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Introduction to Construction Project Management

Introduction

Management has been defined as the process of dealing with or controlling things or people¹; however, the term management itself is widely understood and used in almost every facet of our personal and professional lives, for example:

- Managing one’s work duties.
- Managing personal and family tasks.
- Managing an organization for those who own or manage their businesses.
- Managing personal finances.
- For students, managing school duties.
- For an administrator of an organization, managing the department under their responsibility.

This means that the person in charge (the manager) has to deal with all the human, financial, and other resources under his/her jurisdiction to achieve the set objectives.

What we manage ranges from simple tasks such as preparing a sandwich or a meal, to a complicated mega-project or program such as building a skyscraper or manufacturing a commercial jet. This takes us to the classification of these “pieces of work.” Depending on size and complexity of this piece of work, we give each a different name, although this matter is somewhat subjective. In project management, we may call the small components an activity. In general, an activity (also called task) can be independent, such as making coffee or brushing one’s teeth, or it can be part of a bigger and more complex scope of work, such as baking a cake for a birthday or wedding party or trimming a tree as part of garden maintenance.

In the management hierarchy, the higher the manager is, the greater his/her responsibility, authority, and jurisdiction get. In addition, especially in larger organizations, management is divided horizontally by specialty: Finance, IT, human resources, and so on.

1 Oxford Dictionary, <https://www.lexico.com/en/definition/management>.

Basic Definitions

In project management, a *project* is defined as a temporary endeavor undertaken to create a unique product, service, or result². There are two keywords in the definition: temporary and unique:

- Temporary because it has a start point and a finish point, and terminates in a deliverable: product (building, road, or refinery), service (repair, remodel, or demolish), or result (improve efficiency or reduce cost).
- Unique because there are no two projects that are identical. Many people think of the project only from a design perspective (how it looks after completion), but the *project* in this context is the process that ends with the finished product. There are similar projects but not identical. They may differ in soil conditions, weather (at time of construction), labor productivity, cost, type and quality of materials, equipment used, site conditions, and circumstances (e.g., accidents).

Every project must have a starting point, a finishing point, and a deliverable (a product, service, or result).

Many of what we do in life are projects, but we never think of them this way. Think about it and give a few examples.

A typical project has components of different sizes and complexity, including activities, work packages (assemblies), and subprojects. An *activity* is a component of the project, which serves as a basic unit of work as part of the total project that is easily measured and controlled. It is time and resource consuming. This activity can be small such as stripping a column formwork or plumbing a vertical member, or as large as excavating 50,000 cubic yards of soil. However, for practical purposes, we like to limit the activity size to a reasonable range. This will be discussed later in subsequent chapters, mainly under the scheduling topic. Activities within a project are usually defined by breaking down the project into components we define as activities. This process depends on several factors that will also be discussed later.

Even though we look at the activity as the smallest component in construction project management, sometimes, we can even divide the activity into smaller components called steps. This may be necessary to distribute the cost or resources (called resource loading) over the duration of the activity.

A *work package* or *assembly* is simply a collection of related items or activities within a bigger scope of work (usually the project). The work package includes items assembled to form more comprehensive items to facilitate and speed up the construction process. It can be as small as a simple partition assembly or as large and complex as a 3D building component. It can be assembled onsite or delivered pre-assembled to the construction site. Compared to the auto industry, we can look at the finished automobile as the project, and the components such as upholstery, suspension systems, and the engine as assemblies.

A *subproject* is a smaller portion of the overall project created when a project is subdivided into more manageable components or pieces. It is *not* a stand-alone piece of work regardless of its size. A project

² PMI, PMBOK, 7th edition, 2021.

may be divided into subprojects based on specialty, location, phase, or size. The subproject typically is composed of activities and work packages, and sometimes sub-subprojects.

A subproject is usually managed independently; however, it may affect and/or be affected by other subprojects in the overall project. It may even have smaller components, sub-subprojects. In fact, a large/complex project may be divided into subprojects, or it may be considered a program with its components as projects.

The idea of breaking up the project (or large/complex work) into smaller and more manageable and controllable components, is well-known to simplify and facilitate the management of the project.

We are now defining two terms representing a piece of work larger than a project: a program and a portfolio. There are similarities between them but there are traits that make them different.

A subproject cannot be considered a stand-alone project. It has to be a part of a project.

A *program* is a group of related projects, subsidiary programs, and program activities that are managed in a coordinated manner to obtain benefits not available from managing them individually³. Programs may include elements of related work outside of the scope of the discrete projects in the program.

Programs, such as projects, are temporary (start point and finish point), although many organizations have departments called programs that are continuous/perpetual. For example, a municipal government may have a stormwater program and a road maintenance program. These “programs” usually have an annual budget as well as an annual list of projects that can be performed within that budget. If we imagine a conventional program such as a box with many components inside (projects, activities, and subprograms), the “perpetual program” will then look like a conveyor belt: loading components and budget at its start and unloading finished projects at its end. A one-year snapshot of this conveyor belt will be a conventional program (Figures 1.1 and 1.2).

A *portfolio* is a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs in the portfolio may not necessarily be dependent or directly related. An example of a portfolio is a group of projects that have one element in common, serving a strategic goal for the organization. It is like the retirement portfolio for a person: it may contain investment in different types of investments, for the purpose of providing the best and most secure retirement for the person.

Example on a program through a step:

- Program: Summer Olympic 2028 in Los Angeles
 - Project: Constructing a new building to house athletes
 - Subproject: Electrical work in the building project
 - Work package: Foundation or roof assembly
 - Activity: One spread footing
 - Step: Setting the formwork for the spread footing

³ PMI, PMBOK, 7th edition, 2021.

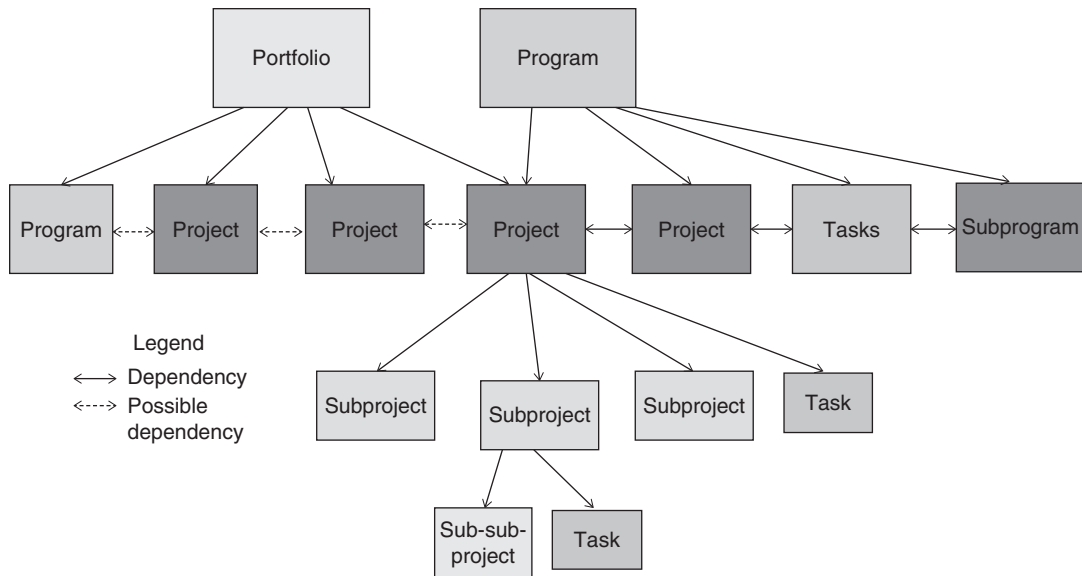


Figure 1.1 Programs, portfolios, and projects.

