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Application of Agile Project Management Techniques in Construction Sector

An Enquiry and Analysis

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ABSTRACT

Internationally, there has been a trend towards the greater adoption of agile project management techniques in various industries. Construction contributes to a country's economic prosperity while providing employment opportunities. After each census (the time frame varies by nationality), the need for new housing is determined. To meet this need, government and private construction companies try to fill the gap or make a business out of it. Effective application of project management techniques facilitates business organisations to execute construction projects efficiently. As a result, evaluating the impact of project management techniques is crucial for the development of the construction industry. Hence, the purpose of this thesis is to analyse the current practices of project management and provide recommendations that apply to the construction paradigm. This study also aims to comprehend the operational framework of a market leader in the sector. This was performed through two major case studies. The research differentiates between traditional project management and examines benefits attained through agile project management. Furthermore, this research is extended to organisations' agility. The option of comparison with other case studies will be possible because this study was performed at a detailed level. To achieve this goal, the following research questions were devised: Which agile techniques are employed in construction project management? What are the direct and indirect benefits of using APM in the construction industry? What is the likelihood of adopting the APM methodology in the construction industry? What distinguishes organisations that utilise agile project management from traditional methods? This thesis was focused to study and analyse the benefits of using Agile project management in Lodha Group, based on actual projects in different time periods. Different time periods were chosen to evaluate and compare the impact of COVID-19 on the organisation and the real estate sector. This study starts with knowledge providing the background required to simplify the jargon of project management. The methodology of choosing the Lodha Group is also presented. For data collection and analysis, a qualitative descriptive method was employed to answer the research question and meet the study's objectives using semi-structured interviews. The obtained data is subjected to analysis to arrive at findings and a conclusion is presented at the end.

Keywords: *Agile Project Management, Construction Industry, Scrum, Lean, Hybrid Approach, Organisational Agility.*

ASTRATTO

A livello internazionale, c'è stata una tendenza verso una maggiore adozione di tecniche di gestione dei progetti agili in vari settori. L'edilizia contribuisce alla prosperità economica di un paese fornendo opportunità di lavoro. Dopo ogni censimento (il periodo di tempo varia in base alla nazionalità), viene determinata la necessità di nuove abitazioni. Per soddisfare questa esigenza, il governo e le società di costruzioni private cercano di colmare il divario o di farne un'impresa. L'applicazione efficace delle tecniche di gestione dei progetti facilita alle organizzazioni aziendali l'esecuzione efficiente dei progetti di costruzione. Di conseguenza, la valutazione dell'impatto delle tecniche di gestione dei progetti è fondamentale per lo sviluppo del settore edile. Pertanto, lo scopo di questa tesi è quello di analizzare le attuali pratiche di gestione dei progetti e fornire raccomandazioni che si applicano al paradigma della costruzione. Questo studio mira anche a comprendere il quadro operativo di un leader di mercato nel settore. Ciò è stato eseguito attraverso due importanti casi di studio. La ricerca distingue tra la gestione tradizionale del progetto ed esamina i vantaggi ottenuti attraverso una gestione agile del progetto. Inoltre, questa ricerca è estesa all'agilità delle organizzazioni. L'opzione del confronto con altri casi di studio sarà possibile perché questo studio è stato condotto a livello dettagliato. Per raggiungere questo obiettivo, sono state ideate le seguenti domande di ricerca: quali tecniche agili sono impiegate nella gestione dei progetti di costruzione? Quali sono i vantaggi diretti e indiretti dell'utilizzo di APM nel settore edile? Qual è la probabilità di adottare la metodologia APM nel settore edile? Cosa distingue le organizzazioni che utilizzano la gestione agile dei progetti dai metodi tradizionali? Questa tesi si è concentrata sullo studio e sull'analisi dei vantaggi dell'utilizzo della gestione dei progetti Agile in Lodha Group, sulla base di progetti reali in diversi periodi di tempo. Sono stati scelti periodi di tempo diversi per valutare e confrontare l'impatto del COVID-19 sull'organizzazione e sul settore immobiliare. Questo studio inizia con la conoscenza che fornisce il background necessario per semplificare il gergo della gestione dei progetti. Viene inoltre presentata la metodologia di scelta del Gruppo Lodha. Per la raccolta e l'analisi dei dati, è stato utilizzato un metodo descrittivo qualitativo per rispondere alla domanda di ricerca e raggiungere gli obiettivi dello studio utilizzando interviste semi-strutturate. I dati ottenuti vengono sottoposti ad analisi per arrivare ai risultati e alla fine viene presentata una conclusione.

Parole Chiave: *Agile Gestione del Progetto, Industria delle Costruzioni, Scrum, Lean, Approccio Ibrido, Agilità organizzativa.*

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LIST OF ABBREVIATIONS

PM	Project Management	**OOPSLA**	Object-Oriented Programming, Systems, Languages & Applications
APM	Agile Project Management	**SBOK**	Scrum Body of Knowledge
TPM	Traditional Project Management	**PBI**	Product Backlog Item
PMI	Project Management Institute	**TPS**	Toyota Production System
WBS	Work Breakdown Structure	**PO**	Product Owner
WP	Work Package	**JIT**	Just In Time
CPM	Critical Path Method	**WIP**	Work in Progress
PERT	Program Evaluation Review Technique	**MIT**	Massachusetts Institute of Technology
CSF	Critical Success Factors	**TDS**	Toyota Development System
USA	United States of America	**NVA**	Non-Value Added
PDCA	Plan Do Check Act	**RE**	Real Estate
PDSA	Plan Do Study Act	**LP**	Last Planner
RAD	Rapid Application Development	**USD**	United States Dollar
FDD	Feature Driven Development	**DSM**	Design Structure Matrix
XP	eXtreme Programming	**ADePT**	Analytical Design Plan Technique
DSDM	Dynamic System Development Methods	**QFD**	Quality Function Deployment
HBR	Harvard Business Review	**IMF**	International Monetary Fund
NASA	The National Aeronautics and Space Administration	**GDP**	Gross Domestic Product
PMBOK	Project Management Body of Knowledge	**COVID-19**	Corona Virus Disease 2019
MRP	Material Requirements Planning	**ILO**	International Labour Organisation
ERP	Enterprise Resource Planning	**FDI**	Foreign Direct Investment

UAE	United Arab Emirates	**ITP**	Inspection and Test Plan
PPE	Personal Protection Equipment	**DCU**	Design Control Unit
VP	Vice President	**MD**	Managing Director
DVP	Deputy Vice President	**CEO**	Chief Executive Director
AVP	Assistant Vice President	**GFC**	Good For Construction
GM	General Manager	**PES**	Project Execution Strategy
COO	Chief Operating Officer	**RMC**	Ready Mix Concrete
CAGR	Compounded Annual Growth	**DCO**	Design and Cost Optimization
MMR	Mumbai Metropolitan Region	**BOQ**	Bill of Quantities
CPT	Central Procurement Team	**SR**	Service Request
RERA	Real Estate Regulatory Authority	**MMRDA**	Mumbai Metropolitan Region Development Authority
GST	Goods and Service Tax	**EHS**	Environmental Health and Safety
INR	Indian Rupee	**KPI**	Key Performance Indicator
FY	Fiscal Year	**PR**	Purchase Request
OC	Occupancy Certificate	**SOP**	Standard Operating Procedure
NCR	National Capital Region	**PMO**	Project Management Office
IT	Information Technology	**DDS**	Due Diligence System
LLP	Limited Liability Partnership	**MOM**	Minutes of the Meeting
MEP	Mechanical, Electrical and Plumbing	**SAP**	System Application and Products in data processing
PCF-P	Pei Cobb Freed & Partners	**VPN**	Virtual Private Network
PMC	Project Management Contract	**AOP**	Annual Operating Plan
BIM	Building Information Modelling	**BHK**	Bedroom, Hall, Kitchen
TTM	Time To Market	**CFO**	Chief Financial Officer
B2C	Business-to-Customer	**VFC**	Valid For Construction
KA	Knowledge Area	**VoC**	Voice of the Customer
CSI	Customer Satisfaction Index		

1 INTRODUCTION

Chapter summary: This chapter will provide the reader a general understanding of the thesis topic and will introduce the background of the thesis and the problems associated with it. A brief discussion of Agile Project Management and its need in today's changing world is also presented in the chapter, giving rise to the research question, purpose, and framework of the thesis. This chapter ends with the flowchart presentation of the research method.

