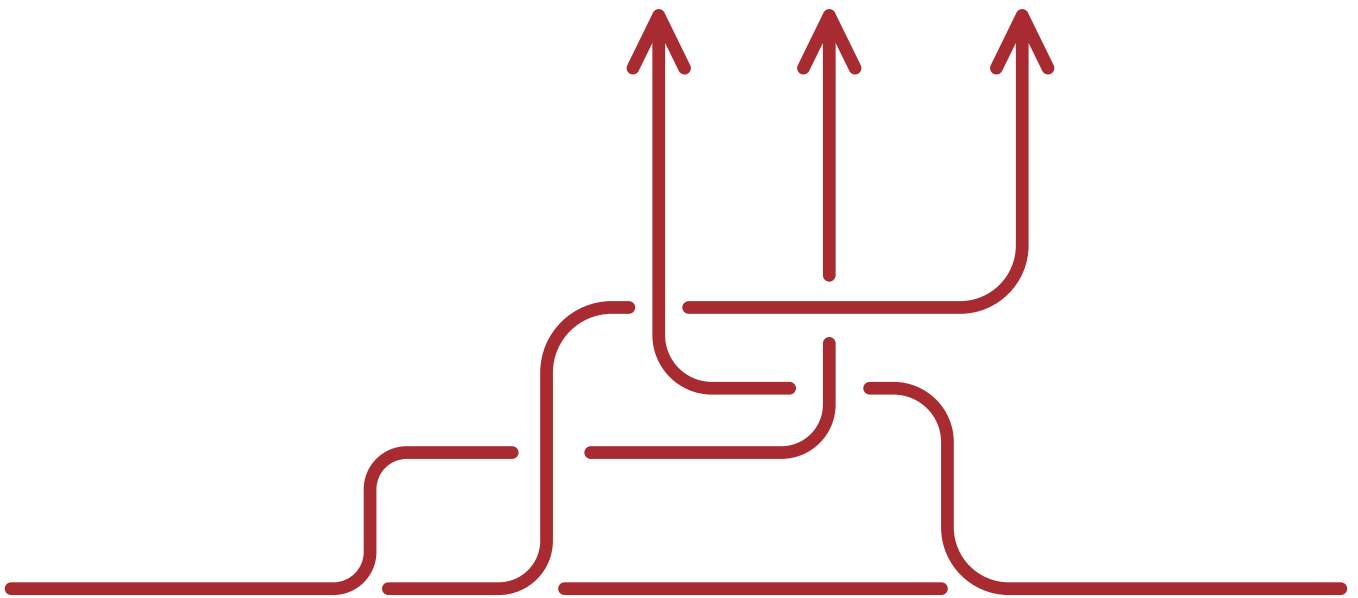


PROJECT MANAGEMENT



PRADEEP PAI

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Project Management

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Project Management

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Dedication

I dedicate this book to the memory of my father Late *Kulyadi Prabhakar Pai*
and my mother Late *Prabha Prabhakar Pai*.

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Preface

Projects and Project Management techniques have been around for ages. Entrepreneurship, which is an essential element for successful businesses, also follows the concepts of project management very closely. Further, decision making, a key requisite for managers also imbibes the properties of project management. It is therefore imperative that all managers and business leaders be groomed in the skills of project management. The subject of project management is thus an important part of the academic curriculum for all management programs.

The subject of project management has many dimensions like the optimising aspects, conceptual aspects, practical aspects, operational aspects, project case studies, project guidelines, etc., which make the scope fairly wide. The contents that may be of relevance to a project management practitioner or project management professional or a project management student could be entirely different. Currently, most of the project management books available cover one or some of the aspects listed above but miss out on the comprehensive coverage of the subject from a student's or a beginner's perspective. Besides, authors from the project management practising areas focus on the operational aspects, those with a finance grooming focus more on the financial aspects of projects and the optimizing experts focus only on project optimization by including this subject as a chapter in Decision Sciences books.

Just like the scope for a project is very important for its success, the scope of this book addresses the learner's requirement of project management skills more than a practitioner's requirement. Having said that, the practitioner of project management could use this book as a reference for the base topics and concepts on which the framework of project management exists. Students and faculty will find this book most useful in understanding the concepts of project management like the optimizing techniques for the various concepts namely CPM, PERT, Crashing, Resources scheduling, Earned-value analysis along with a comprehensive coverage of the financial aspects like capital budgeting, future cash flow statements for project and the ratios that are important for project viability.

Some examples and Indian cases have been added to this book which we hope would give the practical aspects of project management to the students. This book is appropriate for MBA students, post-graduate courses in engineering, and senior undergraduate students undertaking the course of project management for the first time.

Acknowledgements

For any work as tedious and strenuous as writing a textbook, one needs a constant level of motivation besides ample support. I am lucky on both these counts and wish to express my sincere gratitude to everyone who has made the present book possible in its current form.

The primary motivation for this book has been the student fraternity whose requirement of a comprehensive academic textbook in the subject of project management facilitated this book and its contents. In fact, the idea for some of the contents of this book like agile project management and future trends in project management was a result of the students' assignments and class presentations. I express my gratitude to all my present and past students for the same.

The environs for writing the book and the support system for referencing is key for good quality work. My institute NMIMS School of Business Management (SBM) provided me with all the facility required for producing quality work on the subject. I express my sincere gratitude to SBM and the parent body SVKM for this opportunity and sincerely hope that this work will be up to their exacting standards.

I express my gratitude to all my faculty colleagues who were always willing to support me in this endeavour and helped me immensely in making this work possible. Prominently, I received encouragement from Prof. Mayank Joshipura on project finance matters, Prof. Papiya De on the usage of English language, Prof. Harikumar Iyer on chapterization and Prof. Souvik Dhar in providing lighter moments when the proceedings were stressful.

My special thanks to Provost and Dean SBM Dr Ramesh Bhat for his critique and encouragement at every stage of the development of this work.

I will be failing in my duty, if I do not acknowledge the support of the Vice Chancellor of NMIMS University, Dr Rajan Saxena, for his wonderful words of advice and for writing the foreword for this book.

I take this opportunity to thank Shri Raghunandan Kamath proprietor of Naturals Ice creams for helping me write the case study on their successful business ventures.

My wife Sujata and daughter Priyanka were instrumental in keeping me awake all night by providing ample cups of tea while writing this book and I take this opportunity to thank them for their support always.

My sincere thanks to Partha Bhagowati, Varun Goenka for being extra patient with me on many occasions and for lending a helping hand in every difficult situation. My gratitude to everyone at Pearson for the wonderful work in compiling this text.

My prayers and thanks to God Almighty for his blessings for the success of this venture.

Foreword

I am delighted to write this introduction for Pradeep Pai's book on Project Management. Pradeep Pai, who is a faculty at NMIMS School of Business Management, Mumbai, is an acknowledged academic resource in Project Management and Operations Management. He combines his understanding of the subject with industry experience. This book, therefore, benefits from this unique combo experience of the author.

The book is an exhaustive text in the area of Project Management starting with concepts in project management and defining significant players like government and the world bank in project planning and execution. This is particularly true for emerging markets like India. The author has also explained various tools in project analysis, planning and design and execution. He has also covered the approaches and tools used in project appraisal and selection. The unique feature of this book, I understand is a detailed section on financial tools used in appraising the project. This book is suited for management programs of the University of Mumbai and other Universities in India.

I recommend this book.

Dr Rajan Saxena, Vice-Chancellor of the SVKM's NMIMS

About the Author

Professor Pradeep Pai has been in the field of academics for over 28 years, along with serving the industry parallelly for almost 20 years. His field of work has been in quantitative subjects like Operations Research, Project Management, Business Statistics and Supply Chain Management. Presently, he is working as Associate Professor, Decision Sciences and Chairperson at NMIMS University, School of Business Management (SBM), an AACSB accredited institute. He started his professional career with M/s Godrej GE Appliances Pvt Ltd., in their refrigerator division. Besides his academic interests, Prof. Pradeep Pai also consults organisations in the field of operations and management of projects.

Chapter

1

INTRODUCTION TO PROJECT MANAGEMENT

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- Explain the project, project management, project life cycle and the fundamentals of project management.
- Describe the ‘S’ curve.
- Examine the parameters for success of a project work breakdown structure (WBS).
- Enumerate the differences between an EPC company and a company’s own project organization.
- Discuss the case study on project management—The Konkan Railway Corporation Limited.

INTRODUCTION

Mankind’s greatest marvels and landmarks, whether it is the Great Pyramid of Giza, construction of canals for irrigation in Mesopotamia and Egypt, landing on the moon, building the magnificent the Eiffel Tower or the Taj Mahal, are examples of successfully executed projects.

Projects are not only related to monuments or engineering feats but are also essential to business ventures or personal decisions. Consider the following examples:

1. Mahindra & Mahindra Ltd, a \$6 billion company is considering acquiring another automobile company.
2. Mukand Ltd is considering an expansion project in its Hospet steel plant.
3. Mustang Engineering Company is considering the establishment of a new centre in India.
4. The Government of India is considering linking major rivers in the country.
5. A business executive is considering to purchase a new flat and has to select the best option among various available options.

All the above examples comprise processes that are unique and non-repetitive. Each of these examples explain situations where the schemes of investments can be assessed independently besides laying out the milestones to be achieved in the process. The basic characteristic of a *capex*

What is a project?

- A set of non-repetitive or an on-off kind of task is referred to as a **project**. The size of a project in terms of investments, resources or outcome is not instrumental in describing any activity as a project. However, a project is defined based on the fact that the set of tasks should be non-repetitive, sequential and one of a kind.
- Some of the tasks comprising a project can proceed simultaneously, whereas some tasks cannot happen unless the prior activities are completed. One of the objectives in project management is to identify the set of tasks that require the longest duration and are termed as **critical path**. This critical path defines the duration of the project, and in order to ensure that the project does not get delayed, these critical path tasks should not be delayed.
- Any set of tasks in a project needs to be controlled within three set of parameters: scope, time schedule and financial and other non-financial but key resource constraints, such as manpower, equipment and finance. Proper planning and foresight help in the completion of the project within the above listed constraints without much delay or confusion.
- At times, when there is a constraint on the availability of resources, knowledge of priority rules for activities can be helpful in completing projects without affecting the project schedule.
- Sometimes, there is a possibility of speeding up the project schedule by providing extra resources at additional costs. The decision to avail of such facility or not is again a managerial decision, which must be taken on the basis of cost-benefit analysis. This analysis is termed as **crashing**.
- During the course of the project, there might be a peak requirement of a limited resource, and at other times, that particular resource may not be required at all. The skew in the requirement is ill-advisable and project management techniques help in streamlining these peak and low demand periods.
- Activity on node (AON) diagrams are gaining popularity rapidly. Although the earlier form of network, known as activity on arrow (AOA), is immensely popular, the utility of an AON diagram makes it preferable to AOA. Situations where parallel processing of preceding and subsequent activities, albeit a time lag is feasible, can be addressed by AON networks. AOA networks cannot be admissible in place of AON networks involving parallel processing.

or capital expenditure of a project typically comprises cash outflow (which can be current or future) and cash inflow, with projects having higher cash inflow preferred over projects having lower cash inflow.