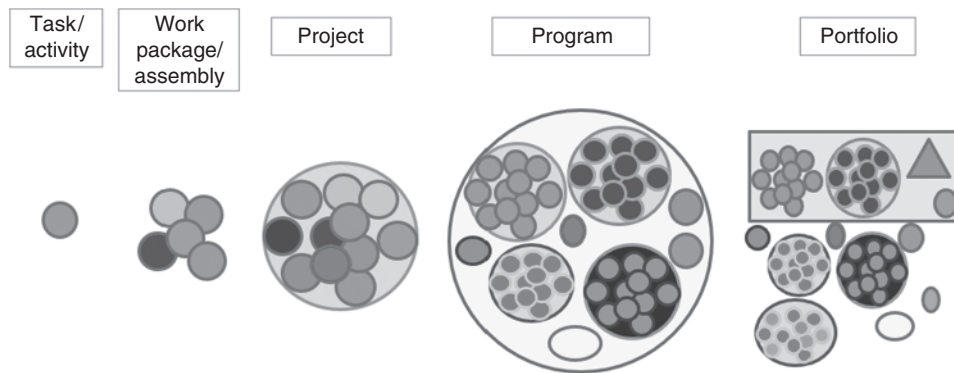


Figure 1.2 Activities, programs, portfolios, and projects.

Relating to the same example, think of a construction company that is contracted to perform part of the infrastructure work for the Summer Olympics in 2028, and the company may have a “City Works portfolio” that includes its portion of the Summer Olympics 2028 program in addition to other projects/works with the city outside the scope of the Summer Olympics. The entire portfolio serves a strategic goal for the company in its relationship with the city government. The city, on the other hand, may also have a portfolio that includes part of the Summer Olympics program as well as other projects/works that serve a strategic goal of “improvement of city infrastructure.” In both examples, the portfolio overlaps with the program, but each is defined differently with different components and objectives.

Another example is obtaining a bachelor's degree for a high school senior. Let us assume the student is "good average," meaning he will pass all classes and graduate in 4 years:

- Program: Graduating with a bachelor's degree in civil engineering⁴
 - Project: One semester
 - Subproject: One course
 - Work package: Homework (for the entire course)
 - Activity: One set of homework

There is one reservation in this example: All projects, subprojects, and to some extent, work packages, have the same predetermined duration. This is not the case in construction and other industries.

Where to draw the line? In many cases, the line between an activity and an assembly, an assembly and a project, or even between an activity and a project, is subjective and not so clear. Many chunks of work can be classified as an activity, assembly, or a project, depending on the overall context and the user's preference. For example, baking a birthday cake can be considered a project, or an activity within the "the party project."

Other examples:

1. Building concrete block wall around a building: An activity, subproject, or a project?
2. Converting my garage into an office: An activity or a project?
3. Replacing the carpet in my house: An activity or a project?
4. Changing a flat tire: An activity or a project?

In almost everything we do, we can break down the work based on the nature (specialty) of work, location, phase, or size. The "independence" of the work item can make a difference in labeling it. For example, in example 1 above "Building concrete block wall," if it is part of a bigger work assignment (project), then it can be an activity (task) or work package. If it is an independent work assignment, it can be considered a project.

The components may also differ in resource requirements, importance, urgency, and other criteria, but they still have one thing in common: their temporary nature (start + finish). However, what if this activity/project has repetitive, perhaps routine, nature, such as mowing the lawn, cooking dinner, changing air conditioning filter, or cleaning the house? In this case, we consider each occurrence as a "stand-alone" activity or project with its start and finish points, and the deliverable (what we have achieved). We deal with the multiple/frequent occurrences within the context of "time management," which comes within the bigger context of "life management." Such activities may be done routinely (daily, weekly, and monthly) or sporadically/occasionally. In business, these repetitive/routine/sporadic activities become part of *operations management*.

Unlike project management, operations management does not have a starting point and finishing point because it continues with continuous input and output. There are many examples of operations management such as:

- Managing a department store or a supermarket, or a specific department in the store or the supermarket.
- Managing a company, restaurant, bank, clinic, or any other business.

⁴ S/he can add constraints such as: Time = 4 years, tuition cost ≤ \$12,000, and GPA ≥ 3.0.

- Managing a department (such as IT, finance, and human resources) in a public or private entity.
- Managing a professional society or charity organization.

No two projects are identical, even if they look so. They may differ in the type of soil, labor, equipment, methods, management style, location, regulation, weather (when erected), productivities, or even accidents or incidents during construction.

Operations management has its own methods and rules for running and evaluation/measuring success. Project and operations management have similarities as well as differences. This book focuses on the management of construction projects. After the completion of the construction project, its operation and maintenance (building, road, or refinery) through its lifecycle is another topic that is outside the scope of this book.

Why and How Projects Are Initiated

Construction projects get initiated for a variety of reasons. There could be a need for the project itself or it could be an investment project. In the latter case, its expected rate of return, ROR, has to be greater than or equal a minimum threshold called the minimum attractive rate of return, MARR.

Some investors and owners like to do a pro forma for the project, which is a projection or estimate of the cost/benefit ratio or ROR on an investment. Typically, a pro forma includes all expected costs (initial, recurring, and occasional) and expected revenues throughout the life cycle of the project, and then calculates the ROR. It helps project owners and investors decide on whether or not to carry out the project.

The process of initiating construction projects also differs. A private owner has the authority to initiate a project regardless of the formalities, as long as the project satisfies legal requirements and falls within the owner's financial capacity. Corporations, privately or publicly owned, have their own rules and regulations for initiating projects, with authority usually balanced between the executives and the supervising boards. Public agencies are even stricter with the process because they deal with public money. There are many restrictions in public agencies regarding the approval of a project, the funding, the selection of a contractor, and more. In addition, public agencies must be transparent in all their dealings.

In most cases, the project starts with a proposal, and then the proposal gets vetted in what is known as feasibility study, which includes all legal (such as zoning, building code, and environmental), financial, and other aspects. For example, an owner wants to build a shopping mall on land that is currently zoned as agricultural. The feasibility study must address issues such as "Is it possible to rezone the land for commercial use?" Considering that part of the land is classified as "wetland," will there be enough land for the buildings, parking, roads, and green areas? Can this wetland be "mitigated"? Or what is the maximum building area possible there? Will the project generate net ROR greater than the set MARR? There may be more questions about the details, but the process must help the owner make the final say on the "Go/No Go" decision. Keep in mind that some issues in the feasibility study may require conducting geotechnical and other testing/studies. This is part of the planning process, which costs money, only to provide better guidance on the decision to go or not to go ahead with the project.