1.1 Background and Scope

"Project management approaches and techniques are used to coordinate resources to achieve desired results. Each project has a distinct timeframe to deliver the result. Whether be it a relatively small private firm or a public corporation, all organisations strive to yield the desired outcome, while combating uncertainties, variabilities, and mitigating risks. According to the literature, once a project has been initiated and money has been spent, it is harder to regulate the project on a higher degree" (Yllén et al.,2012).

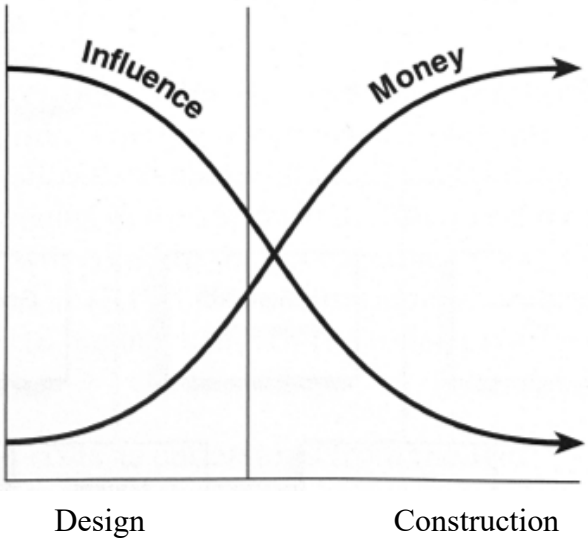


FIGURE 1 As project expense increases, control capability of project decreases (Source: Gould & Joyce, 2009)

"It is true that cost and time are inversely proportional after the initiation of any project" (Gould & Joyce, 2009). "Traditional project management practises have been deep-rooted and are not sufficient to combat the fast-paced problems as they do not offer flexibility. The documents used in the initiation stage such as Project Charter might be overlooked and might contain errors, which upon the unfolding of the project disrupts the path of the project. New technical trends demand innovative solutions. Agile attitude comes into play in this situation. Examining and defining how projects are currently managed and carried out may help to alleviate the uncertainty and confusion" (Lenfle & Loch, 2010). TPM has been extensively used, but how APM might aid the construction sector on a detailed level has yet to be determined. It is the central theme of this thesis. However, most studies in the construction sector have only found minor or indirect advantages using APM. "The booming construction sector is the core of this project where the market is continually changing and demanding. To meet the shifting market demands, construction companies will

require more flexible and adaptive solutions" (Pheng & Hou, 2019). In this study, the impact, aspects, and prospects of APM approaches in the construction industry is investigated. It's portion of a wider multinational project management practises research. "The uniqueness of the APM data gives useful information on APM's operations and success factors, as well the facility to compare it to other PM systems. The reasons for the growing focus on agile management, which better handles risks at each stage of the project, are also discussed in the paper. This literature review also aids in gaining a greater comprehension of project managers' motives and the criteria for using the APM strategy in the construction industry. As a result, understanding the significance of APM in the construction field is essential for the multidisciplinary course's progression. To put it in other words, for project managers it is critical to comprehend the best practises currently used in the field of construction that involve the dynamics of external variables" (Jetter et al., 2016).

1.2 Research Gap

"In the construction business, a significant amount of money is usually invested. In a sense, they foster the infrastructure of our society" (Yllén et al.,2012). The real estate sector has played and will play an important role in increasing their country's GDP. However, the outbreak of the Corona virus put a massive restraint on the real estate market in 2020, as the needs and demands of the services offered by these organisations declined due to the lockdowns imposed by governments globally, causing economic stagnation (Egole, A., 2022). "There are many motives to the stakeholders to be focused on the project's success, apart from the remunerations. Uncertainties like this may arise in the future and organisations came to a realization of practicing a more adaptive method. It is true that sizable part of the construction field is conservative and implementing a new technique (APM) might jeopardize their existing competencies. However, when the change certifies to combat in a flexible and an agile way, there will be a competitive advantage. It is always preferable to embrace the change. A literature paper cites that, the Agile approach has similarities with the Lean philosophy, which is a concept already introduced in the construction business. Agile has its roots in the software sector, but that does not preclude it from being used to other industries. As APM is external to the construction industry, it makes it peculiar to understand the benefits and drawbacks of the industry. Fostering a transparent, flexible, and proactive approach (APM) promotes communication between the various actors involved. As a result, it is more advantageous to make possible changes early in the project (planning and design), thus decreasing the risks as the project develops further" (Yllén et al.,2012).

1.3 Research Question

This thesis addresses the following specific research questions:

1. Which agile techniques are employed in construction project management?
2. What are the direct and indirect benefits of using APM in the construction industry?
3. What is the likelihood of adopting the APM methodology in the construction industry?

The objective of this research is to provide qualitative answers to the research questions presented above.

1.4 Thesis Purpose and Limitations

The purpose of this thesis can be divided into three parts. First, agile practises/project management approaches in the construction sector will be presented. Partly, to compare the benefits of APM approaches with TPM approaches used in organisations, and partly to study and analyse the benefits of using APM in Lodha Group based on actual projects in different time periods. Different time periods were chosen to evaluate and compare the impact of Covid-19 on the organisation and the real estate sector.

The scope of this thesis is limited to the general implementation of APM in construction projects. It is also limited to comparing the APM approach with the traditional approach commonly used in the construction industry. No other approach was examined in more detail. The research question indicates that the implementation of APM is also explored. The implementation of the approaches is briefly discussed in the second and fourth chapters - literature review and empirical findings, synthesis, and analysis, respectively. However, changing an organisation and implementing a new management method is a large topic that needs to be studied and elaborated more thoroughly and therefore has only been briefly addressed in this master thesis. This master thesis has been conducted over a period of 27 weeks, corresponding to 12 ECTS.

1.5 Thesis Framework

The first chapter discusses the background and scope, research gap, research question, purpose of the thesis, and delimitations. The second chapter includes a literature review, definitions, and describes the differences in project management. The third chapter discusses the choice of research method and its reflections. Thereby follows the fourth chapter, which discusses the empirical findings, synthesis, and analysis of the case study. The entire literature review serves as the basis for the analysis when compared to the empirical findings from the case study - Lodha Group. The thesis then concludes by answering the research questions, some final considerations, strengths, and delimitations. Finally, future research and the scope of application of the findings in the research are also discussed.

The thesis framework is illustrated by the flow chart shown on the next page (Refer *figure 2*)