Inventories are treated as assets in the balance sheet, whereas anyone involved in inventory management (and, thus, exposed to concepts such as zero inventory) will agree that inventory is anything but an asset and it would have been better if inventory had been classified as a liability. Similarly, an expenditure resulting in streams of benefits in the future (some examples include research and development expenses, equipment retrofitting and reconditioning, etc.), should ideally be classified as capital expenditure but at times, get wrongly classified as revenue expenditure. In case of projects, project management is concerned with capital expenditure. The manager should rightfully view any *capex* expenditure (even if classified as revenue expenditure for accounting purposes) as an example of project management and thus, apply all the project management evaluation techniques.

Projects and project management are not restricted to the private sector or to businesses with profit-making objectives. Project management is also a vehicle for performing social work and community services. Endeavours such as providing relief to tsunami victims in Japan or victims of earthquake devastation in Turkey require the applications of proven project management techniques.

The Project Management Institute's (PMI) Project Management Professional (PMP®) credential is the most important industry-recognized certification for project managers. Globally recognized and demanded, the PMP® demonstrates that the certificate holder has the experience, education and competency to successfully lead and direct projects.

DEFINITION OF A PROJECT

Having briefly discussed the various types of projects from pre-historical times and some of the aspects related to project management, let us define a project.

According to Wikipedia, 'a **project** is a temporary endeavour with a defined beginning and end (usually time-constrained, and often constrained by funding or deliverables), undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value'.

A second definition says, 'a **project** is an organized unit dedicated to the attainment of a goal, which is the successful completion of a development project on time, within budget, in conformance with predetermined program specifications'.

Another simpler definition as coined by the PMI is as follows: 'a **project** is a temporary endeavour undertaken to create a unique product or service'.

In all the above definitions, a common element is the words 'temporary endeavour' and 'unique product'. This is the essence of project management, wherein a non-repetitive task is performed every time an activity is defined as a 'project'. The major goal of any project is to satisfy the customer's need, and in this sense, the project or project management is similar to other functions of any product or service organization. Beyond this similarity, the features of a project are completely different from other organizational functions described as follows:

1. An established goal or objective, which when achieved, completes the purpose and hence the existence of the project. Projects are therefore temporary and need to be disbanded after the objectives are complete. The organization functions on the other hand continue to exist even when the goals are achieved.
2. It has a defined lifespan with a start and an end. Another example of temporary existence is the start and end times, which are predetermined.
3. A project encompasses professionals wearing many hats or personnel with multifarious credentials, which means more generalists and less of specialists. Multitasking being the need of the hour, the preference is always a generalist rather than a specialist.
4. It comprises a unique set of activities, which have hitherto not been performed. A company in the field of construction makes many residential buildings that are not similar. However, a motorcycle-manufacturing company manufactures the same product repetitively and reaps the benefits from such a mass production. Similarly, benefits of a learning curve as is applicable in labour-intensive industries performing repetitive jobs are largely lost.
5. Specific scope, duration, cost and quality parameters—The evaluation of project success and often, the payment(s) related to completion of the project, are linked to the scope, duration, cost and quality parameters. Some of these are not the requisites for product or service pricing, which differentiate the projects from other non-project organizations. The four constraints account for a higher degree of accountability in a project, which is not so specific for

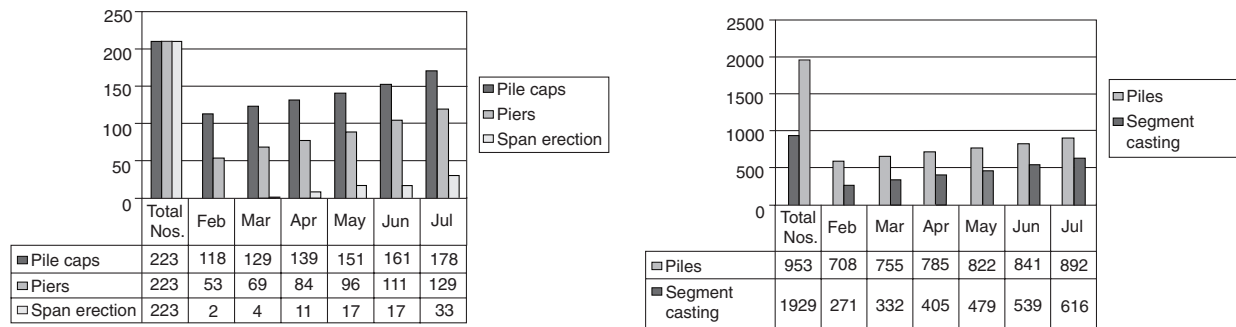


Figure 1.1 Progress report/status of Bengaluru-based 'Namma Metro' as on August 1, 2009

other organizations. The price or configuration of products as in case of laptops may change frequently or the time to deliver may also be affected due to extraneous reasons. Although these aspects may be acceptable for products and services, such violations must be strictly avoided for projects. Figure 1.1 illustrates progress report/status of Bengaluru-based 'Namma Metro' as on August 1, 2009.

DEFINITION OF PROJECT MANAGEMENT

Although projects have been in existence since the beginning of civilization, the concept of project management is relatively new. In the early 1900s, the Industrial Revolution eventually led to understanding the need for an organized skill in managing diverse projects. Although the projects are unique and non-repetitive, project management, on the other hand, is fairly repetitive and the techniques used for managing projects are the same whether the projects are large ones (such as building a dam or a highway) or small projects, typically with short durations like 1 hour lectures.

Project management can be simply defined as 'an organized venture for managing projects'. A more detailed definition could be 'project management is the application of knowledge, skills, tools and techniques' to project activities in order to meet or exceed stakeholder needs and expectations from a defined project, thus balancing the following:

1. Scope, time, cost and quality
2. Stakeholders' expectations
3. Requirements (needs) versus unidentified requirements (expectations)

In other words, project management involves the scientific application of modern tools and techniques in planning, financing, implementing, monitoring, controlling and coordinating unique activities or tasks to produce desirable outputs in accordance with the predetermined objectives within the constraints of time, cost and quality. There are certain institutes such as the PMI which have courses on various aspects of project management. A PMP® certificate is, at times, mandatory for working on software projects or for working in engineering procurement and construction (EPC) companies.

Project management consists of the following stages:

1. Project planning
2. Project scheduling
3. Project implementation, controlling and monitoring
4. Project commissioning
5. Project hand-over to the operations team/client organization

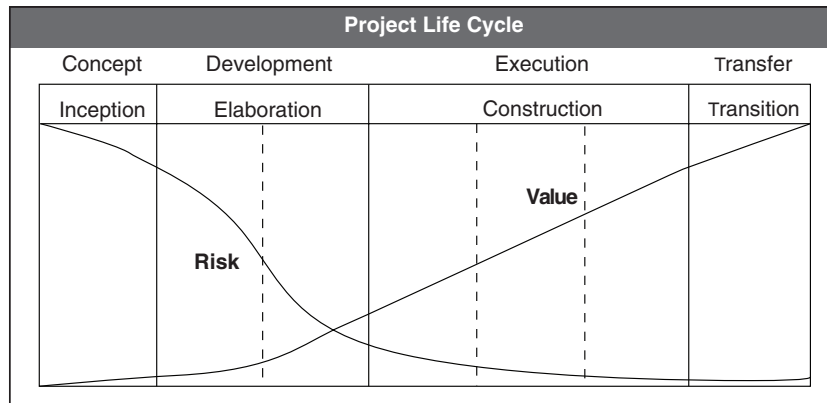


Figure 1.2 Risk reduction (red curve) and value creation (green curve) during the project life cycle

PROJECT LIFE CYCLE

As in the case of a product life cycle, there are four stages and the probability of completing the projects increases as the stages progress. These are as follows:

1. Project concept stage or inception stage
2. Project development or the elaboration phase
3. Project construction or the execution phase
4. Project transition or the transfer phase

The specific goals of the project team vary over the life of the project. In the beginning, there is considerable flexibility in the expectations from the project. It may not be clear whether the project is feasible or if it is even likely to be profitable. At this time, the activities centre around screening of ideas, feasibility studies, financial modelling for attaining closure of the project, appointment of the project contractors, etc.

Towards the end of the project, when the product itself is usually complete, the issues of quality, delivery and completeness then take centre stage. At different times, tasks are undertaken in new ways and work products will have new content. Another factor that needs to be considered is the risk element in successful project completion, which reduces as the project progresses. Similarly, with the passage of time and completion of more phases, the intrinsic value of the project increases thus depicting higher probability of project completion. These aspects are shown in Figure 1.2.

To coordinate the project team's effort at various phases of the project life cycle, the broader activities at each stage are shown in Figure 1.3. For ease of remembering the four phases of a project life cycle, they can be classified as C ~ D ~ E ~ F or Conceive ~ Develop ~ Execute ~ Finish.

THE 'S' CURVE

The 'S' curve is a well-known project management tool and consists of 'a display of cumulative costs, labour hours or other quantities plotted against time'. The name is derived from the S-like shape of the curve, flatter at the beginning and end and steeper in the middle, because this is the way most of the projects look like. The 'S' curve is useful as a cost estimation tool because it is the way most of the projects look like in the real world. It can be considered as an indicator and is used for many applications related to project management, such as target, baseline, cost and time.

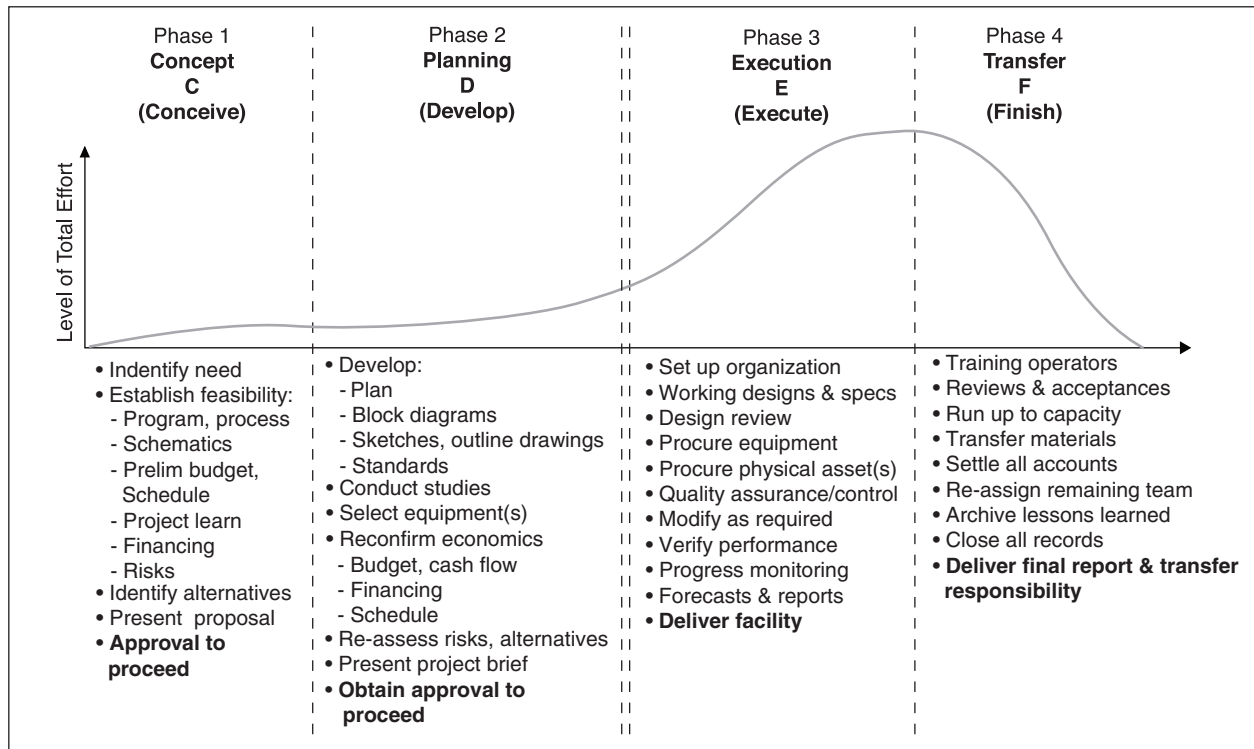


Figure 1.3 Total effort put in by the project team in various phases of the project life cycle

There are various ‘S’ curves, which are as follows:

1. **Cost versus time ‘S’ curve:** Appropriate for projects that contain labour and non-labour tasks.
2. **Target ‘S’ curve:** This ‘S’ curve reflects the ideal progress of the project if all tasks are completed as currently scheduled.
3. **Value and percentage ‘S’ curves:** The percentage of ‘S’ curves is useful for calculating the project’s actual percentage completion.
4. **Actual ‘S’ curve:** This ‘S’ curve reflects the actual progress of the project to till date.

