,000
P1-132	Uninterruptable Power Supply Improvements at Plant 1	Construction	\$9,600,000
P1-133	Primary Sedimentation Basins No. 6-31 Reliability Improvements at Plant No. 1	Construction	\$12,100,000
P1-134	South Perimeter Security and Utility Improvements at Plant No. 1	Close-Out	\$8,150,000
P1-137	Supports Buildings Seismic Improvements at Plant No. 1	Design	\$27,600,000
P1-138	Industrial Control System and IT Data Center Relocation at Plant No. 1	Project Development	\$16,500,000
P1-140	Activated Sludge-1 Rehabilitation at Plant No. 1	Preliminary Design	\$470,000,000
P1-141	Administrative Facilities Demolition	Project Development	\$4,286,000
P1-142	Trickling Filter Media Replacement at Plant No. 1	Project Development	\$47,000,000
P2-98A	A-Side Primary Clarifiers Replacement at Plant 2	Construction	\$165,894,000
P2-122	Headworks Modifications at Plant No. 2 for GWRS Final Expansion	Close-Out	\$30,400,000
P2-123	Return Activated Sludge Piping Replacement at Plant 2	Close-Out	\$10,000,000
P2-127	Collections Yard Relocation and Warehouse Demolition at Plant No. 2	Construction	\$8,800,000
P2-128	Digester Replacement at Plant No. 2	Design	\$555,000,000
P2-128A	South Perimeter Wall and Soil Improvements at Plant No. 2	Design	\$33,000,000
P2-135	Chemical Systems Rehabilitation at Plant No. 2	Design	\$9,200,000

Figure 12: Example list of active projects from a CIP annual report.

Source: <http://ocsan.gov/wp-content/uploads/2024/10/CIP-Annual-Report-23-24.pdf?id=45872&year=all>, p.d.



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Master Plan

A Master Plan is a technical engineering document intended to guide decisions infrastructure improvements. A Master Plan often include the following: summarize existing infrastructure including condition and performance assessment results, forecasts future demands, identifies potential improvement projects, compares alternatives, estimates costs at a high-level, provides recommendations on improvements and priorities.

Often a Master Plan is created every 3 to 5 years. To keep it relevant, it is helpful to make updates or amendments to the plan each year. Master Plan recommendations often become new projects.

Project Selections

The following are potential steps for project selection in a CIP:

1. Create a table of potential projects (rows) and motivations (columns).
See Table 4 for an example.
2. Sum the number of motivations (also called drivers) for each potential project (greater = high priority),
3. Estimate the cost for each potential project (often in Master Plan),
4. Compare total cost to program budget available,
5. Decide on projects to proceed based on motivations, costs, and program budget,
6. Schedule out projects based on resources and budgets,
7. Prepare business plans for each potential project,
8. Present to and obtain approval from decision makers.

In Table 4, the last two columns “No. of Motivations” and “Cost per Motivation” can be used to help select projects for proceeding. Projects with the most motivations and with the lowest cost per motivation are highlighted **red**. Some motivations such as regulatory requirements may necessitate selecting projects with higher cost and fewer motivations.

Potential projects that cost more than the available budget have the following options:

1. Split into multiple smaller projects and advance only the first project/phase.
2. Excess budget can be passed to the next year and combined with that year’s budget to give enough funding for the project.
3. One or more active projects can be paused/delayed to free up funding.
4. Budget can be transferred from another program with justification and approval.
5. Budget can be increased with justification and approval.

Table 4: Example CIP Project Planning Table

ID No.	Potential Project Name	Cost Estimate (\$M)	New Development	Climate Change	Water Reuse	Effluent Water Quality	Remaining Useful Life	High Risk Ranking	Redundancy	Qualifies for Funding	Regulatory Needs	Other	No. of Motivations	Cost per Motivation
1	Influent Pump Station Expansion	\$3.0	X						X				2	\$1.5
2	Grit Removal Rehabilitation	\$1.2					X	X					2	\$0.6
3	Aeration Basin Rehabilitation	\$0.8					X	X				Safety Improvement	3	\$0.3
4	Clarifier Mechanism Replacement	\$0.6				X		X					2	\$0.3
5	Plant Water Reuse System	\$1.0			X					X			2	\$0.5
6	Yard Piping Rehabilitation	\$0.8					X	X					2	\$0.4
7	Transfer Pump Station Replacement	\$1.8	X				X	X	X				4	\$0.5
8	Selector Tank Addition	\$2.1	X			X					X		3	\$0.7
9	Phosphorus Removal Addition	\$3.0				X				X	X		3	\$1.0
10	New Chemical Building	\$2.2	X	X				X			X	City Council Agenda Item	5	\$0.4
11	Flood Protection Improvements	\$1.5		X						X		City Council Agenda Item	3	\$0.5
12	Isolation Valve Additions	\$0.4							X			Correct Lack of Isolation	2	\$0.2
13	Instrumentation Upgrades	\$0.3				X		X				Highest COF	3	\$0.1
14	Actuated Valve Replacements	\$0.6					X	X					2	\$0.3
Total (\$M)		\$19.3	\$9.1	\$3.7	\$1.0	\$6.0	\$5.2	\$8.3	\$5.2	\$5.5	\$7.3	\$5.2	-	-

Example Problem 8

Program Manager Pat helped prepare Table 4 and now needs help to select which projects to proceed, while staying within a program budget range of \$4.0M to \$4.5M. The goal is to proceed with the greatest number of projects that are highlighted **red** in the last two columns. Help Pat decide which project(s) should be eliminated and what is the total cost?