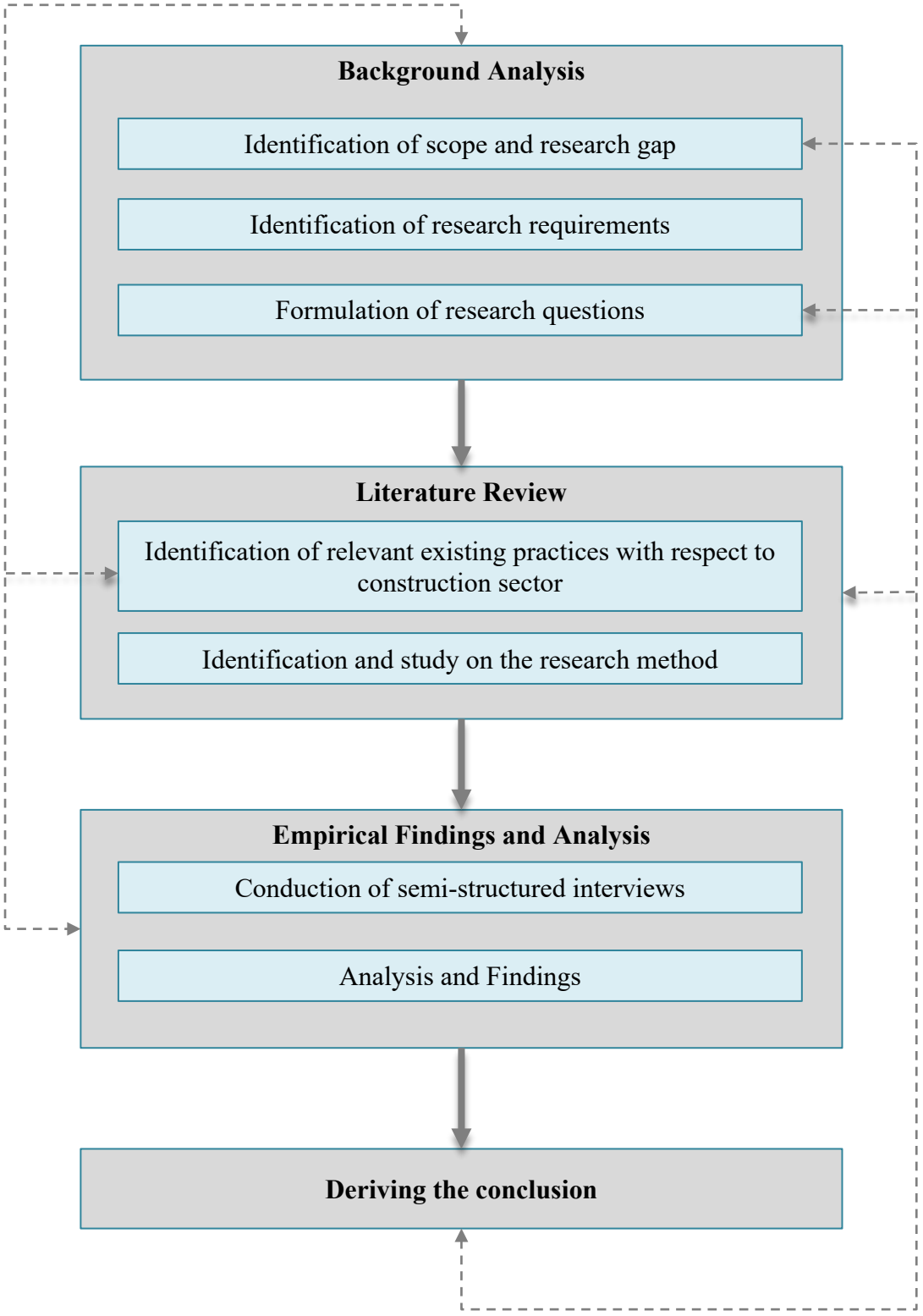


FIGURE 2 Thesis framework (Source: Author)

2 LITERATURE REVIEW

Chapter summary: This chapter summarises prior studies on the subject and compares TPM to the current role of APM. The aim of this chapter is to establish the foundation for the thesis. This will be the base when analysing and answering the research questions. The literature review starts with explaining the TPM and APM approaches and then continues with elaborating and comparing on its application and limitations in the construction industry. The detailed study contributes to fulfil the purpose of introducing and analysing agile approach to the construction industry. It also briefly presents the impact of COVID-19 and the challenges faced in the related sector. The chapter ends with briefly explaining the existing research in hybrid practises in organisations, that can be related to implementing a new management method.

2.1 Traditional Project Management

2.1.1 Definitions of Project and PM Terminologies

"Application of Project management (PM) is now a common practise in many industries, and there is no limit to the scale of the project" (Androniceanu et al., 2015). PM has been defined by several academicians and practitioners over the years. "A temporary activity taken on to produce a unique product, service, or result" (PMBOK, 2016). The temporary aspect of projects denotes that the project work or a segment of the project work has a beginning and an end. Projects can exist alone or a portion of a bigger program or portfolio."(PMBOK, 2021). British Standards Institution (BSI) defines project as, "a project is a unique process that consists of a plethora of coordinated and monitored activities with beginning and completion dates that are performed to meet a defined goal, while adhering to time, cost and resource limits" (ISO 10006 :2017).

TABLE 1 Definition of Project and PM by various scholars

Definition and Citations
"Each project has a life cycle. Tasks, team members, organisations, and other resources may change throughout the progression of a project" (Nicholas et al., 2012).
"Every project is unique, the rationale being a once-off activity and is never repeated under the exact same conditions" (Nicholas et al., 2012).
"PM is about translating the idea into reality. Also, this is fractal management because every project stage considers a small project. Therefore, the project life cycle involves the management process at lower levels" (Turner, 2014).
"Project management requires discipline in the implementation of knowledge, skills and strategies to project events to meet project requirements" (Brewin et al., 2014).
"The project management is a string of planning, organising, directing, and controlling the organisation resources to achieve the specific goals and objectives" (Kerzner, 2014).

"As it is a multidisciplinary subject, the following terminologies give a vivid knowledge of the same. Project portfolio includes a collection of projects, programmes, and other work. A programme is composed of interconnected projects and other activities. Every project is distinctive as there might be differences in deliverables, stakeholders, resources being used, constraints, and the way processes are tailored to provide the deliverables. According to PMI, PM is the application of knowledge, expertise, abilities, resources, and methods to project operations in order to fulfil project requirements. Project management refers to guiding the project work to deliver the intended outcomes. Project teams might use a variety of strategies to produce the desired results (e.g., predictive, hybrid, and adaptive)" (PMBOK, 2021).

2.1.1.1 Project management:

The set of methods, tools and organisational requirements (one thing required as a precondition for something else to happen or exist) needed to co-ordinate, through a set of processes, roles and skills, a time-limited and complex effort consisting of a long list of organisational actions aimed at realizing a specific product or set of products or services.

2.1.1.2 Program management:

The management of a collection of connected projects to jointly achieve one or more strategic objectives. Integration into a program ensures some benefits that would not be possible with independently managed projects. Examples of benefits may include risk reduction, achieving economies of scale, cost optimization, integration of services provided. "In this sense, the program has a scope that necessarily goes beyond individual projects and therefore requires a level of governance, i.e., control" (PMI, 2013).

2.1.1.3 Portfolio Management:

The management of a set of programs and projects that an organisation (or department or division) manages over a period of time related to the organisation's strategic plan. Each project or program present in the portfolio is therefore linked to specific business objectives and is evaluated in a report on its contribution to the business. The purpose of portfolio management (project portfolio management) is to make sure that the priority of each project and program is regularly reviewed in order to allocate resources and investments coherently and in line with organisational and strategic objectives.

TABLE 2 Pairwise comparisons of Project, Program and Portfolio Management (Source: PMI, 2013)

Organisational Project Management			
	Projects	**Programs**	**Portfolios**
Scope	Projects have defined objectives. Scope is progressively elaborated throughout the project lifecycle.	Programs have larger scope and provide more significant benefits.	Portfolios have an organisational scope that changes with the strategic objectives of the organisation.
Change	Project managers expect change and implement processes to keep change manage and controlled.	Program managers expect change from both inside and outside the program and are prepared to manage it.	Portfolio managers continuously monitor the changes in the broader internal and external environment.
Planning	Project managers progressively elaborate high level information into detailed plans throughout the project lifecycle.	Program managers develop the overall program plan and create high level plans to guide detailed planning at the component level.	Portfolio managers create and maintain necessary processes and communication relative to the aggregate portfolio.
Management	Project managers manage the project team to meet the project objectives.	Program managers manage the program staff and the project managers; they provide vision and overall leadership.	Portfolio managers may manage or coordinate portfolio management staff or program and project staff that may have reporting responsibilities into the aggregate portfolio.
Success	Success is measured by product and project quality, timeliness, budget compliance, and degree of customer satisfaction.	Success is measured by the degree to which the program satisfies the needs and benefits for which it was undertaken.	Success is measured in terms of the aggregate investment performance and benefit realization of the portfolio.
Monitoring	Project managers monitor and control the work of producing the products, services or results that the project was undertaken to produce.	Program managers monitor the progress of the program components to ensure the overall goals, schedules, budget, and benefits of the program will be met.	Portfolio managers monitor strategic changes and aggregate resource allocation, performance results and risk of the portfolio.

Effective application of PM enables business organisations to execute projects efficiently. "Project management is prominently utilised in these industries: Engineering & Construction, Business & Financial, Information Technology & Telecommunications, Manufacturing, Management, Research & Development, and many more" (Lecture, 2020). "To regulate both external and internal factors, management decides to use project management strategies" (Popa, 2016). "A project is realized as a win, if it accomplishes the project objectives according to the acceptance criteria, on schedule, and within budget" (Naybour, 2020).