In order to generate an ‘S’ curve, a baseline and a production schedule are necessary because they contain important information for each task, which are enlisted as follows:

1. The baseline contains information about actual start redundant and finish date. The baseline can also contain information about man-hours and costs.
2. The production schedule contains information about the actual percentage completed for the project.

The ‘S’ Curve Generator is a software package that integrates with MS Projects to automatically generate ‘S’ curves.

As can be seen from the Figure 1.4, the cost incurred or requirement of finances for the project is very less at the initiation or concept phase and at the transfer or the closure phase. There is a steep rise in the requirement of funds during the execution or development phase. Any curtailment of funds at this stage can lead to project delays.

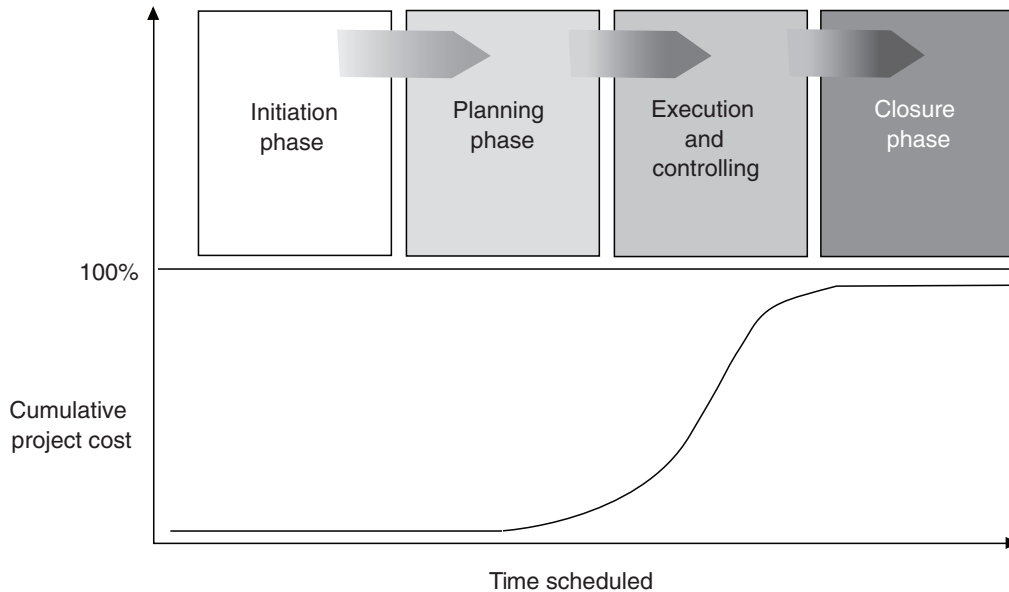


Figure 1.4 Sample project cost 'S' curve

TRAITS OF A PROJECT MANAGER

The project manager is an integral part of a project and often, the success or failure of a project is a result of the project manager's efforts or the lack of it. For starters, the project manager has an unenviable task of getting diverse functions to work together on a path that gets scripted as it is traversed. The contributions of the functional specialists should be properly coordinated by the project manager, who has to necessarily be a generalist. The role of a project manager is in preventing the untoward and unplanned happenings as depicted in Figure 1.5.

The qualities expected of a project manager for the successful execution of a project are similar to those required of an entrepreneur, who has to strive hard for the success of his business venture. Some of the prominent abilities required from a project manager are listed here.

1. **Planning ability:** The planning ability is the foremost requirement for the successful execution of the project. As all projects are dissimilar to a large extent and get completed over long-time horizons, the ability to set targets and milestones becomes the primary responsibility of the project manager. A structured and detailed breakdown of the achievable tasks on a time frame becomes important to monitor the progress of projects and for analysis of variances in completion at regular time intervals. This breakdown of tasks (later explained under the heading work breakdown structure) is required to set progress milestones and calls for extensive planning skills.
2. **Maturity:** Due to the uniqueness of the project and involvement of a vast number of functional specialists, consultants and sub-contractors, there may be complex situations that need to be handled patiently. This is when the project manager has to exhibit maturity and take things in his/her stride with a sense of timing to make certain moves in the interest of the project. It is simple to conclude that there is disagreement between functional specialists and that the project cannot proceed further, but it is more important to bring these diverse views into convergence in the best interests of the project.
3. **Toughness and willingness:** This requires the manager to take contrary positions rather than taking an easy way out, or to take a path of least resistance or to cave in to the pressure.

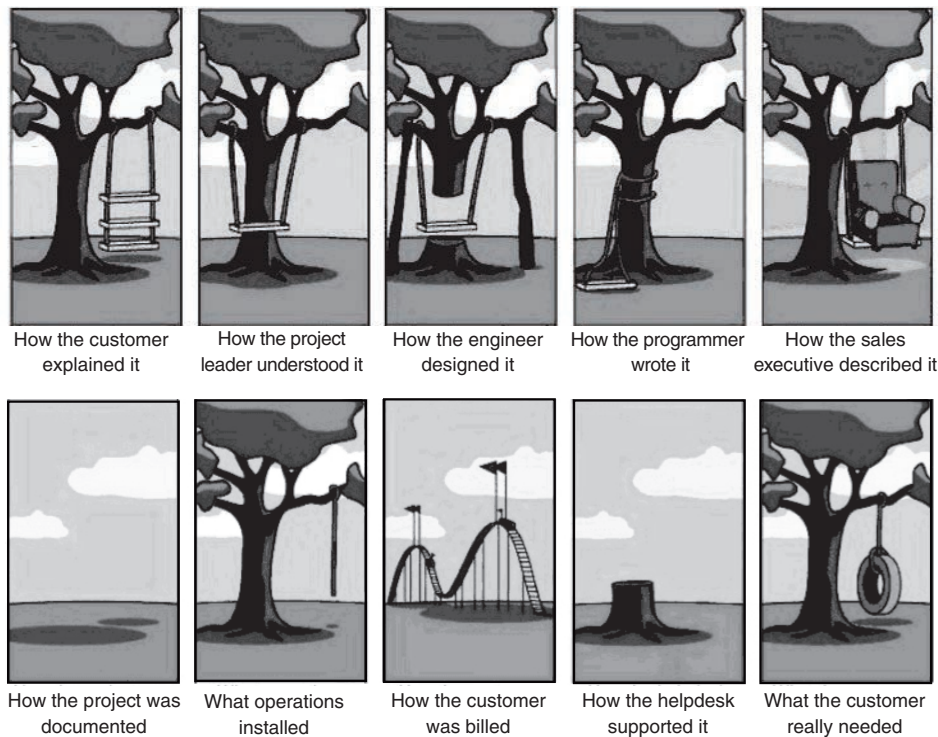


Figure 1.5 Situations a project manager has to prevent

At times, unconventional wisdom might have to be used to arrive at unique solutions in which case, lot of opposition would be faced from many quarters. At these times, the risk-taking ability of the entrepreneur and the willingness to take tough decisions must be exhibited by the project manager. However, it must be understood that these contrary positions should be in the long-term interests of the project and should not be in the form of *jugaad*, for which Indians are famous for.

4. **Receptive:** A project manager should be open to ideas from different sources and should not be fixed on his/her own views. This means that he should have the ability to take directions, suggestions, hints and criticism from various personnel involved in the project and convert them into positive action. Essentially, since projects are unique, unless complete, the lesson cannot be derived from the project. Hence, any kind of alternate solutions should be appreciated by the project manager.
5. **Communication skills:** Both written and oral instructions and paper work are involved in the various stages of a project and enough confusion exists as it is. Any further confusion due to communication errors is certainly undesirable. The project manager should be well aware about these issues and make additional efforts in improving his/her communication skills.
6. **Energy:** To deal with problems and work hard, unlike office work, which can be performed under fixed work hours, projects and project management require many more hours of hard work at. On other occasions, there can be instances of lack of work. Further, inputs received from global consultants working in different time zones add to the complexity of work. A project manager should, therefore, possess a lot of energy to meet these requirements.

7. **Ability to take measured risks:** Projects generally face unknown problems and require solutions which are untested. In such situations, there is a fair amount of risk that is involved in decision-making. Unless the project manager has this risk-taking ability, the progress of the project would be hindered.
8. **Go-getter attitude:** A project manager is like an entrepreneur and unless he/she has an optimistic approach to issues, not much development can happen. Projects require a fair amount of enthusiasm to make progress under different adverse conditions. It would be much easier to give reasons for work not being done but it is very difficult to do work surpassing these obstacles. Hence, unless the project manager has a go-getter attitude, it will be difficult to attain success in a project.

In addition to these personal qualities, the project manager should also possess the following managerial qualities:

1. **Good interpersonal skills:** Project management is more about management of people than resources. Ability to negotiate your way through seniors and subordinates in a situation as dynamic, uncertain and overlapping as projects is the key to success of the project.
2. **Conflict-solving ability:** With regular overlap of activities and many claimants for limited resources, conflicts are an inevitable part of projects. Such conflicts, if not resolved amicably, can lead to costly delays and other problems. Therefore, the conflict-solving ability of a project manager is important to the successful completion of a project.
3. **Problem-solving capabilities:** In a largely unstructured set-up of projects, unanticipated problems crop up frequently. The ability to understand problems, place them in perspective and develop and implement solutions is necessary to achieve the project goals.
4. **Perspective vision:** This trait ensures that a backward step is taken to gather an overall view of the developments, to review the symptoms of problems and to work a way ahead. In some situations, the problems are so engrossing that finding a solution seems almost impossible. Looking at the problem with a different lens or perspective helps in addressing the immediate limitations.
5. **Effective time management/Ability to delegate:** Problems and activities are overwhelmingly complex. Management of time is a vital requirement. No project manager can survive a day without the ability to delegate tasks and authority effectively. Finding the right activity to be delegated to the right subordinate and to uphold the decisions of the subordinate in this regard is an important managerial trait, necessary for a project manager.
6. **Familiarity:** The manager's familiarity with the organization to understanding funding and decision-making process is paramount. The process of decision-making and the authorities of the personnel involved in decision-making is an important requirement for proper and conclusive decision-making process. Decisions made should be such that it is not questioned by the higher authorities at a later date. Hence, the project manager should be familiar with the organizational structure and hierarchy so that decisions made are not overruled at a later stage.
7. **Initiative:** Initiative and risk-taking ability to accept/delegate tasks are essential attributes of a manager. The project manager should encourage decision-making at every stage of the project from those involved in delivering the stage requirement. Even if decisions involve some risks related to the project, the project manager should support such measured decisions. This will ensure that everyone in the organization is willing to take the initiative and help in completing the project on schedule.