The feasibility study may differ in content and effort based on the type of project: residential, commercial, industrial, or other. Public projects also must go through this process, but if the project is identified as “*eminent domain*,” it will have different and “*more forceful*” approach. *Eminent domain* refers to the power of the government to take private property and convert it into public use when the project is deemed a must for the interest of the citizens in the public agency’s jurisdiction. Of course, the government must compensate the owners of the land taken by the government for the project, according to the local law⁵.

If the project is approved, the next step is to do the project charter. The project charter (also called project definition or project statement) is a statement of the scope, objectives, and participants in a project. It provides a preliminary delineation of roles and responsibilities, outlines the project objectives, identifies the main stakeholders, and defines the authority of the project manager (PM). It serves as a reference of authority for the future of the project⁶. The Project Management Institute (PMI) defines project charter as a document issued by the project initiator or sponsor that formally authorizes the existence of a project and provides the PM with the authority to apply organizational resources to project activities⁷.

The formalities of the project charter may be more emphasized in public and private corporations. Private owners may or may not do the project charter, but they are strongly encouraged to do proper planning, including defining the project scope along with major constraints and conditions (Figure 1.3).

Defining the scope and constraints of the project, as in the charter, will be the foundation of several project disciplines to be managed during the execution.

Project Lifecycle

The project usually starts with a proposal followed by feasibility studies. After that, the decision is made to go ahead with the project or not. If not, the proposal is either abandoned or returned for modification that hopefully makes it acceptable in the resubmission. Once it is approved, the project starts for the owner in the planning phase. This is an important phase that is underestimated by some owners. Planning may get combined or coupled with the design phase in a way that allows the owner to modify the scope and constraints of the project based on the design development. After the design is completed, the owner will acquire a contractor to build the project. In Figure 1.4, the owner is using the traditional (*Design-Bid-Build*) delivery method⁸, where design and construction are two separate contracts, performed sequentially. The contractor’s project starts with signing the contract, but the contractor’s planning may start when the bidding or negotiating process starts. After the final completion of the project, it gets handed from the contractor to the owner. This is an important legal

5 The term “*eminent domain*” is used in the United States of America. In other countries, there may be similar laws under different names.

6 <https://www.sciencedirect.com/topics/computer-science/project-charter>.

7 PMI, *PMBOK*, 7th edition, 2021.

8 To be explained in Chapter 3, *Contracts and Contracting*.

| Project Charter | | | | | | | | | | | | | | | |
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| Project Name | | | | | | | | | | | | | | | |
| Project Description | | | | | | | | | | | | | | | |
| Project Manager | | Date Approved | | | | | | | | | | | | | |
| Project Sponsor | | Signature | | | | | | | | | | | | | |
| Business Case | | Expected Goals/Deliverables | | | | | | | | | | | | | |
| <p style="text-align: center;">Team Members</p> <table border="1"> <thead> <tr> <th>Name</th> <th>Role</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table> | | Name | Role | | | | | | | | | | | | |
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| Risks and Constraints | | Milestones | | | | | | | | | | | | | |
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Figure 1.3 Project charter sample.

step where the owner takes possession and responsibility for the project. This step ends the “project” for both.

In Figure 1.5, the owner is using the Design–Build delivery method, where design and construction come in one contract, and may overlap. The contractor’s project starts also with signing the contract, which includes design and construction.

Project Management

The Project Management Institute (PMI) is the leading organization in the field of project management, and it defines it as application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Accomplished through the appropriate application and integration of the project management

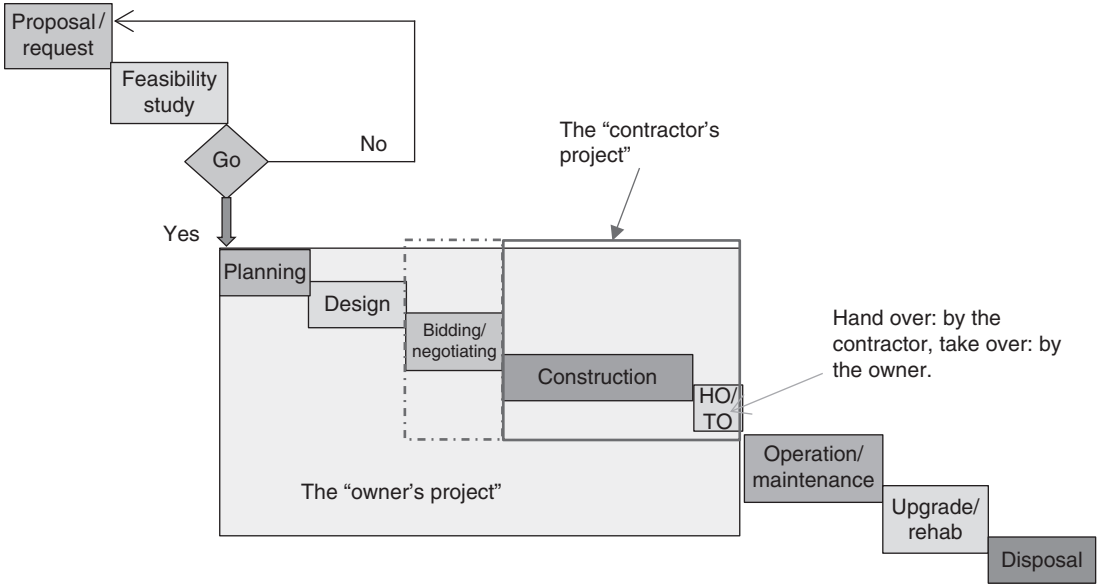


Figure 1.4 The lifecycle for a traditional (Design-Bid-Build) project.