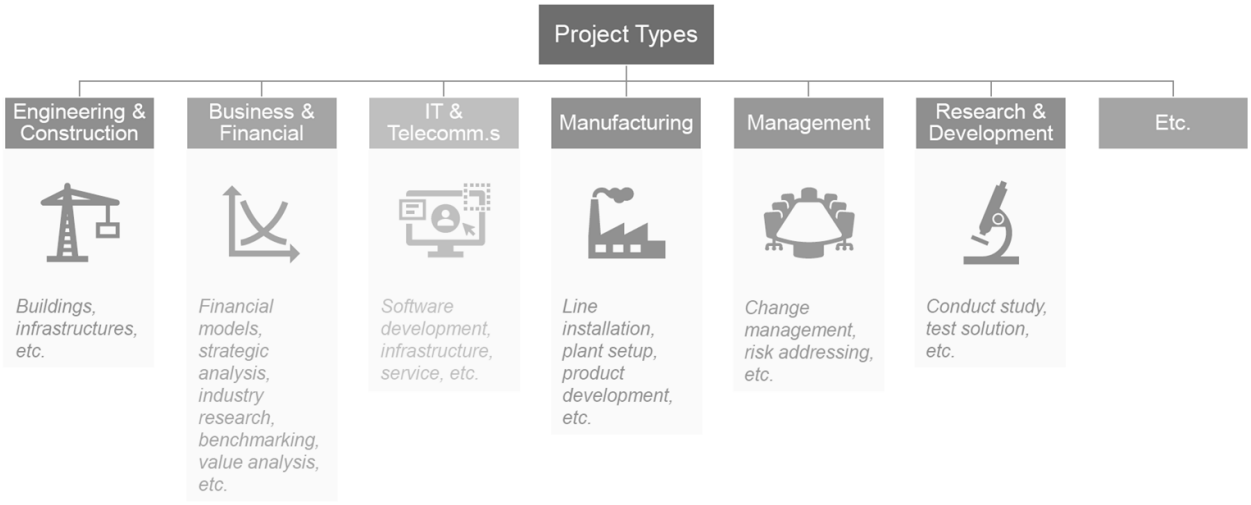


FIGURE 3 Project Types (Source: Lecture)

2.1.2 Etymology And Progression of PM

"Since the start of civilization, PM has been practised. The proof of many large-scale architectural structures such as The Pyramids of Giza, Great Wall of China, the Hanging Gardens of Babylon, Stonehenge etc. by great architects and engineers exists till now. Ancient civilization projects required hundreds to thousands of workers that someone needed to manage the resource allocation and monitor the progress of the project and make sure it was completed on time. It is impossible that these projects were not planned and executed. Engineers took on the secondary role of project managers for these projects to succeed" (Kwak et al., 2003). "Mark Kozak-Holland claims in his book- The History of PM, that these historic projects would not have been a success without a proper comprehension of project management principles" (Kozak-Holland, 2011).

"Regardless of many successful construction projects across the history, there is no actual documents and records of the tools, methods and approaches used. This might have been due to the division of societal classes in history. Upper society would be rather interested in the result than the planning and execution of the actual project. Other factors can be due to the secrecy of the craftsmanship techniques that passes between one generation and other" (Seymour & Hussein, 2014). "A History of Ancient PM: From Roman Empire to Mesopotamia" provides a rationale for the absence of documentary evidence could be because the term project was not widespread in history" (Chiu Y. C., 2011).

"The concept of modern PM emerged in between the 1900s and 1950s. There have been identified four phases to reflect the history of contemporary project management: (1) before to 1958, (2) 1958–1979, (3) 1980–1994, and (4) 1995–present" (Kwak et al., 2003).

TABLE 3 Four periods of PM (Source: Kwak et al., 2003)

Periods	Theme	Sub context
Prior to 1958	Craft system to HR Administration	▪ Project Management ▪ Actual Projects
1958 -1979	Application of Management Science	
1980 - 1994	Production Centre: Human Resources	
1995 - present	Creating a new environment	

TABLE 4 The brief history of PM (Source: Kwak et al., 2003)

	Technology	Management Science	Project Management & Technology	Major Projects	Project Office
1958	- Telegraph - Telephone - First computer - Automobile - Airplane - First database	- Adam Smith - Frederick W. Taylor - Henry Fayol - Henry Gantt - A McGregor's XY theory	- Parametric Cost Estimating - PERT/CPM - Gantt Chart - Monte Carlo Simulation - Systematic Application	- Inter-Continental railroads - Hoover Dam - Polaris - Manhattan project - Panama Canal	- Focal point - "proximity" - Traditional project office procedures - Navy Special Project Office(SPO)
1959 - 1979	- IBM 7090 - Xero x copier - UNIX - Microsoft Founded	- ISO - Total Quality Management - Globalization - Quality Management	- PMI - Inventory Control - MRP	- Apollo 11 - ARPANET	- Project Supporting Office
1980 - 1994	- Personal Computer - Wireless in-building network - First Internet browser (MOSAIC)	- Manufacturing resource planning - Risk Management	- Matrix organisation - PM Software for PC	- Boeing 777 - Space Shuttle Challenger - The English-France Channel project	- Project Headquarter - War Room
1995 - Current	- Internet	- Critical chain - ERP	- PMBOK (PMI)	- Iridium - Y2K project	- Virtual Project Offic - Web-base - Project Office

"Henri Fayol (1841- 1925) and Henry Gantt (1861- 1919) are considered the forefathers of Project Management due to their significant contributions in the field of management. Henri Fayol, a French iron and steel engineer, identified the five management functions: planning, organising, commanding, coordinating, and controlling. Fayol also proposed 14 principles for managers to follow in order to effectively carry out those five managerial functions. The second forefather of modern project management, Henry Gantt was an American engineer and later a management consultant. He is known for inventing the Gantt chart (1910 – 1915), which recognises the benefits of breaking large projects into smaller manageable tasks" (Chiu Y. C., 2010). "Gantt charts were used in macroscale projects for World War one and in the construction of Hoover dam which is still used today. They are deemed as an essential tool for a project" (Seymour & Hussein, 2014). "However, another literature cites that, in 1986, Karol Adamieckic, a Polish economist invented a method to visualize the interdependencies called Harmonogram. Because his publications were only published in Polish and Russian, his idea did not receive widespread recognition or adoption in the west" (Marsh, 1975). "In the west, Gantt chart was being widely adopted tool and consequently, the charts became synonymous with Henry Gantt" (Seymour & Hussein, 2014). "Snyder and Kline (1987) claim that the invention of the Critical Path Method (CPM) and Program Evaluation Review Technique (PERT) in 1958 marked the beginning of the modern project management era" (Kwak et al., 2003). CPM and PERT processes will be explained in the approaches and tools.

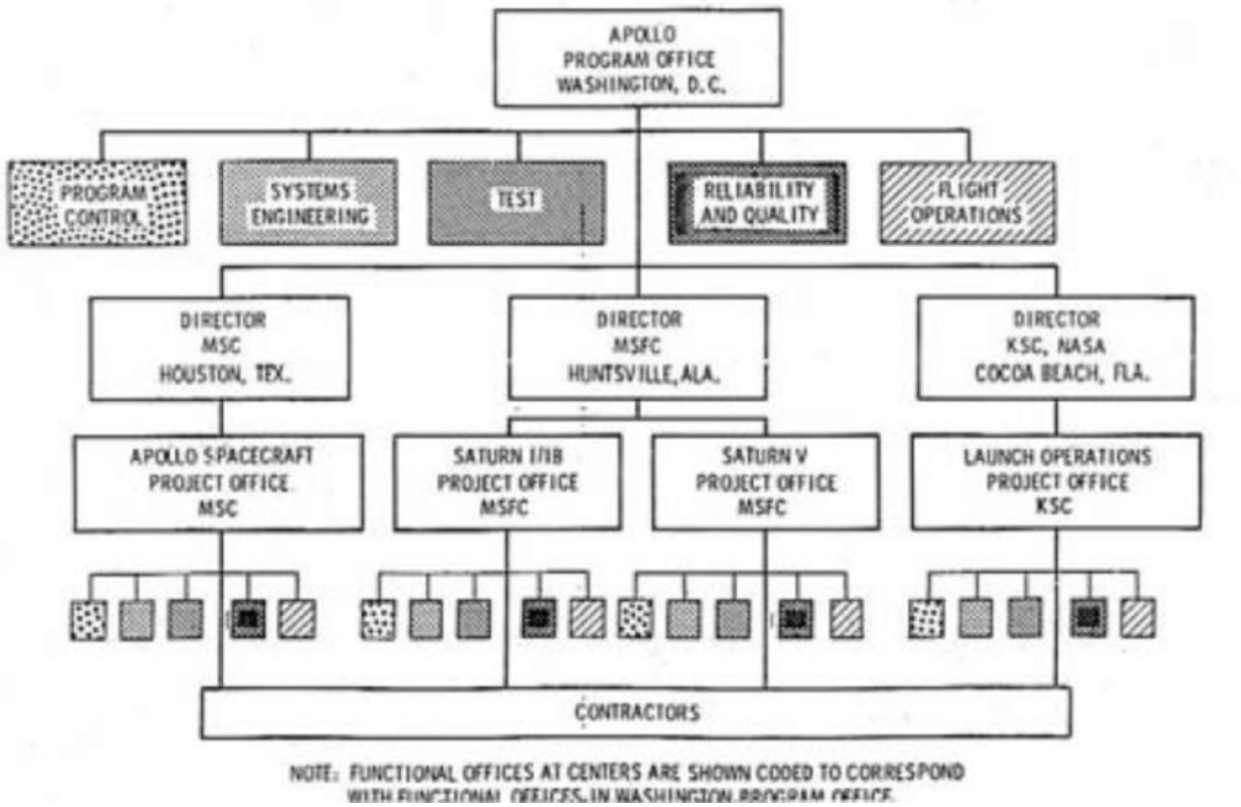


FIGURE 4 Apollo Program - organisation management (Glennan, 1961)