PARAMETERS FOR THE SUCCESS OF A PROJECT

A project is akin to a three-legged stool. If any of these legs is not up to the mark, a project is not completely successful. The three legs of project are as follows:

1. **Scope:** Deliverables as per the contract. Performance as agreed upon in the contract.
2. **Time:** As agreed in the contract.
3. **Cost:** As agreed in the contract.

The degree of success of a project is measured by the sum of performance on the above three counts. In addition to these three key points, the quality of the project must be maintained. Although the scope would encompass this requirement, it is important that the quality parameters are clearly defined.

Each project has its own peculiarity. While ‘scope’ is most important in most cases, there are cases where time assumes paramount importance. In cases such as the Commonwealth Games conducted in Delhi in 2010, there was no scope for time over-run. Although there can be minor compromises on scope and cost of the project in such instances, there can be no compromise on the time or duration of the project.

In commercial contracts, cost and scope both have equal importance, whereas, cost overruns are not allowed. Sometimes, due to unavailability of specialized equipment, like the barge-mounted Hercules crane used in the construction of Bandra-Worli Sea Link (BWSL), there is a possibility of the project being delayed. Defining the scope is very important. Scope should be defined in a quantitative manner to the maximum possible extent. Qualitative terms in scope definition only lead to litigation. For example, saying a ‘big house’ is as vague as it can get. The client must specify the number of rooms of various dimensions required. Time and cost are functions of scope and will be quoted as per the definition of scope. Any change in scope at a later date will result in either extra time or cost over-run or both. Further, if the scope is changed without changing the time and cost, then, the quality may be impacted. Quality problems could be noticed immediately or can come to light in the future.

Quality is hard to define, and even more difficult to specify. A broad understanding is required with the client regarding his quality requirements. Finally, the effects of an economic activity do not get included in the project statement from the point of view of the main project participants. Therefore, the financial costs and revenues that accrue to projects as a result of adverse or favourable economic activities cannot be factored in earlier.

The last point to be considered is the externalities, which represent part of the difference between private costs and benefits, and social costs and benefits. Externalities should be quantified and valued and included in the project statement for economic analysis. A viaduct over Pedder Road in Mumbai would create enormous social benefits for everyone. Hence, in such cases, the economic analysis should also factor in the social benefits.

WORK-BREAKDOWN STRUCTURE (WBS)

In project management, a work-breakdown structure (WBS) is a fundamental project management technique for defining and organizing the total scope of a project using a hierarchical tree structure. It is a deliverable-oriented decomposition process of a project, divided into smaller components. A WBS defines and groups a project’s discrete work elements in a way that helps organize and define the total work scope of the project. A WBS also provides the necessary framework for detailed cost-estimation and control along with providing guidance for schedule development and control. Simply put, the WBS is a tree structure, which shows a subdivision of effort required to achieve an objective.

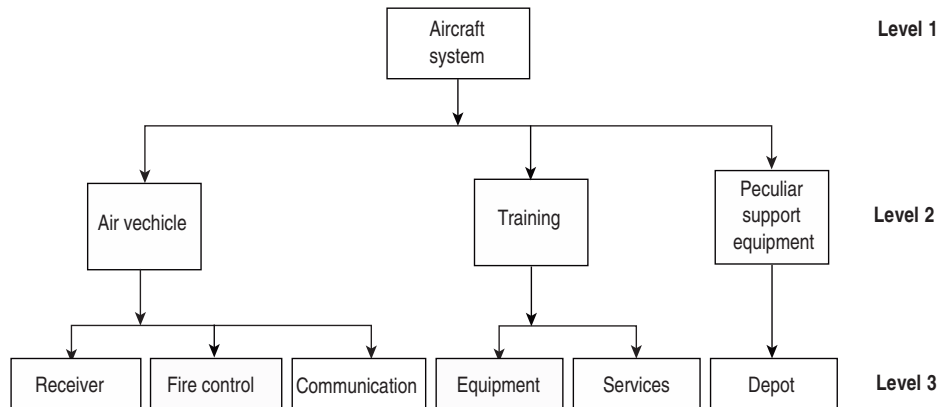


Figure 1.6 Defence material item categories from MIL-STD-881C

The first two levels of the WBS (the root node and level 2) define a set of planned outcomes that represent of the project scope. At each subsequent level, the children of a parent node collectively represent 100 per cent of the scope of their parent node. A well-designed WBS describes the planned outcomes instead of planned actions. Outcomes are the desired ends of the project and can be predicted accurately, whereas actions comprise the project plan and may be difficult to predict accurately. A well-designed WBS makes it easy to assign any project activity to one and only one terminal element of the WBS.

The WBS is organized around the primary products of the project (or planned outcomes) instead of the work needed to produce the products (planned actions). Since the planned outcomes are the desired ends of the project, they form a relatively stable set of categories in which the costs of the planned actions needed to achieve them can be collected. A well-designed WBS makes it easy to assign each project activity to one and only one terminal element of the WBS. In addition to its function in cost accounting, the WBS also helps map requirements from one level of system specification to another. A requirement's cross-reference matrix mapping functional requirements to high-level or low-level design documents is an example in this regard.

The idea of WBS was developed by the United States Department of Defence (DoD) along with the development of Project Evaluation and Review Technique (PERT), an acronym for PERT for their Polaris missile project in 1957. While the term 'work breakdown structure' was not used, this first implementation of PERT organized the tasks into product-oriented categories. The WBS for the Polaris missile project is shown in Figure 1.6.

Some of the essential features of the WBS are as follows:

1. **100 per cent rule:** The 100 per cent rule states that the WBS includes 100 per cent of the work defined by the project scope and captures all deliverables—internal, external and interim—in terms of the work to be completed, including project management. The 100 per cent rule is one of the most important principles guiding the development, decomposition and evaluation of the WBS. The rule applies at all levels within the hierarchy: the sum of the work at the 'child' level must equal 100 per cent of the work represented by the 'parent' and the WBS should not include any work that falls outside the actual scope of the project, that is, it cannot include more than 100 per cent of the work. The same 100 per cent rule also applies to the activity level. The work represented by the activities in each work package must add up to 100 per cent of the work necessary to complete the work package.
2. **Mutually exclusive elements:** The elements of the tree or level 2 should be mutually exclusive and should, therefore, not have an overlap of activities. This is necessary to ensure that the sum

total of all the outcomes is 100 per cent and not more than 100 per cent. To give an example, the components of the communication tree and the fire control tree shown in Figure 1.4 are mutually exclusive.

3. **Plan outcomes, not actions:** The planned outcomes are the desired ends of the project and they form a relatively stable set of categories in which the costs of the planned actions needed to achieve them can be collected. If the WBS designer attempts to capture any action-oriented details in the WBS, he/she will probably include either too many actions or too few actions. Too many actions will exceed 100 per cent of the parent's scope and too few actions will fall short of 100 per cent of the parent's scope. Therefore, the best way to adhere to the 100 per cent rule is to define the WBS in terms of results or outcomes.
4. **Level of detail:** Certain sets of details are required for WBS but the level of detail is not known. Certain heuristics aid in deciding the level of detail to which we have to work the WBS. One of the heuristics is the '80-hour rule' which means that no single activity or group of activities that produce a single deliverable should require more than 80 hours of effort. The second heuristic is that no activity or series of activities should be longer than a single reporting period. Therefore, if the project team is reporting monthly progress, then no single activity or series of activities should last for more than a month. The last heuristic is the 'if it makes sense' rule. Applying this heuristic, one can apply 'common sense' when creating the duration of a single activity or a group of activities necessary to produce a deliverable defined by the WBS.
5. **Terminal element:** A terminal element is the lowest element in a WBS and it cannot be further subdivided. Terminal elements are the items that are estimated in terms of resource requirements, budget and duration—linked by dependencies—and scheduled. At this juncture of the WBS terminal element and organization unit, control accounts and work packages are established and performance is planned, measured, recorded and controlled.
6. **Misconceptions:** There are some misconceptions in regard to the WBS and it is important that these misconceptions are cleared. Some misconceptions are as follows:
 - (a) A WBS is not an exhaustive list of work: It is instead a comprehensive classification of project scope.
 - (b) A WBS is not a project plan, schedule or a chronological listing. It specifies what would be done, and not how or when would the specific task be done.
 - (c) A WBS is not an organizational hierarchy, although it might be considered as such when assigning responsibilities.

An example of a WBS for construction of a house is shown in Figure 1.7. As can be seen, all the characteristics of the WBS such as the 100 per cent rule, mutually exclusive elements, planned outcomes, level of detail and the terminal elements are incorporated in the example.

PROJECT ORGANIZATION

Typically, the traditional form of an organization is the functional organization or dividing the organization on the basis of the function. Within each of these functions, there is a well-defined hierarchical organization. Any organization would, therefore, comprise departments such as manufacturing, materials, quality, service, finance, human relations, legal, and sales and marketing. Some of these departments can be further differentiated into line and staff departments on the basis of whether the costs associated with these departments can be directly apportioned to the product or not. Line managers have the primary responsibility of achieving the goals of the firm and are vested with key decision-making authority. Staff managers have administrative powers within their departments but by and large serve as advisors to line managers. This traditional form of organization is quite appropriate for handling operations that are established and are characterized by repetitive processes.