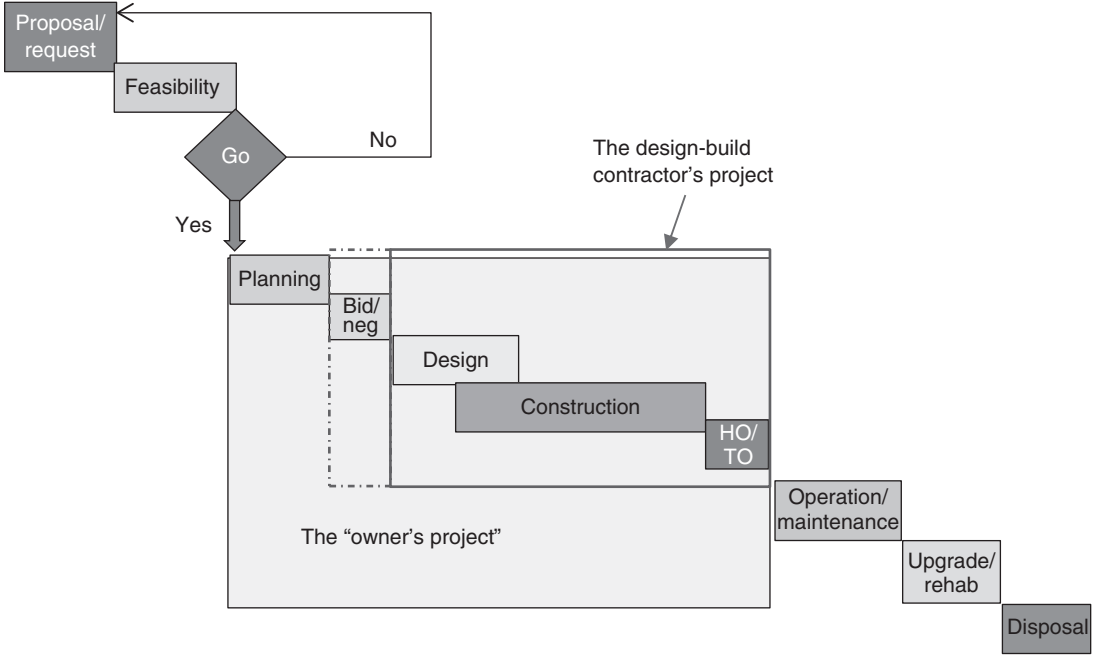


Figure 1.5 The lifecycle for Design-Build Project.

processes identified for the project (initiation, planning, execution, monitoring and controlling, and closing). Project management enables organizations to execute projects effectively and efficiently⁹.

Project management, in general, is a combination of experimental/empirical science, trial and error, rules of thumb, experts' opinions, and even art. It also contains certain scientific components. In many issues, there is no unique right way to doing things. However, there are always guidelines and standards set by professional organizations and successful individuals.

When project management is broken into areas of specialty, and each area is broken into specific topics, we can then tie each topic to the principles and rules that are most applicable.

Keep in mind that in almost every facet of project management, there are many good rules but there is no such thing as "one size fits all." The industry is so dynamic and versatile, and each project has its own characteristics and conditions that make a specific concept or tool more effective than others for the situation. Even this best concept, tool, or practice, may and does change with time.

The PMI also defines *Program Management* as the application of knowledge, skills, and principles to a program to achieve the program objectives and obtain benefits and control not available by managing program components individually¹⁰.

Project management focuses on interdependencies *within a project* to determine the optimal approach for managing the project. Program management focuses on the interdependencies *between projects, and between projects and the program level* to determine the optimal approach for managing them.

According to the PMI, the 10 Project Management Knowledge Areas are:

1. Project Integration Management
2. Project Scope Management
3. Project Time Management
4. Project Cost Management
5. Project Quality Management
6. Project Human Resource Management
7. Project Communications Management
8. Project Risk Management
9. Project Procurement Management
10. Project Stakeholder Management

These 10 areas apply to all industries but need to be customized to fit each industry's characteristics and traits. We will cover these areas in this book, from a construction industry perspective.

The Construction Industry

The construction industry represents a large component of the national economy. In the United States, as of January 2021¹¹:

- Value of Construction = \$1.516 trillion, up 15.6% from 2020
- Value of gross domestic product (GDP) = \$20.991 trillion in 2021

9 Project Management Institute, PMI, PMBOK, 7th edition, 2021.

10 Project Management Institute, PMI, PMBOK, 7th edition, 2021.

11 <https://www.abc.org/News-Media/News-Releases/entryid/9801/constructions-contribution-to-u-s-economy-highest-in-seven-years>.

- Construction = 7.2% of GDP (was 6.6% in 2019)
- From 1999 through 2015, real (inflation-adjusted) construction investment varied from 5.1% of real GDP in 2010 and 2011 to 9.4% of GDP in 1999. In 2015 and 2016, construction investment was 6.2% of GDP.

In addition to the economic impact, the construction industry touches the lives of every person and many businesses. It is comprised primarily of small companies, though there are some very large companies (Figure 1.6).

What Makes Construction Projects Unique?

1. Projects are intricate and heterogeneous, involving many different specialties (crews/subcontractors). New specialties are added as technology advances in materials, equipment, and methods.
2. Projects take from a few weeks to several years to complete and cost up to billions of dollars.
3. Projects live from years to centuries. Many of them become eminent or historic and attract visitors.
4. Most projects are visible and usable by the public. For the project team leaders, there is excitement in watching the project get built! They are also likely to take pride in being part of the project creation team, especially for eminent projects.
5. Projects are characterized by their uniqueness, non-standard production, and infinite variability.
6. Projects (while construction and after completion) are subject to weather and climatic conditions. Site safety is a major concern: unlike factories, it is hard to see all actions.
7. The “as-built” rarely, if ever, matches the “as-planned.” This is because the design and construction plan are predictions of a future event, which involves a lot of uncertainty.
8. Less “automation” and more “human touch” than most other industries, although this is changing with more modularization, 3D printing, and other technological applications.

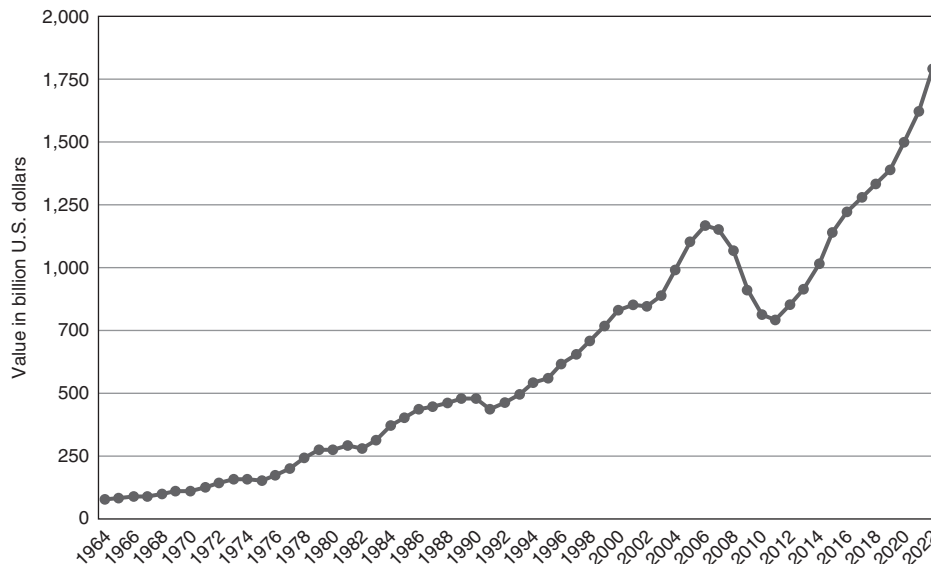


Figure 1.6 Value of construction in the U.S., 1964–2022. Source: U.S. new construction value 1964–2022 | Statista.