"Simultaneously, institutionalization of PM began in 1965 with the creation of first PM association - International Project Management Association" (IPMA, 2018). "IPMA has developed significantly since its foundation in 1965 and is currently the leading international advocate of PM in Europe, Asia, and Arab. The Project Management Institute (PMI), which is primarily based in the USA, was established four years later" (Seymour & Hussein, 2014). "In the 1970s, Polaris and The Apollo program of NASA is among the momentous historical examples of significant PM implementation. NASA's chief historian said, Of all the obstacles NASA encountered in its effort to send humans to Moon in the Apollo mission, management was perhaps the greatest challenge"(Roger D. Launius, 2008). "Dr. George E. Muller's project management system (Refer *figure 4*) for the Apollo project– breakdown of five areas (Flight Operations, Program control, Testing, System engineering, and Reliability & Quality) ensured that all phases worked successfully"(Kuittinen, H. & Velte, D., 2018).

"Project management programs in the 1980s largely followed the Projects Resource Organisation Management Planning Technique II (PROMPT II) paradigm, which was eventually improved into the PRojects In Controlled Environments (PRINCE) model" (Bizness Académie, 2012). "PMI is a well-known publisher of the PMBOK. The book contains a collection of project management methods and knowledge areas that are widely acknowledged as best practise" (ITRM Guideline CPM 110-01, 2006). "PMBOK® was first issued by PMI in 1987, and it was built on the 'Ethics, Standards, and Accreditation Committee Final Report', a white paper"(Webster, 1994). "The guide was an attempt to standardize and document accredited project management and procedures. The PMBOK® guide has become the global standard for the industry" (Seymour & Hussein, 2014).

2.1.3 Project Management Process

"Project Management Institute cites PM process as a collection of connected procedures followed to produce a predetermined good, service, or outcome. Each process is defined based on its inputs, tools, and procedures that may be used, and the outputs that are produced. PMBOK Guide recognises, Initiating, Planning, Executing, Monitoring (or) Controlling, and Closing as the five PM Process Groups" (PMBOK, 2017). The following is a description of processes and methodologies an organisation should follow for each project phase.

2.1.3.1 Initiating:

"The part's goal is to understand and define the entire project in a comprehensive perspective. Various feasibility studies (internal and external stakeholder analysis, project requirements, financial measures, and product vision) are performed at this phase with the intention to get the approval of the stakeholders" (PMBOK, 2021). It involves preparing a proposal and analysing and validating the feasibility of the idea to get approval to start the project. Project initiation is the assumption that a project or phase is to be started and the PM team is committed to making this happen.

2.1.3.2 Planning:

The objective this section is to select the most optimal technique to finish the project. “To deliver the objectives in the most efficient way possible with taking uncertainties into account. The key activities of this phase include defining scope, activities & sub-activities for project objectives (WBS), scheduling (relationship between activities), resource allocation, Gantt charts, communication transparency with stakeholders, creation of milestones, and baselines and performance metrics. A crucial part of this phase includes risk management, which states possible risks adhered to the project and the strategies to mitigate them (risk response matrix)” (De Marco, 2011). The sequence for risk management tailored to each project is as follows: plan RM, identifying risks, performing a qualitative risk analysis, performing a quantitative risk analysis, planning risk responses, monitoring and controlling risks. The project planning process leads to the development and maintenance of a workable plan for meeting the project's business needs and objectives. It includes defining the overall scope, establishing the planning strategy, building the cost and schedule, revising estimates, and analysing commitments, optimizing the project plan, creating plans for risk management, and organising project staff.

2.1.3.3 Executing

“This section's goal is to co-ordinate the assigned resources to complete the objectives (while trying to adhere with the baseline as much as possible). Apart from these key activities this phase includes reports related to the development, performance, and quality metrics of the project” (De Marco, 2011). This process brings together an organisation and other resources to carry out the tasks described in the PM plan to guarantee that the project is completed successfully and that the project requirements are met.

2.1.3.4 Monitoring and Controlling

“From a business perspective controlling and monitoring are called ‘Project control’ as measures, analyses, and actions are closely related. Monitoring is the measurement of cost, schedule, and performance metrics (Earned Value Analysis). It paves an approach to assess the trend between real-time situations and the baseline” (De Marco, 2011). Project controlling makes ensuring the project's goals are realized by tracking, reviewing, and tracking advancement and performance, and identifying areas where adjustments to the plan are needed and implementing those adjustments. “This is done to control the project if needed and minimize the variation from the baseline (control). This includes collecting information on project status, assessing deviations, and providing project updates” (De Marco, 2011).

2.1.3.5 Closing:

“The project closing procedure guarantees that all activities across the project are completed and are officially accepted and that it comes to a formal close of the project. Delivery, commissioning, official termination of any project-related contractors, and feedback learning from key takeaways are all part of the closing processes” (De Marco, 2011).

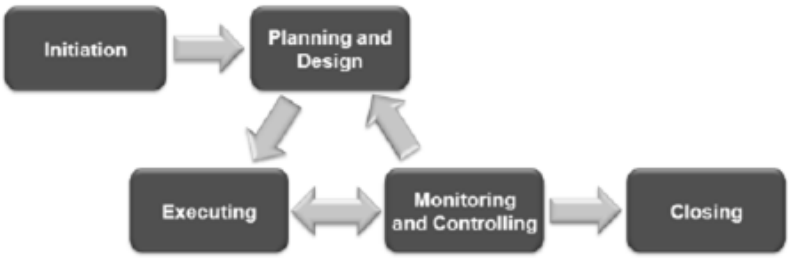


FIGURE 5 Macro processes and interactions - operative flow chart (Source: processglobal.biz)

"*Figure 5* depicts the operational flow chart of these five macro-processes and their interconnectivity. Apart from the initiating and closing procedures, it is obvious that PM is a cyclic reiteration of three processes: planning, executing, and managing" (Bortolussi, 2016).

2.1.4 Project Management Areas of Knowledge (PMBOK, 2013)

"The PMBOK Guide's 47 project management methods are logically grouped into ten Knowledge Areas. A Knowledge Area implies to a professional sector or area of specialty that contains a comprehensive collection of concepts, terminology, activities, and duties. It is implied that each team should use the ten fields of knowledge (Refer *figure 6*) appropriately for their specific project (tailored to the specific project). Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communications Management, Project Risk Management, Project Procurement Management and Project Stakeholder Management are the knowledge areas. Each of these areas of knowledge also corresponds to one of the five process groups, resulting in a matrix structure" (PMBOK, 2013).

2.1.4.1 Project Integration Management:

"It is the process of assuring that various components of the project are appropriately identified, defined, combined, and coordinated. To successfully manage stakeholder expectations, execute projects under control, and achieve requirements, integration involves elements of unification, consolidation, communication, and integrative actions" (Project Management Institute, 2013).

2.1.4.2 Project Scope Management:

It is the process of assuring all components and variables required to define and control the project are considered (Kwak & Ibbs, 2002, 152). This means that all the work required for the realization of a project is clearly defined and its boundaries established.

2.1.4.3 Project Time Management:

It is the process of ensuring the timely completion of a project, which is among the biggest challenges in almost any project (Kwak & Ibbs, 2002,152). It includes aspects like defining and sequencing activities, estimating duration and resources, developing the schedule, and controlling the schedule.

2.1.4.4 Project Cost Management:

Project cost management is the process of making sure the project is completed within the approved budget (Kwak & Ibbs, 2002). It has aspects such as setting the budget, planning & estimating costs, and controlling costs.