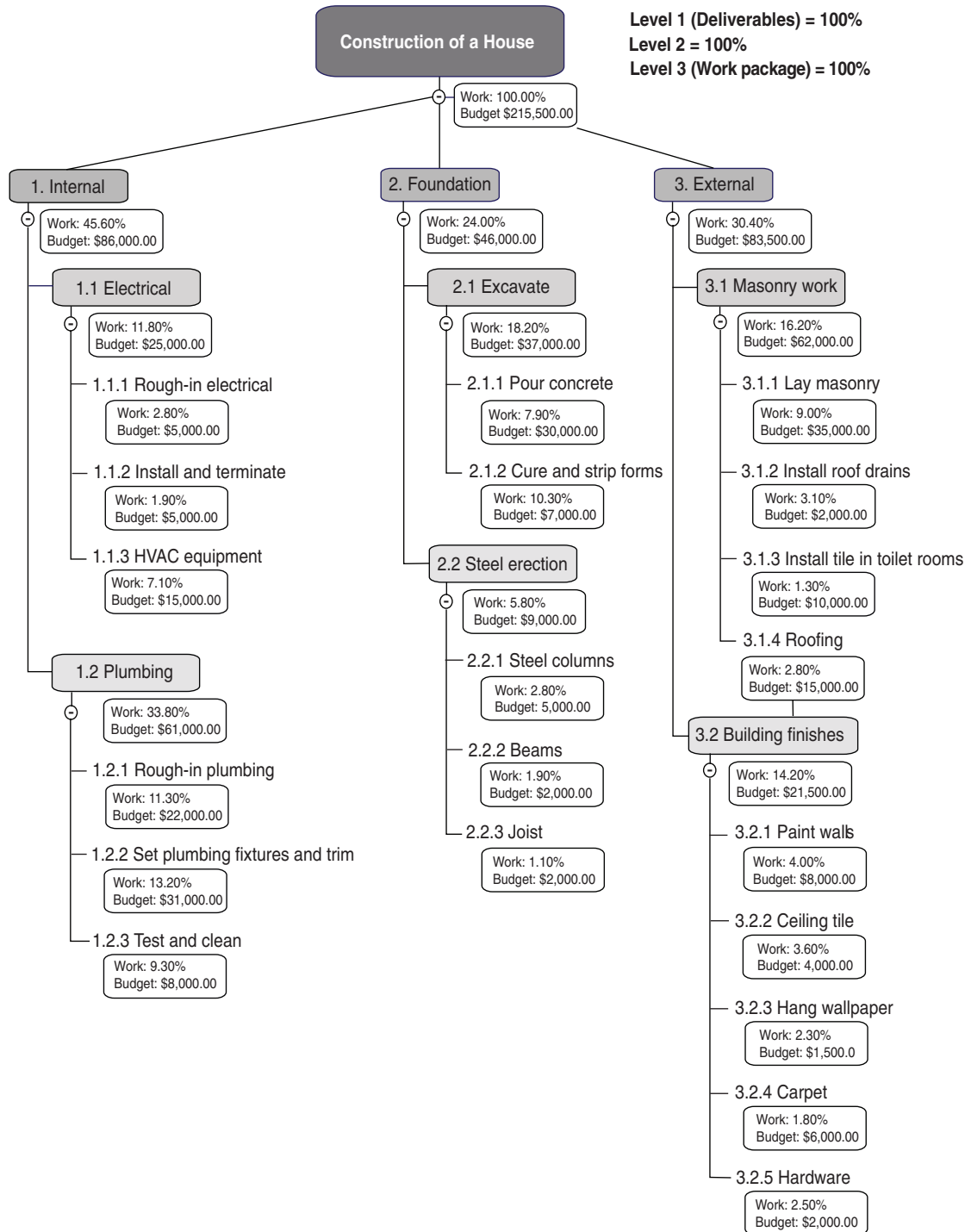


Figure 1.7 Example of a work breakdown structure

However, this traditional form of organization is not suited for project management due to the following reasons:

1. A project is a non-repetitive, non-routine undertaking plagued by uncertainties.
2. The responsibilities and relationships in a project are often temporary, dynamic and need to be flexible.

3. The skills required in different phases of the project are different with talent required from different functions at different points of time.
4. Many external agencies in the form of consultants, sub-contractors, vendors, licensing authorities, etc., are involved in completion of the project.
5. The work content of every functionary in the project organization undergoes changes fairly frequently. Moreover, there are times when the functionary could be idle and is used for other responsibilities.
6. The requirements of integrating the different levels of hierarchy below the top management are often required during various project phases.
7. The requirements of communication, coordination and control are different for the project/project organization.

Hence, there is a need for entrusting an individual or a group of individuals with the responsibility of integrating the activities and functions of the various departments and the external organizations involved in the project work. This aspect gives rise to a matrix organization, where the personnel working on the project have a responsibility to their functional superior as well as to the project manager. This further means that the authority is shared between the respective functional managers and the project manager.

An example of a project management matrix organization is depicted in Figure 1.8. The matrix organization is an attempt to combine the advantages of the pure functional structure and product organizational structure. This form is ideally suited for companies, such as construction companies, that are 'project-driven'. Information sharing is mandatory in such an organization, and several people may be required for performing the same piece of work. However, in general, the project manager has the total responsibility and accountability for the success of the project. The functional departments, on the other hand, have the functional responsibility to maintain technical excellence on the project. Each functional unit is headed by a department manager whose prime responsibility is to ensure that a unified technical base is maintained and that all available information is exchanged for each project on a regular basis.

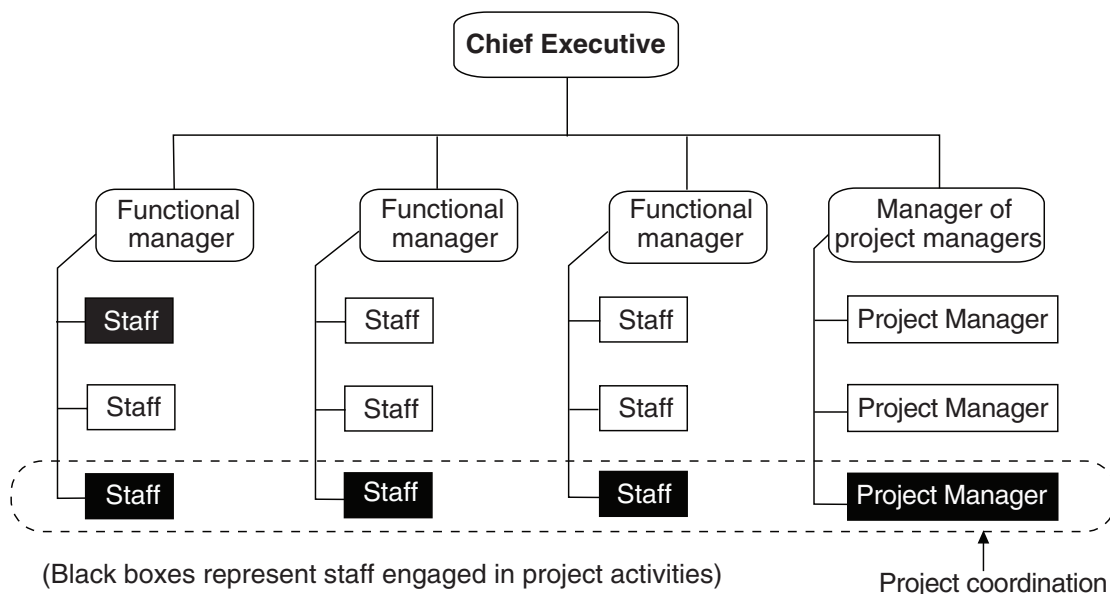


Figure 1.8 A typical project management organization

The basis for **matrix organization** is an endeavour to create synergism through shared responsibility between project and functional management. Other advantages of a pure matrix organizational form for project management include the following points:

1. The project cost is minimized because key people can be shared and the shared cost is much less compared to one complete individual.
2. Conflicts are minimal, and those requiring hierarchical referrals are more easily resolved.
3. There is a better balance between time, cost and performance.
4. Authority and responsibility are shared.
5. Stress of timely delivery on commitments is distributed among team members.

PROJECT NOMENCLATURE

At times, we hear schoolchildren speaking about completing their projects in time or getting punished and at the same time, we hear scientists speak about completing the Mars space probe project successfully. Similarly, construction companies speak about completing development projects, software consultants mention completion of software upgradation project, NGOs speak about social welfare projects being completed, Metro engineers speak about completing sections of the Metro project, organizations speak about their expansion projects, etc. What is a project? Can a school project which can be completed with less investment or a space project that requires a few billions of dollars be actually a 'project'?

We, therefore, need some mechanism to differentiate between the various types of projects. One way of assessing the potential complexity of a project has been suggested by Turner and Cochrane (1993) who have developed a 'goals and methods matrix'. The matrix is shown in Figure 1.9.

As can be seen from the matrix, four quadrants are created on the basis of goals being well defined or not and methods being well defined or not. The bottom left side quadrant has the highest probability of projects being completed because the requirements for completion of a project are well-defined in that space. As a corollary, the quadrant on the top right side comprises projects that have a high chance of failure as neither the goals nor the methods required to attain the goals are well-defined. Therefore, depending upon the characteristics of the projects, we can club them in either quadrants and the projects within quadrants would, by and large, carry the same features.

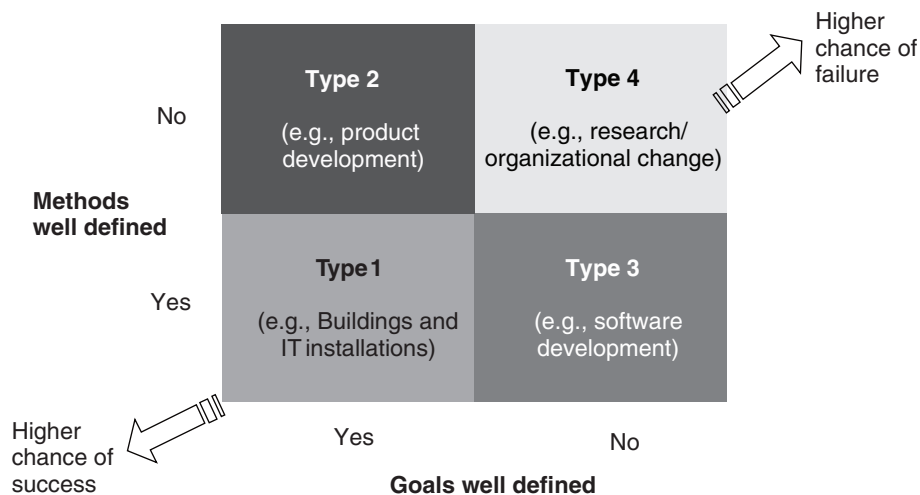


Figure 1.9 Turner and Cochrane's goals and methods matrix

Projects are also classified on the basis of the size of the capital requirement for the company putting up the project. However, this classification is not based on an absolute value of investment but on the relative value of investment for an organization. Projects that require investments equal to the capital of the present organization defined as the money, property and other valuables which collectively represent the wealth of an individual or business, are termed as **major projects**. A **large project** has a value roughly equal to one tenth of the capital of the parent organization; a **medium project** is ten times smaller than the large project and a **small project** is ten times smaller than a medium project.

The Government of India primarily classifies projects into four groups—micro-sized projects, small-sized projects, medium-sized projects and large projects. This classification is done on the basis of requirements of funds and for computation of incentives for the projects. The investment limit for different kinds of projects are announced by the government regularly and are based on various macro-economic factors such as inflation, exchange rate, political compulsions, etc.

At present (as per the Government gazette 311, dated Friday, June 16, 2006), the investment limits are as follows:

1. An investment on plant and machinery up to a limit of ₹25 lakhs is classified as a micro enterprise.
2. An investment on plant and machinery up to a limit of ₹5 Crores is classified as small-sized enterprise.
3. An investment on plant and machinery up to a limit of ₹10 Crores is classified as a medium enterprise.
4. An enterprise with investment requirement of more than ₹10 Crores (₹0.1 billion) on plant and machinery is categorized as large-sized enterprise.

In case of the enterprises engaged in providing or rendering of services, the investment limits are as follows:

1. A micro enterprise, where the investment in equipment does not exceed ₹10 lakhs.
2. A small enterprise, where the investment in equipment is more than ₹10 lakhs but does not exceed ₹2 Crores.
3. A medium enterprise, where the investment in equipment is more than ₹2 Crores but does not exceed ₹5 Crores.
4. A large enterprise, where the investment in equipment is more than ₹5 Crores.

On the basis of need, projects can be further classified into new projects, expansion projects, modernization projects, replacement projects, diversification projects, forward or backward integration projects, socio-economic development projects, etc.

COMPONENTS OF A DETAILED PROJECT REPORT (DPR)

Although the discussion on various aspects of a detailed project report (DPR) would be taken up in later chapters, it is necessary to introduce the components of a DPR. A DPR contains the information carried out in the feasibility study in detail. The intention of preparing a DPR is to formally communicate the project promoter's decision to venture into a new project. A DPR is also the starting point when approaching financial institutions or lenders for funding projects. Due to the liberalized industrial licensing policy of the government, an industrial entrepreneur's memorandum (IEM) has to be filed with the government for sanction. Similarly, a DPR must be filed with the government for their approval, permission and consent for new projects as well.