9. There are many project risks that are usually distributed among project stakeholders according to the contract and local laws.
10. As technology advances, the race to build structures that are bigger, taller, longer, stronger, or challenging in any way, continues. The challenge also is in the more efficient utilization of the resources and the preservation of the environment.

The definition of project management mentioned earlier applies to all types of projects, including construction and others. Managing construction projects has distinctive characteristics and guidelines. It has been described as one of the most exciting, challenging, and rewarding professions; construction management (CM) is a professional service that uses specialized, project management techniques to manage the planning, design, and construction of a project, from beginning (pre-design) to end (closeout). For all types of projects – large, small, vertical, horizontal, domestic, or international – a construction manager ensures the scope of work is skillfully adhered to, and the project is successfully delivered¹².

Managing construction projects from a general contractor's (GC) perspective is the overall management of the construction operations; technical; administrative; and others, in order to deliver the project to the client on time, within budget, and in conformance with the specifications and other contract terms, and within the boundaries of the law. This undertaking must be done while taking care of the welfare of the GC's own organization in terms of profitability, reputation, competitiveness, and long-term success, as shown in Figure 1.7.

Construction projects include a wide variety and can be divided according to several classifications. One classification includes these four categories:

1. Residential Building
2. Institutional and Commercial Building

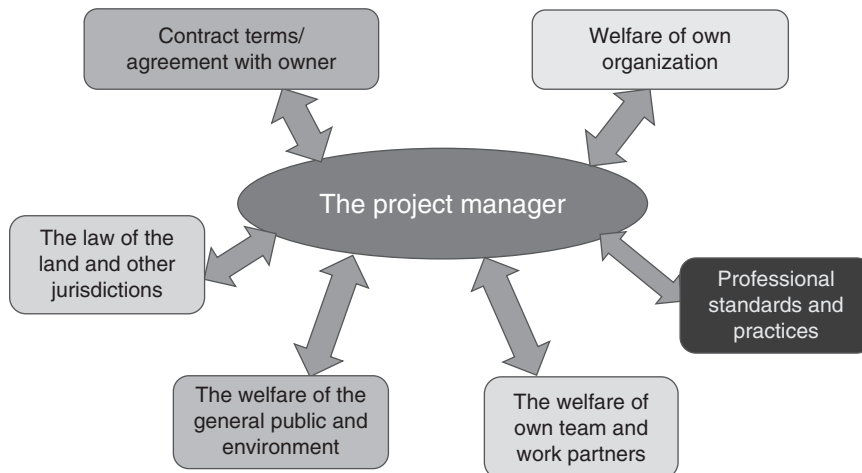


Figure 1.7 Responsibilities of the GC's project manager.

¹² Construction Management Association of American, CMAA, <https://www.cmaanet.org/about-us/what-construction-management>.

3. Specialized Industrial Construction
4. Infrastructure and Heavy Construction

Another classification breaks projects into two groups: horizontal and vertical construction. Horizontal projects include highways/roads, bridges, tunnels, mass transit, railways, and airports. These are usually led by a civil engineer. Vertical projects include all types of buildings, with architect as the lead designer.

Another classification is infrastructure or heavy construction projects, which include:

- Highways/roads
- Bridges and tunnels
- Mass transit and railways, airports,
- Airports
- Water supply/resources, hydro-electric structures (dams)
- Waste management (solid and wastewater management)
- Dredging/flood control projects
- Power generation and transmission
- Telecommunications
- Process industry (oil and gas)
- Hazardous waste removal and storage

Another group is commercial and institutional projects, which include clinics, sports facilities, large shopping centers, hospitals, jails, universities, banks, libraries, warehouses, retail chain stores, skyscrapers, schools, and other projects of various sizes and types.

Residential construction seems to be a category by itself. Projects include single-unit homes, subdivisions, cottages, apartments, townhouses, and condominiums. Most home builders are specialized: tract housing (also known as cookie-cutter) or custom homes.

Pre-engineered/premanufactured/prefabricated homes and trailers belong to manufacturing industry and not the construction industry. We are seeing more and more overlap between the two industries in construction projects. In many cases, preassembled 2D or 3D units are used in construction. We can still count these projects as “construction projects” because the final process takes place at the permanent location of the project. The main difference between manufacturing and construction is not in what we do but rather in where we do it.

Professional Organizations Related to the Construction Industry

In the United States, there are many professional organizations and societies related to the construction industry. For example, these two organizations are very important for official certification of architects and engineers:

American Institute of Architects (AIA)

National Society of Professional Engineers (NSPE)

They also produce professional documents to standardize their profession, and work between their constituency (architects and engineers) and legislators.

Other professional organizations, general or specialized, work as a hub for professionals in the same specialty. They also advance the profession in a variety of ways. For example:

The American Society of Civil Engineers (ASCE)
The American Society of Mechanical Engineers (ASME)
Institute of Electrical and Electronics Engineers (IEEE)
National Institute of Building Sciences (NIBS)

There are professional organizations that work to advance the industry and professions under the industry by doing research and producing technical and other standards, such as

The Project Management Institute (PMI)
Construction Management Association of America (CMAA)
AACE International

The following are professional organizations for professionals in the construction industry, specialized or general:

Associated General Contractors of America (AGC)
Associated Builders and Contractors (ABC)
National Association of Home Builders (NAHB)
American Subcontractors Association, Inc. (ASA)
The Mechanical Contractors Association of America, Inc. (MCAA)
American Institute of Constructors (AIC)
Design-Build Institute of America (DBIA)
The Engineering and Construction Contracting (ECC) Association
National Association of Women in Construction (NAWIC)
National Contract Management Association (NMCA)
National Electrical Contractors Association (NECA)
National Utility Contractors Association, Inc. (NUCA)
American Water Works Association (AWWA)
Institute of Transportation Engineers (ITE)
The American Academy of Environmental Engineers and Scientists (AAEES)
American Society of Professional Estimators (ASPE)
Construction Financial Management Association (CFMA)
The American Arbitration Association (AAA)
Modular Building Institute (MBI)
American Wood Council (AWC)
The Society of Construction Law North America (and The Society of Construction Law, International)
The U.S. Green Building Council
SAVE International (formerly The Society of American Value Engineers)
College of Performance Management (CPM)
The North American Society for Trenchless Technology (NASTT)
National Contract Management Association (NCMA)

These organizations focus on construction education and/or research:

American Council for Construction Education (ACCE)
 Associated Schools of Construction (ASC)
 American Society for Testing and Materials (ASTM)
 American National Standards Institute (ANSI)
 Construction Specifications Institute (CSI)
 The Construction Industry Institute (CII)
 American Concrete Institute (ACI)
 The National Fire Protection Association (NFPA)

Although our list includes only organizations either practicing in the USA or based in the USA, we must mention the International Organization for Standardization (ISO), based in Geneva, Switzerland, but its influence covers most of the world. It is focused, as its name implies, on standardizing products and specifications.

We may also mention the Royal Institution of Chartered Surveyors, RICS, based in the UK but influential in many parts of the world. It covers many construction-related specialties and issues certification for them. RICS is now expanding its activities to the USA and the Americas.