2.1.4.5 Project Quality Management:

Making sure the project adheres to the requirements is this step. To check the project requirements are met or exceeded. It involves activities like planning. and implementing quality assurance and quality control.

2.1.4.6 Project Procurement Management

Making sure that products and services are acquired from businesses outside of project and implementation companies is the process. It involves actions such as conserving acquisition, carrying out the process of contract negotiation and termination.

2.1.4.7 Human Resource Management for Projects

The human resource management of a project is the method for guaranteeing the efficient use of each team member or staff member, i.e., the people who have been assigned roles and responsibilities to deliver the project. At its core, it is about effectively directing, inspiring, and managing the project team. This incorporates things like defining and assigning project roles and responsibilities, sourcing staff, team development, leadership, conflict resolution and much more.

2.1.4.8 Project Communication

It is the procedure for making sure project information is created, collected, disseminated, stored, and disposed of in a timely and appropriate manner. Effective collaboration is a crucial element in project access. It consists of things like developing a communication plan, creating, distributing, and storing information, and monitoring, controlling and satisfying the information needs of all stakeholders.

2.1.4.9 Project Risk Management

It is a procedure that assures identification, analysis and response planning to project risks. It incorporates things like definition, identification and analysis of risks, the development of risk response plans and strategies, and control processes.

2.1.4.10 Project Stakeholder Management

It is the process of assuring identification of people and organisations involved in or likely to be affected by a project, the analysis of their expectations and requirements, and the development of appropriate strategies for managing them effectively.

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

FIGURE 6 PM Process Group and KA table (Source: PMBOK Guide, 2013)

2.1.5 TPM Approaches and Tools

"The WBS solves the issue of 'what to do' to attain the project objective in the planning phase after the initiation phase (defining scope). WBS provides a logical framework for managing and decomposing totality of the work (where an element is decomposed into child elements - an element is a bigger level of project objective)" (Bortolussi, 2016). "It is a hierarchical breakdown of the whole scope of the job that should be completed for project objectives completion". It should be drafted in an intelligent way to accommodate alternative ways of organising and representing the work (uncertainties). TPM offers WBS, Gantt chart, Critical Path Method, and PERT approaches" (PMBOK, 2013). Each of these approaches and tools are briefly explained below.

2.1.5.1 Work Breakdown Structure (WBS):

"WBS includes individual Work Packages. PMI describes Work Packages as the lowest level WBS components, where planned work is contained, and for which cost, and period can be estimated and managed. A WP has a specific begin and an end, this aids in effective monitoring & control. The amount of detail for work packages depends on the project's size and complexity, and the degree of breakdown ranges based on the degree of control necessary to successfully manage the project. *Figure 7* shows an outline and deliverable - oriented WBS for an IT system. The decomposition logic of WBS is shown in *Table 5*" (PMBOK, 2013)

1. Online shopping system
    - 1.1. Software
        - 1.1.1. Epic feature: Buy product
            - 1.1.1.1. Sub-feature: Browse products
            - 1.1.1.2. Sub-feature: Register as user
                - 1.1.1.2.1. User story: Sign up
                - 1.1.1.2.2. User story: Validate email
        - 1.1.2. Epic feature: Administrative orders
            - 1.1.2.1. Sub-feature: View orders
            - 1.1.2.2. Sub-feature: Manage orders
    - 1.2. Platforms
        - 1.2.1. Development environment
        - 1.2.2. Versioning system
2. Governance
    - 2.1. Processes
        - 2.1.1. Support processes
        - 2.1.2. Order processes
        - 2.1.3. Reporting processes
    - 2.2. Roles and responsibilities
        - 2.2.1. Maintenance
        - 2.2.2. Administration
        - 2.2.3. End user support
        - 2.2.4. Other roles
3. Changed behaviours
    - 3.1. Educated users
        - 3.1.1. Marketing campaign
        - 3.1.2. Usability feedback
    - 3.2. Educated support staff
        - 3.2.1. Courses
        - 3.2.2. Information material

FIGURE 7 Outline and deliverable - oriented WBS for an IT system (Source: Author)

TABLE 5 Decomposition logic – WBS (Source: Lecture, 2020)

Decomposition logics	Description
By Parts	The project is decomposed in its component parts following the product distinct base.
By Functions	The project is decomposed as per the functionality, the output must achieve.
By Objectives	The project is decomposed as per the output's performance.
By Phases	The project is decomposed to its phase sequence.
By Progressive Releases	The project is decomposed identifying possible progressive releases.
Geographical	The project is decomposed based on the geographical areas in which the project is realized.

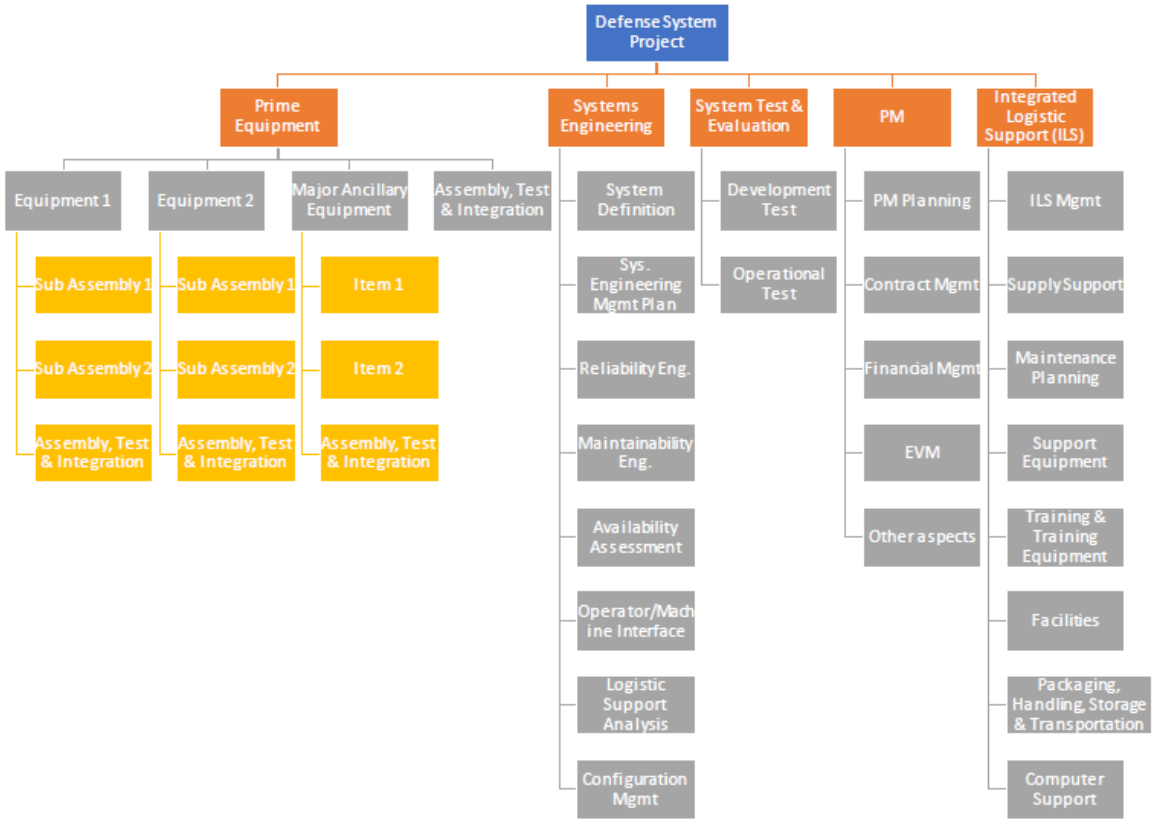


FIGURE 8 Graphical example – Product and functions oriented WBS for a defence system (Source: Lecture, 2020)

2.1.5.2 Gantt Chart:

"The Gantt chart, which was first created in 1917, considered one of the prevalently used, practical, and easy-to-understand representations of deliverables. It's a two-dimensional graphical analysis of the project's activity, with the vertical axis indicating project activities and the horizontal axis reflecting time" (Westcott R. T.,2004). "The Gantt chart is adopted as a planning tool as well as a technique to report real time progress. The anticipated start and ending timings, as well as the activity length, are depicted as a bar across the specified time interval by listing major project work packages or task clusters vertically on a time grid (weeks, months, quarters). Each timeline's anticipated start and ending dates can be shown in columns. Along the key timeframes, important milestones, which are critical review and decision points, might be represented by a symbol" (Bortolussi, 2016). A Gantt chart of a simple construction project is depicted in *figure 9*.