The prominent components of a DPR are as follows:

1. General information about the project.
2. The details of project promoters and their past experience in this field or elsewhere are required to judge their competence in putting up a project.
3. Details of past projects completed by the promoters or working results of businesses owned by the promoters.
4. Details of the project should comprise the following:
 - (a) Product information.
 - (b) Raw material source and details of raw materials.
 - (c) Plant capacity.
 - (d) Manufacturing technology and details on the application of technology in other projects.
 - (e) Management team responsible for execution of the project or the project management consultants (PMC).
 - (f) Details of land, environmental clearances, buildings, plant and machinery, etc.
 - (g) Details of utilities such as power, water, infrastructure, such as roads, highway connectivity and the source for these utilities.
 - (h) Periodicity of raw material availability or confirmed availability of raw materials.
 - (i) Effluent treatment arrangements and steps proposed to prevent environmental damage.
 - (j) Requirement and availability of labour and facilities for their welfare.
5. Project implementation schedule.
6. Project financials and calculation of returns. Profitability and cash flow estimates.
7. Means of financing the project.
8. Requirement of working capital and arrangements made for the same.
9. Commercial details relating to marketing and distribution arrangements.
10. Mode of term loan repayment.
11. Government approvals, local body consents and other statutory permission.
12. Details of collateral security that can be offered to the financial institutions, other than the project.

ROLE OF THE GOVERNMENT OF INDIA IN PROMOTING PROJECTS

In 1991, the Government of India decided to take a series of measures to unshackle the Indian industrial economy from the cobwebs of unnecessary bureaucratic control. These measures complement the other series of measures being taken by the government in the areas of trade policy, exchange rate management, fiscal policy, financial sector reform and overall macroeconomic management. The idea was to promote the growth of the Indian industry and transform the investment climate into a pro-investor one in order to encourage them to undertake mega infrastructure projects. Some prominent points of the liberalized industrial licensing policy are as follows:

1. Industrial licensing will be abolished for all projects except for a short list of industries related to security and strategic concerns, social reasons, hazardous chemicals and overriding environmental reasons and items of elitist consumption (list attached as Annex II). Industries reserved for the small-scale sector will continue to be so reserved.
2. Areas, where security and strategic concerns predominate, will continue to be reserved for the public sector.
3. In projects where imported capital goods are required, automatic clearance will be given in cases where foreign exchange availability is ensured through foreign equity or if the cost, insurance and freight (CIF) value of the imported capital goods required is less than

25 per cent of the total value (net of taxes) of plant and equipment, up to a maximum value of ₹2 Crores. In other cases, import of capital goods will require clearance from the Secretariat for Industrial Approvals (SIA) in the Department of Industrial Development (DID) according to availability of foreign exchange resources.

4. In locations other than cities having population of more than 1 million, there will be no requirement of obtaining industrial approval from the central government except for industries, subject to compulsory licensing. For cities having population of more than 1 million, industries other than those of a non-polluting nature such as electronics, computer software and printing will be located outside 25 km of the periphery, except in prior designated industrial areas. A flexible location policy would be adopted in respect of such cities (with population more than 1 million) which require industrial regeneration. Zoning, land use regulation and environmental legislation will continue to regulate industrial locations. Appropriate incentives and the design of investments in infrastructure development will be used to promote the dispersal of industry, particularly to rural and backward areas and to reduce congestion in cities.

In addition to the policy-making, the government also establishes the fiscal policy through budgets and monetary policy through the Reserve Bank of India (RBI). Apart from fiscal and monetary policy, the government also uses the following control measures to effect the desired pattern of resource allocation:

1. Industrial licensing
2. Capital investment control
3. Limits on foreign direct investment (FDI)
4. Export promotion and import tariff to reduce imports
5. Control over monopolies and restrictive trade practices
6. Control over pricing and distribution of commodities
7. Effect of new industries on small-scale sectors
8. Industries reserved for women and home trade
9. Socio-economic effects and environmental decline due to industries such as mining, etc.

Moreover, the government also helps in funding the projects on the basis of merit through the Industrial Development Bank of India (IDBI), Small Industries Development Bank of India (SIDBI), National Bank for Agriculture and Rural Development (NABARD) and such other financial institutions. The lending rate for projects is much lower than the market rates with extended repayment periods. In addition, many incentives are also made available by the government for projects that generate rural employment, reduce carbon emissions and projects that bring about socio-economic welfare.

Some of the benefits offered by state governments for industrialization are as follows:

1. **Sales tax benefits:** Central/State value-added tax is either exempt or treated as an interest free long-term loan. The maximum amount is decided only by the total investment.
2. **Investment subsidy:** A specified amount is given as non-refundable subsidy. The incentive proves to be quite substantial for small-scale industrial (SSI) units. The subsidy amount is treated as the owner's equity by the financial institutions for debt equity ratio.
3. **Octroi refunds:** Octroi/Entry tax paid to local authority on incoming goods is refunded by state for a specified number of years.
4. **Refund of electricity duty:** Electricity duty is refunded for a specified number of years.
5. **Contribution to cost of project feasibility study:** Besides financial incentives, infrastructural facilities that are offered often reduce capital investments and improve profitability.

6. **Setting up of industrial estates:** Basic facilities such as power, water and pre-approved land for industrial use, banks, communication and other urban infrastructure are provided.
7. **Availability of cheap land:** Land is made available at attractive rates which is often far below the actual cost of acquisition and development. It, therefore, reduces many procedural delays and problems in setting up a new industry and proves to be one of the major factors in deciding industrial location.

DIFFERENCES BETWEEN AN EPC COMPANY AND A COMPANY'S OWN PROJECT ORGANIZATION

The main business of engineering procurement construction (EPC) companies is construction of projects. Hence, they develop proficiency in this field. They are able to accurately decide the man hours required for the content of work envisaged and with this data, they are able to quote for the projects through the tendering process. Organizations that develop their own project management teams are not able to envisage all the costs with the fine details as an EPC company, but are content with the fact that the profit generated by the EPC company is retained in-house. Hence, any cost estimate or incurred cost is not viewed with suspicion in an own project management organization, whereas any extra cost incurred by an EPC company comes under intense scrutiny. Some additional points of difference are enumerated in Table 1.1.

HUMAN ASPECTS IN PROJECT MANAGEMENT

One of the toughest challenges in managing a project is to manage people in the project. People are the backbone of any organization and its most important resource. A project manager's performance is dependent upon the performance of the project team and associated stakeholders. Project managers must acquire six important types of interpersonal skills: effective communication,

Table 1.1 Comparison between an EPC company and an organization's own project management team

EPC Project Organization	Own Project Organization
Sets up projects for clients.	Sets up projects for own requirements.
Project execution is a revenue generation activity and profits are booked on completion of the project.	Project is a capital expenditure decision and profits are generated over a long period of time only after project completion.
The company is not concerned with future market risk.	Future market risks affect project profitability.
No project feasibility report is required. Only accurate cost estimation is needed.	Project feasibility report is compulsory for decision-making and financing.
Only short-term financing required as working capital for project execution.	Long-term financing is required for investment in fixed assets.
Company has expertise in project technology and project set-up.	May not have expertise in project technology and project set-up.
Schedules, costs and performance can be closely controlled due to available expertise and information database.	Schedules, costs and performance are difficult to control since it is the first project experience.
Regular and experienced contractors and associates make implementation easier.	New contractors and consultants take time to get acquainted.

motivation, negotiation, conflict management, stress management and leadership. In order to compete globally, project companies must emphasize the human factors in project management and create an environment that provides effective leadership and facilitate open and effective communication. They must induce an environment in which everyone feels committed to produce their best while having fun as well.

Interpersonal conflicts are an inevitable part of projects but minimizing them is the key to successful completion of projects. Therefore, it is very important to understand human nature and achieve satisfactory human relations in the project team. A project manager has to handle problems and challenges relating to the following HR issues:

1. **Authority:** Project managers very often have to be content with split authority and dual subordination in their set-up (with the exception of divisional form of organization). In addition, with all the criss-cross and overlap of responsibilities and paucity of resources and its sharing, assigning blame is rather difficult. In such a difficult situation, a project manager has to rely on the informal authority, that is, his/her rapport with project personnel. His/her skills in resolution of conflicts, skills of communication and persuasion ability and the ability to act as a link between technical, engineering, financial and commercial personnel gives him/her the real authority over people.
2. **Personnel orientation:** Most project managers are engineers who have a background in science. In a scientific world, most aspects are well-defined, structured and contain a degree of certainty. Therefore, managers are accustomed to well-structured and defined forms. Human psychology plays a very minor role in such set-ups. However, projects are almost diagrammatically opposite to a typical engineer's world. It is an unstructured world where little is defined and is full of uncertainties. And half the uncertainties emanate from people's mood. An ego hassle over a total non-issue between two key personnel can hold up the project for days despite availability of resources. Therefore, personnel management is the key to the successful execution of projects. Therefore, project manager has to transform the technical orientation of his/her managers to personnel orientation.
3. **Motivation:** Performance of employees is dependent on their motivation. In an unstructured set-up, where standards of performance are hard to define, motivation assumes further importance. However, with split authority and dual subordination, as in the case of a matrix organizational structure, keeping people motivated becomes very difficult. In a dual subordination set-up, rewarding people is a little difficult and meting out punishment even more so. His/her other superior, under whom he/she works on permanent basis is always there to provide an alibi to cover up for his failures. Projects give people a chance to perform tasks which are clearly defined and visible. If the project manager is appreciative and gives public applause to performance/contribution, it motivates the personnel to a great extent.
4. **Team building:** Most project activities are interrelated and interdependant and most problems require interdisciplinary solutions. The successful management of a project, therefore, is not possible without proper teamwork. Development of mutual trust and respect for each other, open communication and mutual cooperation must be achieved by the personnel.
5. **Communication:** It is a two-way effort involving the transmission of information and understanding from one person or group to another through the use of common symbols. These common symbols can be verbal or non-verbal, written, graphic or multimedia. The information represented by the symbols, expressed as thoughts, ideas, facts or figures, is useful only if it conveys meaningful knowledge to the receiver. Therefore, both the sender and

receiver should seek an exact mutual understanding during the communication process. As a large part of the communication is based on drawings, standard procedures for drawing and tracking the progress of the projects should be followed.

CHALLENGES AND IMPORTANCE OF PROJECT MANAGEMENT IN THE PRESENT WORLD

Project management is rapidly becoming a special way of doing business in the present world. Accentuating the requirement of the project management professionals is the way businesses have transformed in the web-enabled era. The PMI, founded way back in 1969, as a body of the international project managers, has seen an exponential growth of participation in their Certified Associate in Project Management (CAPM) programme. Other organizations such as Larsen & Toubro are setting up their own PMIs. Several reasons for this explosion in interest in project management are illustrated below.

Shorter Product Life Cycles

If we consider new generation products such as iPhones, iPads or smartphones, their extremely short product life cycle is a common factor. In the earlier years, the products enjoyed a life cycle of at least 20 years, whereas the organizations consider them fortunate if the life cycle extends to two years in recent times. 'Time to market' has been very crucial in the present time with organizations such as ZARA Apparel taking no more than four weeks from design to introduction of new fashion accessories/clothing in their shops. As speed becomes a competitive advantage, more organizations are insisting on quick completion of projects.