This book deals with all these areas, at varying depths, from the construction industry's perspective. The author quotes from and refers to the PMI's Project Management Body of Knowledge (PMBOK) with the reservation that PMI and its main reference, the PMBOK, serve the entire project management universe, although the PMI has published a Construction Extension to the PMBOK Guide that targets the construction industry. The construction industry, as discussed earlier, has its own characteristics, and its areas of management need to be "customized" accordingly. The author will use the PMI standards and guidelines as well as sources from other professional organizations.

Project Manager's Qualifications

Do project managers acquire their qualifications through education or experience? How do education and experience relate to each other? In fact, education and experience complement each other: Experience tells you *how*, but education tells you *why*. Experience tells you to put the reinforcement rebar at the bottom of the beam or suspended slab in the midspan, and at the top near the support. But education justifies this by teaching you that rebar must be placed where tensile stresses are high because concrete is weak in resisting tensile stresses.

Experience follows the work demand while education follows the learning process. So, in real life, you may have to jump into a situation without preparation but in education, there are curricula and prerequisites. It is wrong to compare experience to education when it comes to importance, as they complement each other. This is especially important in applied sciences. A fresh college graduate with no or little experience may get intimidated by someone with no college or even high school degree but has 30 years of experience! Of course, young college graduates need to work with others on the basis of respect, especially those with long experience, but they must also believe that their education gives them an edge that should help them reach higher professional levels. In the author's opinion, a college graduate with a few

years of experience may surpass someone with 25 years of experience and no college education. Of course, there are exceptions to every rule, but we make deductions based on the population or the general case, not the exceptions (Table 1.1).

Besides, not all types of experiences are meaningful. Experience without education may become just repetition: 25 years of experience may be indeed one year repeated 25 times. In fact, it may become a barrier to advancement if you stick to the mentality of “but we’ve been doing it this way for 20 years!”

Table 1.1 Comparing education and experience.

| Category | Academic education | Vocational education | Work experience |
|---------------------------------------|--|--|---|
| Type of knowledge | Mostly theoretical | Practical | Practical, hands-on, no theory |
| What does it teach? | Why we do things this way | How to do things | How to do things |
| Instructor/boss | Qualified faculty who must meet certain standards | Qualified professionals | May or may not be adequately qualified |
| Formal? | Yes | Yes | Not necessarily |
| Your choice in what you take | You choose major and courses within restrictions | You choose the specialty | Not much of a choice |
| Knowledge repetitive? | No | No | Yes |
| Sequence of knowledge | Systematic, logical | Systematic, logical | Random, as the job requires |
| Certificate of successful completion? | Yes | Yes | Maybe |
| Keeps up with changes? | A must | A must | Mostly yes but not always |
| Your “colleagues” | Your classmates are close in age, knowledge, and level | Your classmates are close in knowledge | Great deal of variance: Age, qualifications, and rank |
| Needed to get a job | Most likely | Sometimes required but always helps for related jobs | Most likely |
| Continuity of learning | A “project” with a target, plan, and end result | A “project” with a target, plan, and end result | May become just repetition |
| Longevity | Temporary; ends with graduation or dropout | Temporary; ends with graduation or dropout | Permanent, with possible horizontal and vertical moves |
| Knowledge advancement? | Possible via graduate study and research | No (terminal degree) but can learn new skills | Yes informally, depending on the person job, and organization |
| \$\$\$ | You have to pay unless exempted | You have to pay unless exempted | You get paid |
| Objective | To educate YOU | To qualify you for a technical job | To get the job done |

Some people pick exceptional cases when someone achieved high professional success even though did not complete his/her college degree. Scientific observations and rules are based on populations and large samples, not exceptional cases!

Project Manager's Team

The team under the construction PM typically includes technical and nontechnical personnel. Team members may be dedicated to the project and report to the PM or borrowed from the main office and still report to their functional manager in the main office. The team also gets larger or smaller depending on the project needs, which – in part – depends on the stage of the project.

The formation of the project team follows the project management organization structure that the contractor's organization follows. Basically, there are these structures:

- A. Functional project organization where all or most of the PM's team members belong and report to their functional managers in the main office.
- B. Pure project (projectized) organization where the PM's team is almost autonomous. The PM acts like the CEO of his/her own organization.
- C. The Matrix project organization is a hybrid between the above two opposite structures, with varying degrees of leaning toward one of them. The matrix structure closer to the functional organization is considered "weak matrix." Conversely, the matrix structure closer to the projectized organization is considered "strong matrix." (Figures 1.8 and 1.9)

Each structure has its own advantages as well as disadvantages. Also, each construction project lends itself to choosing the best structure for the situation. For example, the PM can have those needed on a full-time basis for the entire duration of the project as own team members. Others that are needed temporarily or on a part-time basis, can be borrowed from the main office or even a third-party source.

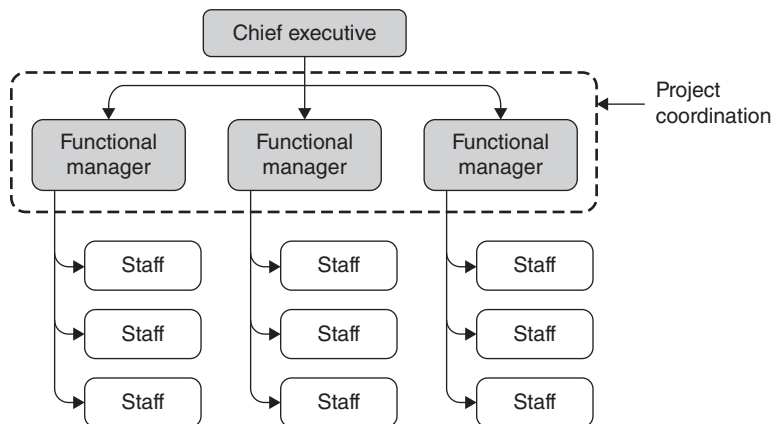


Figure 1.8 The functional project organization.

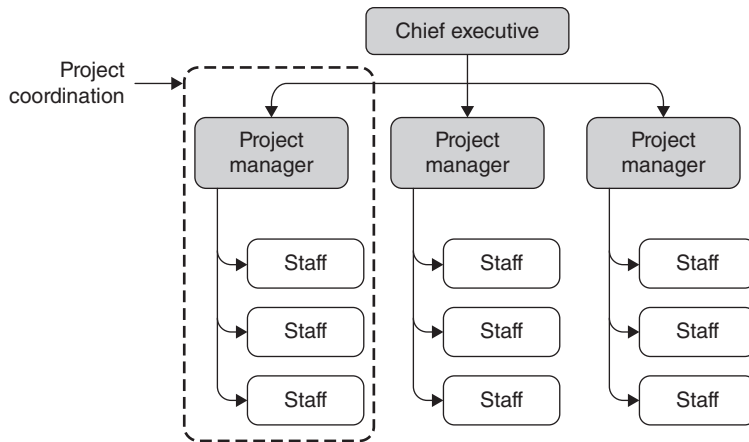


Figure 1.9 The pure project organization.