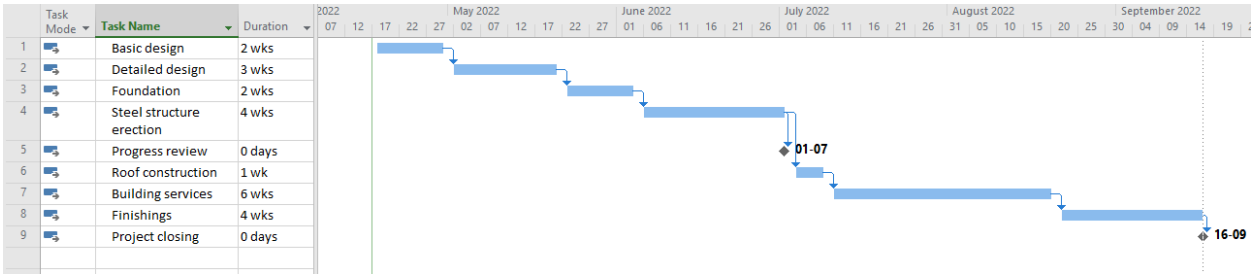


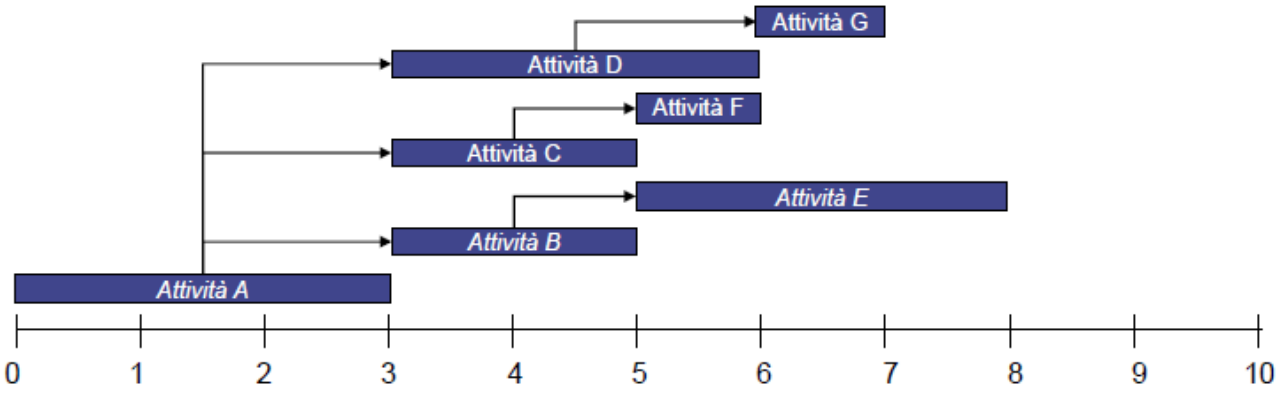
FIGURE 9 Gantt chart example for a construction project (Source: Author)

2.1.5.3 Critical Path Method (CPM):

"CPM was created in 1957 by Dupont company with the intention to make a tool that improves the planning of construction programs and to control time-cost combination. It is a basic yet effective strategy applicable for large and complex projects. Critical path is defined as the longest path through which represents the shortest amount of time in a project" (Morris et al., 2008). "CPM eliminates uncertainty regarding timing, considering deterministic values. It offers a possibility to simulate different scenarios with various duration-costs. CPM associates each activity with two values for duration and cost (normal duration/cost and crashed duration/cost).

The objective of CPM is to reduce time at a minimal cost. Begin with the identification of critical path in the activity network with normal duration. Further, crash the duration of critical activities (among the critical activities select the cheapest activity to reduce – crash critical activities with lowest unit direct cost). Iterate the exact same steps up until $\frac{\mathrm{dcost}}{\mathrm{dt}} < \frac{dgain}{\mathrm{dt}}$ to achieve the minimum total cost.

The result of CPM delivers the "optimal duration" is the one that minimises the overall cost of the project" (De Marco, 2011).



Activity	Pred.	Early Start	Early Finish	Late Start	Late Finish	dC/dT
A	-	0	3	0	3	10
B	A	3	5	3	5	35
C	A	3	5	5	7	/
D	A	3	6	4	7	15
E	B	5	8	5	8	15
F	C	5	6	7	8	/
G	D	6	7	7	8	/

Total time = 8
Total cost = 210
Critical activities A, B, E

FIGURE 10 Example of CPM (Source: Lecture)

In *figure 10*, the activities on the critical path are to be managed carefully (A-B-E). After estimating the expense to crash (among the critical activities) and selecting the cheapest cost, on the first iteration, A (dC/dT = 10) is to be crashed. The iteration is continued until the optimal duration is achieved with lowest cost increment $\frac{\text{dcost}}{\text{dt}} < \frac{\text{dgain}}{\text{dt}}$.

2.1.5.4 PERT:

"PERT was first employed by the States (US) Navy in 1958 for the Polaris project. PERT was well-suited to illustrate the project's various scheduling possibilities given the significant complexity and uncertainty connected with the project's scheduling. The main underlying hypothesis of PERT is, considering independence among activities durations (the way an activity is performed does not affect other activities in the project) and using beta distribution (estimating time with 99% probability). PERT better combats uncertainties involved in a project" (Kwak et al., 2003). Procedure for PERT is as follows.

1. Identify the Critical path and Critical activities (activities with no slack from the network diagram)
2. For each activity k, obtain optimistic ($\boldsymbol{a}$), most likely ($\boldsymbol{m}$), and Pessimistic ($\boldsymbol{b}$)

3. For each activity compute expected time ET=$\frac{a+4m+\mathrm{b}}{6}$
4. For each activity compute variance SD = $\frac{b-\mathrm{a}}{6}$ and order the critical activities based on the standard deviation (highest to lowest)
5. Identify sub-critical activities using the formula, $b > ET + Slack$ and order sub-critical activities based on slack to SD ratio (lowest value is the highest priority).
6. Order non-critical activity based on slack to SD ratio (lowest value is the highest priority)
7. Compute $ET_{project}$ and $SD_{project}$ with the respective formulae $ET_{project}= \sum_i^{critical\ path} ETi_{ct}$; $SD_{project}= \sqrt{\sum_i^{critical\ path}(SD)^2}$

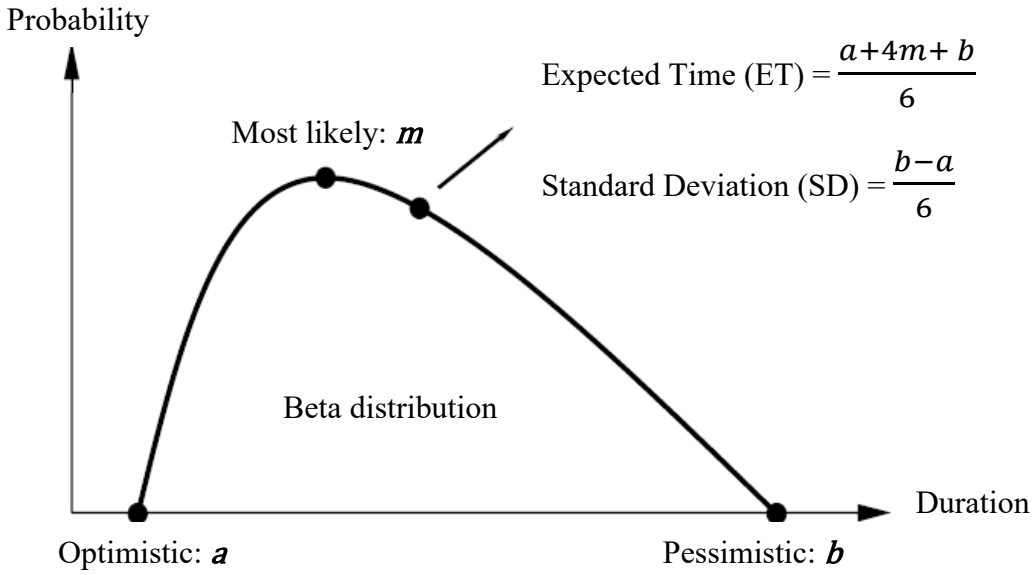


FIGURE 11 Beta distribution for PERT (Source: Lecture)

2.1.6 PM in Construction Industry

"Home is an essential part of an individual as it provides with shelter, safety, and serves to be an identity. It emphasises on improving one's quality of life. The population of a nation has an impact on the demand for new homes. After every census (time frame varies depending on different nationality settings), the demand for new homes is perceived. To meet these needs, governmental and private construction enterprises are trying to bridge the gap or to make a business out of it. The construction industry contributes to a country's economic prosperity while also providing job opportunities. 40 or more industries are required in building a single house. Many minor industries are related to this industry providing opportunities to skilled and unskilled workforce. The construction industry is, without a doubt, one of the world's fastest-growing sectors. Repairs and enhancements to buildings will always be a requisite. As a result, the construction business will continue to exist. The worldwide construction industry's revenue is predicted to increase gradually in the next years" (Siddiqui et al., 2022). It is likely to be more in

2030, as it was in 2020. In 2020, the construction industry was worth 6.4 trillion USD, and by 2030, it is estimated to be worth 14.4 trillion USD. (NMSC., January 26, 2022). *Figure 12* shows the market size of the global construction industry in 2020, with forecasts since 2021 and 2030 (in trillion USD).