Shrinking World

A new product launched in a developed economy is almost immediately available in developing economies. This phenomenon repeats when it comes to lack of interest in product categories. The 'Blackberry', a once successful product of Research In Motion (RIM) Company is now facing an increasing decline in all global economies. Moreover, with web-enabled information flow and social networking sites becoming opinion formers, fast-paced, new projects become a necessity for organizations.

International Quality Standards

Besides cheaper and faster services, better quality products are the need of the hour. Quality movements, including quality certification programmes such as ISO 9000 cover most products and services. These initiatives are like a project with a definite beginning and a confirmed end.

With more global companies outsourcing their work, it offers opportunities for developing countries to offer projects in these areas, besides launching their own quality control standards. With its focus on scope, time and cost, project management becomes the preferred technique to handle these initiatives.

Increased Focus on the Customer

Although the customer was the focus, in the present scenario, the customer has many options and assumes significance. Increased competition has placed a premium on customer satisfaction. As a result, there is focus on customized products and services and the product manager is constrained to act by fulfilling the unique needs and requirements of product differentiators. A common textbook

on management topics is now required to be customized as per the requirements of universities or autonomous institutes. Therefore, the product manager would fail in his/her duty if he/she was oblivious to the principles of project management.

Commoditization of Products

Nowadays, products are getting increasingly commoditized and are being purchased on the basis of their price/features, instead of on the basis of brand loyalty. In these circumstances, the company stand to benefit immensely if the products are brought to the market early. Hence, concepts such as crashing and resources scheduling that are essential components in project management gain prominence. A business manager, therefore, has to be a project manager before anything else.

Information Explosion

The growth in new technologies and information about these new technologies has increased the complexity of the projects. Newer methods such as pre-stressed concrete blocks, use of heavy engineering equipment, etc., have considerably reduced project duration. Product complexities have confounded this problem by adding to the complications of creating a new product. Hence, integrating diverse technologies, with complex equipment has created problems of integration, which project management techniques can achieve.

Lean Organizations

Corporate downsizing is more of a norm nowadays, with leaner and meaner organizations striving for excellence. Besides, outsourcing of non-core activities has also increased the complexities of monitoring processes and their control. Companies outsource a significant amount of project work, necessitating managers to oversee their employees and the work of the subcontracting organizations. As sticking to the core competence is a necessity for survival, more importance is laid on project management skills and techniques.

CASE STUDY

The Konkan Railway Corporation Limited (KRCL)

The Konkan Railway was the missing link between India's commercial capital, Mumbai and Mangalore, the fourth largest city in state of Karnataka. The 741-km railway line connects Maharashtra, Goa and Karnataka, and makes entry into the southern state of Kerala very conveniently. The entire Konkan region is close to the western coastline of India and is a region of criss-crossing rivers, plunging valleys and mountains that soar into the clouds.

The formidable terrain to be conquered and the short construction period meant that the project could only be completed with the help of several technological innovations.

Apart from setting a trend for other infrastructure projects in the country, the Konkan Railway

provides concrete proof of the skills of Indian engineers, their discipline, team spirit and courage. Mangalore, traversing through a distance of 741-km along Western Ghats. The entire stretch comprises 91 tunnels and 179 major bridges some of which have found mention in the record books.

The entire 741-km long project was divided in seven sectors—each approximately 100-km long, headed by a chief engineer. The sectors were Mahad, Ratnagiri (north), Ratnagiri (south), Kudal, Panaji, Karwar and Udupi. With the delegation of adequate powers to the chief engineers and compact sectors that allowed for personal attention, KRCL succeeded in overcoming the proverbial 'red tape' and kept up the pace of work.



The Konkan region: Spectacular but challenging terrain

Credit: Kevin Standage.shutterstock.com

At the corporate office, there was a team of senior officers specialized in civil engineering, electrical engineering, signal and telecom engineering,

mechanical engineering, stores and finance. They provided the strategic inputs of design, planning, tendering and contracting of large works. In the different sectors, chief engineers were assisted by deputy chief engineers of the civil, electrical, signal and telecom disciplines, and by deputy chief account officers. The field level was manned by some 400 young engineers recruited from among fresh graduates belonging to various engineering colleges—a vital step in keeping the set-up highly motivated and dedicated to the objectives.

For the project to be a success, the organization had to be kept lean but effective. At the peak of the construction period, there were no more than 2,400 personnel, starting from the CMD to the lowest rung. The establishment of computer wide area networks (WANs) and local area networks (LANs) augmented their efforts, providing instantaneous

Some Engineering Details

<i>Track</i>		<i>Materials</i>	
Gauge	Broad gauge (1676 mm)	Total quantity of cement	6,00,000 tonnes
Route length	741 km	Total quantity of steel	85,000 tonnes
Ruling gradient	1:150 (0.67%)	Total quantity of high tensile steel (HTS)	3,160 tonnes
Rails: Ultimate Tensile Strength (UTS)	52 kg 90 UTS (welded rails)	Total quantity of structural steel	2,00,000 tonnes
Sleepers: Pre-Stressed Concrete (PSC)	PSC mono block sleepers	Rails	1,00,000 tonnes
No. of curves	342	PSC sleepers	12,87,000 Nos.
<i>Earthwork</i>		Signalling	Panel interlocking with colour light signals
Maximum height of an embankment	25 m	Telecommunications	State-of-the-art optic fiber with digital communication
Deepest cutting	44 m	<i>Longest Span</i>	
Total earthwork	88 million (m ³)	For concrete bridges	53.5 m (PSC Box girder)
<i>Stations</i>		For steel bridges	124.2 m (open web steel through girder)
Total No. of Stations	59	Longest bridge	Across Sharavati river in Honnavar (2065.8 m)
<i>Bridges</i>		Tallest viaduct	Panval Nadi (64 m high)
Major bridges	179 (Lineal waterway 19.823 km)	First bridge to be launched by incremental launching	Panval Nadi Viaduct (420 m long) PSC box girder
Minor bridges	1,701 (Lineal waterway 5.58 km)		
Total	1,880		
No. of road crossings	365 (Road over bridges/road under bridges/Foot over bridges)		

fax and voice communication all along the route, which resulted in quick decision-making and prevented stalling of work.

With such a tight deadline, engineers had to think fast and creatively. Conventionally, when an alignment needs to be worked out, several jeeps and lots of people to run around are required. Rajaram, who was then the chief engineer in Goa and later went on to become the managing director of KRCL, took satellite images, made topographical maps with high accuracy and then—for the first time in the history of the Railways—sent out teams on motor cycles. He ordered several Kawasaki bikes modified to carry equipments, such as levelling instruments and hired young boys, fresh with their engineering diplomas, to go around the state. They were given ₹100 per day and petrol, neither of which they had to account for, so long as they executed a certain amount of work every day. The targets were given in such a way that they would have to work 14 hours a day. However, they felt empowered and gave their best.

Thirty such teams in Goa worked on 16 different alignments, and the data was analyzed, often way past midnight, on an assembled computer that Rajaram bought at a lesser price in Bangalore. Rajaram designed the software for this analysis on his own. This approach meant that survey work was done at 10 per cent of the cost that it would have normally involved.

While the alignment was being finalized in Goa, hectic activity was going on all along the Konkan area. The first working season between 1990–1991 was utilized for a detailed survey:



Tracking its way through: A track through one of many tunnels

Credit: aminkorea.shutterstock.com

pegging out the route on the ground, preparing land plans, drawings and tender schedules, conducting investigations on the soil, deciding at which point exactly a bridge had to be constructed or a tunnel bored. During this intense period, KRCL succeeded in reducing operational benefit to the Railway system.

The achievement was made possible by the fact that several senior officials, including E. Sreedharan, S.V. Salelkar, the engineer-in-chief (Projects) and A.K. Somanathan, the then engineer-in-chief (technical), walked down the entire route, along with the sectorial chief engineers. It was not easy, ascending and descending all those hills and valleys.

A detailed environmental impact assessment study (EIAS) of the alignment was carried out in two phases through Rail India Technical and Economic Services Ltd. (RITES), a public sector undertaking under the Ministry of Railways. Under phase I, stretches between Udupi and Mangalore were covered. Under phase II, the study was conducted between Veer and Sawantwadi. The RITES conducted a separate (EIA) study for the balance alignment in Goa. The Goa government approved the alignment, which was finalized in December 1990 after detailed discussions with state authorities. In March 1991, the new government reconfirmed the alignment.

While working out the plans, many factors such as optimization of earthwork, tunnels and bridges; least possible interference to habituated areas; minimum damage to horticultural lands, especially mango and cashew groves; avoiding reserves and thick forests were considered, while at the same time, achieving the goals of flatter gradients and curvatures. In Goa, where people were particularly emotional about having to give up ancestral property, KRCL engineers personally visited each house to see if there was any way it could be saved. In many cases, the team found a way out. This explains why Goa has the maximum number of curves on the alignment; even the Mandovi bridge is on a curve. As a result of this careful appraisal, only 35 houses were disturbed in Goa, where population density was the highest. They faced with pressure from local residents, but the Konkan Railway team found their engineering skills sharpened.

This case highlights some of the following important project management-related considerations:

1. *Work breakdown structure*: The entire project length of 760 km was divided into seven sectors, each approximately 100 km long, headed by a chief engineer.
2. *Innovative solutions*: For the first time in the history of the Railways, teams were sent out on motor cycles.
3. *Cost cutting*: This approach meant that survey was done at 10 per cent of the cost that it would have normally involved.
4. Matrix and a functional organization at the corporate headquarters.
5. Environment impact assessment study.
6. *Problem-solving and quick decision-making*: The establishment of computer WANs and LANs augmented their efforts, providing instantaneous fax and voice communication all along the route, which resulted in quick decision-making and prevented stalling of work.

CASE STUDY

Naturals

Naturals (formerly, Natural Ice Creams) was launched in 1984 by Raghunandan Kamath. The company's growth story is much similar to the proverbial David in the ₹10,000 Crores (\$148 million) Indian ice-cream business with Goliaths such as Amul, Mother Dairy, Hindustan Unilever, Baskin and Robbins, Haagen-Dazs, Vadilal Ice-cream, etc. While the success of David in the biblical story is attributed to the backing of God, for Naturals, the success can be attributed to the grit, determination, foresight, innovativeness and quality consciousness of its founder, Raghunandan Kamath, which were the primary drivers of success. Kamath attributes his success to the divine will and engages in philanthropic services too.

The Naturals chain of ice-cream parlours has 126 stores across India with 11 stores managed directly and the rest by franchisees. Currently, the stores are located in key cities of Maharashtra, Karnataka, Goa, Telangana, Kerala, Gujarat, Madhya Pradesh, Chhattisgarh, Punjab, Rajasthan and Delhi NCR regions. In the fiscal year 2017–18, with a total retail area of over 80,000 sq. feet, the chain's annual turnover crossed ₹200 Crores (\$2.96 million). Presently, Naturals produces over 20 tonnes of ice creams every day from its range of 100 flavours using natural pulp from about 60 varieties of fruits, including dry fruits.