The Project Management Office, PMO

PMO is a management structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques¹³. PMO is usually a permanent part of the organization that can go up and down in size, depending on the organization's needs.

A PMO may exist in an owner or contractor's organization, but there is a major difference between the two cases. An owner's organization that frequently executes construction projects may have its own PMO to provide services in both the planning and execution phases, such as preliminary design which helps define the approximate budget and timeframe. Also, it helps in the acquisition of a designer and contractor and in project management, from the owner's side. The contractor's PMO is a major part of its organization. It is like the central command or brain for standardizing the execution of the projects.

No two PMOs operate in exactly the same way, but they can be generally divided into three PMO types¹⁴:

1. Supportive: A supportive PMO collects all projects in an organization, and supplies best practices, templates, and training, but with a low degree of control.
2. Controlling: A controlling PMO checks if the project management tools, processes, and standards are being applied in the projects with some degree of control.
3. Directive: A directive PMO maintains a high degree of control in the project management process within the organization (Figure 1.10 gives a general idea of a PMO).

The size and structure of the PMO are directly related to the organization's culture and structure, but the PMO – by nature – lends itself more toward the functional project organization. Figure 1.10 gives a general idea of a PMO.

13 Project Management Institute, PMI, PMBOK, 7th edition, 2021.

14 <https://www.projectmanager.com/guides/pmo>.

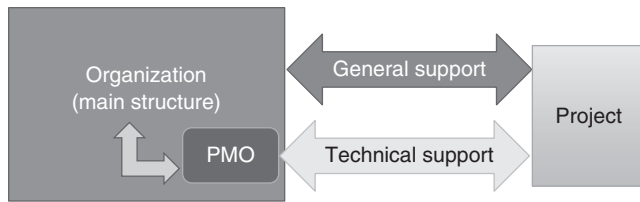


Figure 1.10 The relationship between the organization, the PMO, and the project.

Training, Continuing Education, and Certification

Training for college students is a great idea as it puts classroom education into application. They would know what setting the concrete formwork, framing a window or door, or installing a roof truss means. Internship is a wonderful idea, especially when the student is close to graduation. In addition to the experience it provides, it gives the company that hosts the internship an opportunity to closely “check” this potential job applicant, without a commitment. Many college students get job offers from those companies that hosted them previously during their internship. This is an indirect benefit of internship, provided that the student shows honesty, dedication, and a positive attitude.

Certification is another important milestone in the credentials of any professional. Certification simply means that the person who holds this certificate meets the minimum required level of knowledge in the field. It also helps standardize concepts and practices within the profession. It does not, however, guarantee good performance. In the authors’ opinion, certification is more important and meaningful for a young person with little experience. It assures the potential employer that the candidate knows the basics of his/her field. For a senior professional with lots of proven experience, the certification is less meaningful, although it is still a “feather in his/her cap.”

The most common certifications in construction project management are the PMI’s project management professional (PMP) and the CMAA’s Certified Construction Manager (CCM). In the UK, MRICS has several certifications in the field of construction.

For architects, the National Council of Architecture Registration Board (NCARB) is the main certification in the US. Engineers get certified as professional engineers (PE) by NSPE. Both certifications, NCARB and PE, are also a license to practice the profession and stamp (certify) designs. They both require an academic degree (bachelor’s degree, as a minimum) and minimum number of years of experience in the field, supervised by a certified/licensed professional. Also, these certifications may have “step exams” toward the final certification.

In addition to the PMP certification, the PMI, has also a number of specialized certifications:

1. Program Management Professional (PgMP)
2. Portfolio Management Professional (PfMP)
3. Certified Associate in Project Management (CAPM)
4. PMI Professional in Business Analysis (PMI-PBA)
5. PMI Agile Certified Practitioner (PMI-ACP)
6. PMI Risk Management Professional (PMI-RMP)
7. PMI Scheduling Professional (PMI-SP)

The author was a member of the committee that put the first PMI-SP exam in 2007 (was offered in 2008 to the public for the first time.) Other organizations such as AACE International and CMAA, have their own certifications.

The contractor also needs a “General Contractor” license, which is more of a business license than a professional certification. It still requires passing an exam that covers the main areas of construction and contracting. This license usually falls under the jurisdiction of the local government. The requirements differ by local law. In the state of Florida, USA, it is under the Florida Department of Business & Professional Regulation and has several requirements that guarantee the fulfillment of both the legal, technical, and business needs.

Keep in mind that all types of professional certifications are good within a certain state or country. Sometimes, states or countries have reciprocity rules, where a certified professional in one state/country can practice in another state/country with the same certification. Even with such a rule, the professional has to be knowledgeable of the law, codes, and standard practices in the new location.

Continuing education is another important part of any professional career and certification. It can be both optional for adding knowledge or mandatory to renew a certificate. We all need continuing education for many reasons:

1. Because knowledge keeps advancing and changing, and we need to keep up with it from experts in their field
2. Because people may forget and need a refresher
3. Because renewal of certification likely to require a minimum number of continuing education hours (CEUs)
4. You can also pick up new skills or “support topics” (software, BIM, soft skill, etc.)

In most cases, we have options for continuing education seminars: online or physical, live or recorded. Many of them run concurrently during conferences, exhibits, and other events.

Construction Management College Education: For a long time in the past, construction and construction management were looked at as empirical/experimental science, or something you can pick up by practicing in the field. However, many realized the need for formal education in construction and construction management to standardize and formalize the discipline. In the United States, most construction management (CM) programs started under other older and more established programs such as architectural or civil engineering. Then, gradually they started becoming independent under different titles such as building construction, building science, construction management, construction science, construction engineering, construction technology, and others. These majors may have subtle differences; however, they all aim to pick up from the point architects and engineers left: the execution of the design.

Construction management college education also differs in width and depth. Some schools offer a CM class to their architectural or civil engineering students. Such course is “mile wide, inch deep.” Some schools go further by offering a minor in CM, and others offer it at the master’s or doctorate degrees. Graduate programs in CM opened the doors for research, which added strength to the discipline, especially when academics collaborate with the industry. In this regard, we need to mention the Construction Industry Institute, CII, which was created to bridge the gap between academia and industry.

In addition to the bachelor’s degrees in construction management (with different titles), there are many vocational and training programs in construction trades in schools, union halls, or by professional organizations.

Project Participants and Stakeholders

A few terms are used, sometimes interchangeably to indicate the people or organizations involved in the project. Some are involved in designing or executing the project, some are involved in using/utilizing it after its completion, and others may be involved in both stages. During the construction stage, the term “project team” means the contracting parties: owner, designer, GC, subcontractors, and project management consultant. We may use the term “project participants” to indicate all those who have a role in the project: providing services, goods, finance, and/or permission. This includes the project team in addition to others such as vendors, equipment suppliers, test labs, government agencies (with jurisdiction over the construction process), investors/financiers, and those who may be consulted on specific issues (technical, legal, or other).