Solution:

The projects highlighted **red** are as follows:

- \$1.8M – 7, Transfer Pump Station Replacement, 4 motivations
 - \$2.2M – 10, New Chemical Building, 5 motivations
 - \$0.4M – 12, Isolation Valve Additions, \$0.2M per motivation
 - \$0.3M – 13, Instrumentation Upgrades, \$0.1M per motivation
- \$4.7M – Total

The total exceeds the \$4.5M budget by \$0.2M. The following are options for proceeding:

1. Eliminate Project No. 12 to save \$0.4M for total \$4.3M.
2. Eliminate Project No. 13 to save \$0.3M for total \$4.4M.

In comparing options 1 and 2, Project No. 13 has a greater number of motivations (3 versus 2) and a lower cost per motivation (\$0.1M versus \$0.2M). Therefore, Project No. 13 is a better choice to proceed based on information available.

Recommendation is to eliminate Project No. 12 and proceed with the following projects for a total cost of \$4.3M:

- \$1.8M – 7, Transfer Pump Station Replacement, 4 motivations
 - \$2.2M – 10, New Chemical Building, 5 motivations
 - \$0.3M – 13, Instrumentation Upgrades, \$0.1M per motivation
- \$4.3M – Total



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19. Course Summary

Key takeaways from this course:

- Ideas usually turn into projects through a structured process that assesses their viability and gains formal authorization.
- The idea to project transformation occurs within the initiation phase of the project life cycle.
- Engineering ideas have additional complexities but usually follow the same project development process as non-engineering projects.
- The following are examples steps for transforming an idea into a project:
 1. Idea Generation
 2. Feasibility Study
 3. Go/No-Go Form
 4. Business Case
 5. Stakeholder Approval
 6. Project Charter
- Key definitions:
 - Portfolio = Collection of projects and programs managed as a group
 - Program = Group of related projects that are managed together
 - Project = temporary endeavor with a beginning and an end, aiming to create a unique product, service, or result
 - PMO = Project Management Office = department or group that defines, maintains, and promotes project management standards
 - PPMO = Project Portfolio Management Office = helps manage a single portfolio by selecting, assessing, and prioritizing the projects and programs in a portfolio
 - Value Delivery System = Creates deliverables used to produce outcomes, which ultimately results in benefits to the organization
 - Business Strategy = Comprehensive, high-level outline that defines an organization's long-term goals
 - Business Initiatives = Specific tasks (including projects) undertaken to execute the business strategy



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- Key PMI standards:
 1. *The Standard for Project Management*
 2. *PMBOK® Guide*
- Ideas for new projects usually start as an initial thought, a business need, business initiative, a problem to be solved, or an opportunity to be capitalized on.
- Project selection is unique to each organization. A Go/No-Go Form helps decide if a proposal or project should proceed.
- A comprehensive feasibility study examines several critical areas:
 - Technical Feasibility
 - Economic and Financial Feasibility
 - Operational Feasibility
 - Schedule Feasibility
 - Legal and Regulatory Feasibility
 - Risk Assessment
- Simplified lifecycle cost formula:

$$\text{Lifecycle Cost} = \text{Capital Cost} + \text{Annual O\&M} * \text{Years}$$
- Common return on investment (ROI) formula (revenue can be savings):

$$\text{ROI} = \left(\frac{\text{Annual Revenue} * \text{Years} - \text{Lifecycle Cost}}{\text{Lifecycle Cost}} \right) * 100$$
- Common payback period formula (revenue can be savings):

$$\text{Payback Period} = \frac{\text{Project Cost}}{\text{Annual Revenue} - \text{Annual Costs}}$$
- In a risk register, impact is considered more important than likelihood.
- A “Go/No-Go Form” or “Go/No-Go Checklist” is a structured list of criteria used to determine a "Go" or "No-Go" status.



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- Typical sections of a business case are as follows:
 1. Executive Summary
 2. Introduction/Background
 3. Problem Statement
 4. Options Analysis
 5. Preferred Option & Benefits
 6. Financial Analysis & Affordability
 7. Risk Assessment
 8. Implementation Plan & Governance
 9. Recommendations & Next Steps

- Typical sections of a project charter:
 1. Project Title & Information
 2. Executive Summary
 3. Problem Statement
 4. Project Objectives & Goals (see SMART goals in Figure 9)
 5. High-Level Scope
 6. Key Deliverables
 7. Key Milestones
 8. Budget & Funding
 9. Risks
 10. Key Assumptions & Constraints
 11. Key Stakeholders & Roles
 12. Approvals & Sign-off

- Capital improvement programs (CIPs) have unique project selection processes involving condition assessments, performance assessments, Master Plans, and annual reports. It is helpful to identify and compare the motivations for potential projects.