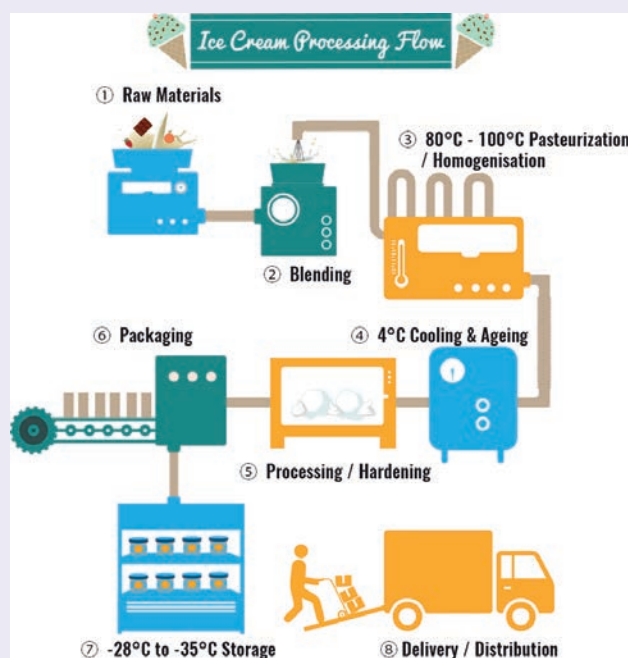
Recognitions and awards have followed Raghunandan Kamath over the years and although

he is happy with his achievements, he is more thrilled to teach the art of entrepreneurship to budding minds. He advises: 'Be an entrepreneur to bridge the gap between poverty and riches'. Prominent among his awards is the Coca Cola Golden Spoon Award in 2016, Gold Medal for the most innovative ice cream in the Great Indian Ice Cream Contest, Corporation Bank's National SME's Excellence award in Food and Agro Industry in 2006, a place in the Limca Book of Records for the largest ice cream slab weighing 3,000 kg (3.3 US tonnes), etc.

Besides featuring on almost all the prominent Indian business magazines and newspapers, Naturals has been the subject of case studies in management schools locally and globally. The below narrative is in the context of successful project management in every business aspect such as product innovation, distribution innovation, process innovation, operations innovation, sourcing innovation and of entrepreneurship in every aspect in the business of manufacturing traditional ice creams. Quality and consistency of the products offered are other hallmarks of Naturals.

The general process of manufacturing industrial ice cream is given in Exhibit II.

At every stage of the ice cream making process, innovation, engineering and enterprise are manifest in Naturals. Let us understand the process in a stage-wise manner.



Generic commercial ice cream manufacturing process

1. **Ingredients:** The basic raw material used in the manufacture of ice creams, commercially, is a mixture of milk and/or cream, sugar, eggs and flavour extracts such as vanilla, emulsifiers and stabilizers. Naturals does not use eggs, flavours, emulsifiers or stabilizers; as a result, the shelf life is extremely less—at best, 15 days. The brand name 'Naturals' ensures that only naturally available products, predominantly organic, are used in the manufacture of these ice creams. The products are thus 'ice-creams' and not 'frozen desserts'. Frozen desserts are made with vegetable oils, whereas ice creams are made with only milk and dairy fat. Most offerings in the ice cream category are factually frozen desserts, whereas Naturals is among the very few ice creams that are factually ice creams. The fresh fruits added in it give the right flavour and texture to the products; they are obtained from source and are invariably, of the best quality. The milk is procured from just one source for consistency. The Toyota production systems adopt the process of 'Keiretsu' or single supplier for outsourced products and Naturals follows the same practices—a

single supplier of milk for the past 35 years. At every stage of the procurement process, commitment to quality and a wonderful foresight of the effects of minor seasonal variations in the final product helped Kamath perfect the art of making ice creams. Sitaphal or custard apple ice creams are the most sought-after flavour. The fruit has a problem of de-seeding while extracting the pulp. It was not possible to manually deseed more than two kilos of fruits by a person on a day, but the demand was over 500 kgs of custard apple. Kamath's used his creativity and developed an indigenous equipment which could separate the seed from the flesh effectively and meet the daily requirements.

2. **Blending:** The traditional native cooking on wooden fire uses a long hollow pipe to blow air in the vessel by heating milk to prevent milk from overflowing from the pot and yet continue to simmer. This common but unique technique enhances the taste of the end product, making milk creamier and tastier. Technically called 'falling film evaporation', the milk temperature is brought to 30°C before cooling it to four degrees and then heating it to 90°C within four minutes. Cooled again to 4°C, it turns into condensed milk, the way it is needed for ice cream production.

Similar to traditional mass cooking, typically in temple food preparation, various vegetables and pulses are added, depending upon the exact time required to cook them right. Naturals has mastered the process of layered blending of fresh fruits to ensure that the best flavours get captured and the finished product retains the consistency of flavours and aroma uniformly from the first scoop to the last scoop. As Naturals uses a unique process, the standard equipment for commercial ice creams was not of much help. Kamath used his own proprietary technical skills and developed specialized equipment for each stage of their unique manufacturing process.

3. **Homogenization:** Homogenization is a process that gives milk its rich, white colour and smooth texture. Milk, which has not been homogenized, contains a layer of cream that rises to the top of the cup, carrying *the*

milk. However, one of the disadvantages of homogenization is that milk becomes sensitive to light, especially sunlight and fluorescent light, resulting in 'sunlight flavour'. As the delicate flavours of many Naturals ice creams is based on fruits such as tender coconut, any sunlight flavour effect can mar the natural flavours. Hence, in the process of manufacturing ice creams, Naturals does not use the process of homogenization.

4. **Cooling and Ageing:** The mix is then aged for at least four hours which allows time for the fat to cool down and crystallize. Ageing provides the desired whipping qualities for the mix and body and texture of the ice cream. Most commercial ice creams use air to make ice creams voluminous. The grading of ice creams is typically super premium (least air called overrun) to standard (most air or overrun). Naturals ice creams do not add air into the ice creams; whatever air is present in the product is the result of the normal manufacturing process. Therefore, when a customer buys 530 ml of Naturals ice cream, he actually gets more than 500 gms of ice cream, whereas in case of most other competing ice creams, 500 ml could fetch more than 250 gms of ice creams plus air.
5. **Processing and hardening:** Processing or freezing/whipping of ice creams is the process where about 50 per cent of the water is frozen and a considerable amount of air is blown, giving the product its characteristic lightness. At this stage, the product is a semi-frozen slurry where the particulate matter such as fruits, nuts, candies or cookies is added. In case of Naturals, the particulate matter or fruits are added at a much earlier stage, giving it a characteristic aroma, which otherwise is lost, should these particulate matter be added at this stage. Second, as mentioned earlier, no air is blown in the ice creams, giving a thickness which no other competing brand can offer. The next stage is to freeze the remaining water and the commercial process is blast freezing at -30°C up to -40°C . Ice creams should be maintained at -25 for stability. In case of Naturals ice creams, the temperature of manufacture is maintained at -22°C .

6. **Packaging:** After the hardening stage, commercial ice creams get transformed into a variety of novelty or impulse products through various filing and forming machines. Naturals, however, prefers to deliver over 40,000 scoops of ice creams manually on a daily basis rather than packaging the scoops in 50 ml or 100 ml containers. This is done to preserve the texture, flavour and composition of ice creams. Furthermore, easy-to-dispose and light weight packaging materials are used in distribution which help reduce the requirement of reverse logistics.
7. **Storage:** The ice creams which are kept at -22°C are packed into boxes along with a plenty of dry ice to keep it from melting.
8. **Delivery and Distribution:** Naturals operates from only one manufacturing plant located in the northern suburbs of Mumbai and supplies to all the outlets from this plant. Transport of ice creams and onwards by road have been facilitated by the Railways. As the taste and freshness of ice creams depend on a specified number of hours before it loses its taste, Natural's trucks can cover only a finite distance. Naturals is in the process of setting up manufacturing units called 'mega-shops' in other locations such as Chandigarh which will provide frozen non-perishable fruit pulp and processed milk to be blended into ice creams. Once successful, the mega-shops would be the launch pad for its global ventures.

Some unique features of Naturals ice creams are as follows:

1. Taste of traditional home-made and hand-made ice creams.
2. Creamier and richer, distinctly Indian.
3. 100 per cent vegetarian ice creams, which have an acceptance across communities.
4. Predominantly fruity flavours, acceptable to all customers.
5. Ice creams which are freshly made without any preservatives and are appealing to all customers, especially health conscious customers.
6. Constant innovations with fruit combinations.
7. Only milk and cream used in the manufacture of Naturals ice creams.

8. Zero advertising expenses and reliance on word-of-mouth publicity.
9. Value for money pricing strategies.
10. More ice cream per scoop due to least over-run (air).
11. High quality standards from receiving fruits and other ingredients to the finished products.

Project management and entrepreneurship are used synonymously, with most successful entrepreneurs being excellent project managers. Innovation and agile project management are the other techniques successfully applied at Naturals in every phase of their growth.

SUMMARY

Projects are unique but Project Management is repetitive. Every exponent of project management should realize this important aspect. Although we see projects of different types in software development or in construction, the factors that drive success in each project remain the same. Scope definition, cost estimation and duration decisions are vital for project completion. Essential working features in a project would be Work Breakdown Structure (WBS) which makes it easy to monitor and track the progress of work. Every project should be characterized by a project life cycle with the effort required at the various phases of the project life cycle when traced should resemble a 'S' shaped curve. These 'S' curves can be further classified as cost v/s time 'S' curve, Target 'S' curve, Value and Percentages 'S' curve and Actual 'S' curve. The project manager plays a very key role in the success of the project, and hence, the traits that would lead to timely execution of the project become very important.

KEYWORDS

- Project scope management
- Project time management
- Project cost management
- Work breakdown structure
- 'S' curve
- Project organization
- Project life cycle
- Detailed project report (DPR)
- Project management professional (PMP)
- Project management institute (PMI)
- EPC company

REVIEW QUESTIONS

1. Answer in True or False.

- (a) Inventories are treated in the asset side of the balance sheet.
- (b) Expenditure for long-term returns is classified as revenue expenditure.
- (c) Projects are always undertaken for the sake of profits.
- (d) Projects are unique but project management is repetitive.
- (e) A project is a temporary endeavour with a defined beginning and end.
- (f) Project life cycle has six stages.
- (g) The risk of completing the project and the value generated for the project work in opposite directions.
- (h) The 'S' curve is a well-known project management tool which displays cumulative costs, labour hours or other quantities against time.
- (i) The project manager should be a specialist in at least one area of the project.
- (j) For the success of a project, the scope, time duration and cost should be within target.
- (k) The work breakdown structure is used to prepare planned actions.
- (l) The first two levels of the WBS—the root node and level 2—define a set of planned outcomes that represent 100 per cent of the project scope.
- (m) Matrix organization is best suited for project management.
- (n) Detailed project report is not required when approaching financial institutions for term loans.
- (o) Human relation aspects are not all critical for project management.

2. Explain the difference between projects and projects management.

3. How would a project organization be different for an EPC company and an organization's own project team?

4. Explain the concept of work breakdown structure in detail. Explain the essential features of a WBS.

5. Why is a project manager termed an entrepreneur?

6. What is the role of the Government of India in promoting projects?

7. What should be the personal traits and managerial traits of a project manager?

8. Explain the concept of 'S' curve and its utility in project management.

9. What is the role of HR in project management?

10. What are the components of a detailed project report?

11. Outline the main features and advantages of 'matrix' type organization for projects.

ANSWERS

1.

- | | | |
|-----------|-----------|-----------|
| (a) True | (f) False | (k) False |
| (b) False | (g) True | (l) True |
| (c) False | (h) True | (m) True |
| (d) True | (i) False | (n) False |
| (e) True | (j) True | (o) False |

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