A project stakeholder is an individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio¹⁵. Stakeholders are typically the members of a project team, PMs, executives, project sponsors, customers, and users. In other words, project stakeholders are the people, groups, or organizations who may have something to gain or lose from your project’s outcome. These stakeholders include:

- The Owner/Client
- The General Contractor
- Designers (Architects and Engineers)
- Subcontractors
- Suppliers
- Government Authorities
- Local Residents and Business Owners
- Activists and Lobby Groups
- Labor Unions (if applicable)
- Professional bodies with jurisdiction over the design/construction process
- End Users

If we mention “key project stakeholders,” we are likely talking about the main contracting parties. The number of stakeholders increases with large and high-profile projects, especially public projects and those owned by shareholders. For example, a road project may include all those residents and businesses along the sides of the road who will be affected by the road. Stakeholders for a factory project will include all residents who may be impacted positively or negatively. It is typical to see two opposing groups of stakeholders for the same project. It is unfortunate that stakeholders do not include the animals whose habitat and livelihood will be impacted by the project!

Types of Owners

1. Public (government): This includes all levels and types of government agencies.
2. Private corporations owned by shareholders, as well as nonprofit organizations. These corporations usually have a board of directors (or trustees) that oversees the running of operations as well as major decisions.

¹⁵ Project Management Institute, PMI, PMBOK, 7th edition, 2021.

3. Private individuals or corporations/businesses owned entirely by an individual or group of individuals.
4. Public Private Partnership (PPP): This is a common type in some states/countries where a private entity funds a public project in exchange for a percentage of the revenue for a period.
5. International or multi-national organizations such as the United Nations and its suborganizations. In this case, the project will be subject to rules and regulations of both: the owner (international organization) and the host country.

Impact of type of owner on many aspects of the project, particularly:

1. Project initiation process and justification. For public agencies, there are strict guidelines for why and how a project can be initiated. These guidelines include cost threshold for any specific process. For example, if the cost exceeds a certain amount, usually \$100,000–200,000, a minimum of three qualified bidders is required. Even when the project is under that threshold, there is still a strict policy for awarding. Any changes to the project later after its initiation, including the budget, must also follow the official guidelines.
2. Authority and the decision-making process: While private owners have the liberty in making decisions on the project, designer and contractor acquisition, or others; public agencies are restricted to protect public money. The authority in making decisions for public agencies is usually well defined and varies at every level of the agency's hierarchy. This applies also to delegation of authority, which has its own guidelines in public agencies.
3. Stakeholders: One main difference between public and private organizations is that the owner and the client can be the same entity in the private sector. In the public sector, the owners are the citizens that the public agency serves. The officials of the public agency are the "clients" who deal with designers and contractors on behalf of the "owner." Stakeholders for public agencies may include a wide group of parties. In fact, every taxpayer among the constituents of the agency can be considered a stakeholder.
4. Source(s) of funding. Public agencies get their funds usually from a variety of sources including taxes, fees, grants, loans, and others. Many types of funds, particularly grants, have strict guidelines that can impact the project scope and constraints. Market trends may impact future projects for public agencies in more than one way: The estimated cost of the project may change before signing the contract. Also, these trends may impact the sources of funding for the project.
5. Transparency: For public agencies, all actions including contracting and spending must be transparent to the public. This is not necessarily required in private projects, especially when the owner and client are the same.

Capital Improvement Projects

A capital improvement project is any major improvement to facilities and infrastructure. Projects may include construction and renovation of roads and streets, bridges, intersections, traffic systems, recreation centers, libraries, parks, automobile parking garages, water and wastewater treatment facilities, solid waste and recycling plants, and power stations. It may also include the purchase of new fleet vehicles and IT networks. A capital improvement project is usually proposed and approved by the government agency that has jurisdiction when it can prove that the project fulfills a need or improves the quality of life for the citizens in that area. These projects are usually included under the capital improvement programs. Such programs get an annual budget that may not be sufficient for all proposed projects,

so these projects are ranked in terms of priority. Some projects get priority in approval and execution, others are postponed or scaled down, while others are canceled.

Most governments put guidelines for projects in order to be called capital improvement projects and thus financed by the capital improvements program, such as a minimum budget and/or minimum lifespan.

Although capital improvement projects usually are created and financed by governments (city, county, state, and federal), it is possible for private organizations to create their own capital improvement projects. Some capital improvements are given favorable tax treatment and may be exempted from sales tax in certain jurisdictions.

The Construction Industry: Past, Present, and Future

Construction is one of the oldest professions and will continue as long as there are humans on the planet. People always need homes and places for work, recreation, worship, and other activities. They need transportation systems, water plants, power generation plants, and infrastructures for other utilities. Perhaps with time and advancement of science and technology, materials, equipment, methods, and concepts change, but there will always be a need for construction projects. Those who want to not only survive in the market but also advance and lead, need to be futurists, creative, and one step ahead. Several trends have already started to advance in the construction industry such as modularization and IT tools and computer software that were not even imagined a few decades ago. At the same time, challenges grow bigger such as global warming (that increased the intensity and frequency of certain natural disasters), shortage of fuel and certain materials, and environmental restrictions. Tomorrow's construction professionals will need to meet these challenges with innovative and efficient solutions to make sure products have quality, durability, and cost-efficiency.

Exercises

- 1.1. Define a project and give an example.
- 1.2. Give an example of a program that contains projects.
- 1.3. Can taking care of your garden be considered a project? Mention two cases where one answer is yes and the other is no.
- 1.4. You are thinking of converting part of your house attic to an office. How can you make this idea into a project?
- 1.5. Do you consider the following as projects (with the description as is)? If not, modify it to make it qualify as a project.
 - a. Improving your education
 - b. Changing a flat tire
 - c. Losing weight

- d. Building a 20 feet by 25 feet expansion for your house
 - e. Cleaning the gutters of your house periodically
 - f. Maintaining your house garden in good shape
 - g. Organizing your garage
 - h. Going on a fun trip for a week
 - i. Doing a birthday party for your younger sister
- 1.6. How does the owner’s “project” differ from the contractor’s “project”?
- 1.7. Why must an owner do feasibility study before approving or making a final decision on the project? What are the main objectives of this feasibility study?
- 1.8. Mention the main stakeholders in a private project.
- 1.9. Mention the main stakeholders in a public project.
- 1.10. In what aspects do public and private projects differ?
- 1.11. What is a capital improvement project?
- 1.12. What are the types of owners of a project?
- 1.13. What benefits does certification in construction management, or one of its specialties, bring to the bearer of the certificate, to the employer, and to the client?
- 1.14. What is a PMO? Why would an organization have a PMO as a part of its structure?
- 1.15. For the same construction project, the contractor has a PM, and the owner may have a project manager. What are the major differences in their roles?
- 1.16. Mention two types of each category:
- a. Vertical construction
 - b. Horizontal construction
- 1.17. What are the two main types of project organization? How do they differ? What is the project organization that is in between the two types?