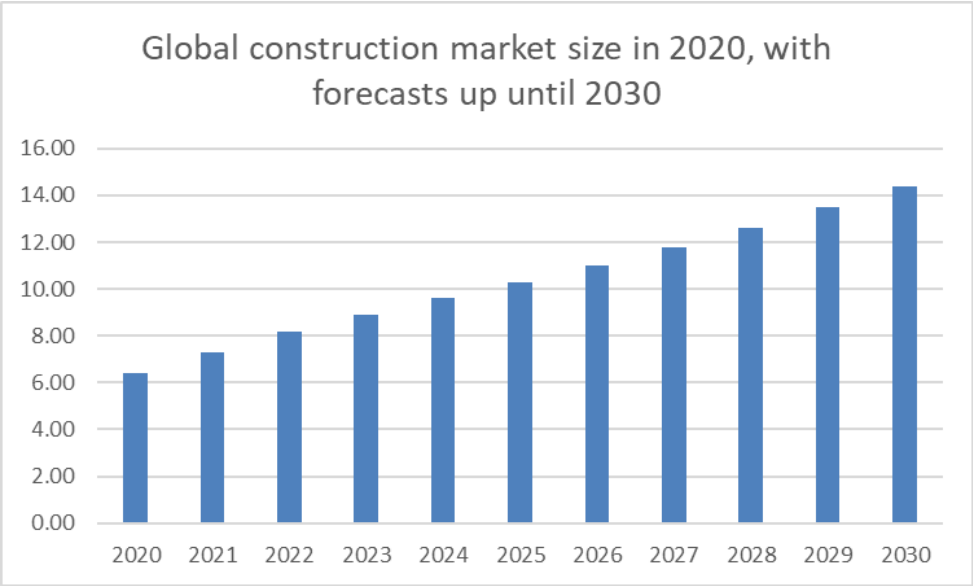


FIGURE 12 International construction market size in 2020, with forecasts since 2021 and 2030 (in trillion USD) (Source: Statista, 2022)

"The primary goal of the construction industry is to meet the client's requirements and expectations for a project that is both functional and cost-effective" (Siddiqui et al., 2022). "As the construction industry contributes at a higher rate to a country's economy, it is critical to curtail the Non-Value-Added activities (NVA's) as much as possible as each activity is associated with a cost. The waterfall model, which has a defined structure and restrains to modify scope changes, is the most used approach in construction projects. Agile approach is an effective and improved approach for reducing the impact of change, increasing maximum KPI's, and controlling risk and change. Agile is becoming more popular to organise, plan, and navigate the entire project process in any business including construction business (Mohammad et al., 2020).

2.1.7 Critical Success Factors

CSFs with respect to project management was initially coined by Rockart in 1982 as a handful subset of factors "that should be satisfied" (Rockart, 1982) for a project to be completed successfully. Identification of CSFs helps the company's leadership to use their limited resources in an efficient way to achieve project success. Over the years, many academicians and practitioners have conducted systematic analyses of the literature and the first insight would be that "The nature and scope of a project, as well as its CSFs, are inextricably linked" (Bergmann, 2018). As every project is unique, there is currently no clarity on what basis CSFs should be considered "to define project success" (Fortune & White, 2006).

TABLE 6 Construction Project Performance Indicators (Source: Alias et al., 2014)

Project Performance indicators	Reference
• Construction cost	(Cho, Hong & Hyun, 2009; Enshassi, Mohamed, & Abushaban, 2009; Takim & Akintoye, 2002)
• Construction time	(Cho et al., 2009; Enhassi et al., 2009; Takim & Akintoye, 2002)
• Quality	(Enhassi et al., 2009)
• Defects, Construction and Time predictability	(Takim & Akintoye, 2002)
• Client content with the service	(Takim & Akintoye, 2002)
• Client content with the product	(Enhassi et al.,2009; Takim & Akintoye, 2002)

"CSFs are classified into hard and soft categories. Hard category includes 'control and management of schedule, cost, and scope' while the soft categories include the following: Support of senior management, Skilled designers, Skilled project managers, Trouble shooting, Project team motivation, Commitment of all the project's participants, Detailed planning in design and construction phase, Adequate communication channels, Effective control – tracking and modifying plans, Effective feedback and Adequate financial budget. The CSFs generally used in TPM are provided in the *table 6*. TPM gauges the project performance as cost, quality, and time (iron triangle). Contemporary research show that there are other important factors such as Customer Satisfaction Index (CSI) are also considered critical" (Alias et al.,2014). "A literature paper cites that CSFs can be split into broad categories that are applicable to a wide range of project types. These groups are management, processes, project factors, organisation, human resources, and technical tasks" (Bergmann, 2018).

2.1.8 TPM Strengths and weaknesses

"TPM is an older approach, but its attributes have allowed it to persist until today. TPM fosters the following benefits namely vivid objective and direction, high degree of monitoring, low degree of uncertainty and transparent documentation. The methodology tries to correspond to the initial base line trying while trying to satisfy stakeholders stated and implied needs. Interestingly the attributes that contribute as the strengths could be argued as it's weakness. The rigidity to cling to the baseline doesn't permit any provision to scope changes on a higher level. The CSFs of TPM which are mainly cost, quality and time are not the only criteria for a project's success as mentioned above. Expense of risk which is associated to external sensitive variables (available technology, productivity, efficiency, skilled labour availability, etc.,) and scope changes is not fully considered and would be overlooked at the initial stages of the project" (Kerzner, 2014).

TABLE 7 Strengths and weaknesses- TPM Approaches (Source: Author)

TPM Approach	Strength	Weakness
WBS	• Helps to anticipate opportunities and constraints. • Systematic approach that helps identifying the elementary activities and facilitates the whole vision. • Facilitates delegation thanks to activities decomposition. • It is the basis for the identification of tasks and their responsible. • Allows to reinforce learning for following projects (e.g.: standard WBS).	• Excessive articulation leading to difficulties in control. • Lack of intermediate levels of aggregation leading to difficulties in balancing work and assigning responsibilities.
Gantt Chart (Suits projects with a small dimension)	• Immediate visual understanding • Quickly highlights the positioning over time of the many activities • Visualizes anticipations and delays	• Difficulty in updating the program • The project logic is not explicit • The activities inter dependencies are not highlighted
CPM (Suits best for repetitive and predictable projects (WPs))	• Parallel activities can be identified. • Identifies critical path– which requires high level of attention by Project Managers and slack time for individual activities. • Depicts activities and outputs as network diagram. • Dependencies between activities can be understood and implied in scheduling (planning phase). • Provision of transparent documentation and consideration of cost variable.	• Resource allocation – levelling is tedious for complex projects • For bigger projects CPM networks can be complicated • Critical path must be accurate. • It delivers an optimal solution but, sometimes could not be the best solution – Heuristic solution.
PERT (Best suits for high uncertainty, non-repetitive and low experience projects)	• Considers and evaluates duration uncertainty. • determines what activities need to be under control	• Translates a stochastic problem into a deterministic one. • Decisional support only on time.

2.2 Agile Project Management

2.2.1 Definitions of Agility and APM Terminologies

"The word agility is derived from Latin (agere) which means, 'to drive, act', implying a sense of ownership, and the agility to drive something forward" (White, K. R. J. ,2008). "Agile is defined as having a fast resourceful and flexible character" (Merriam-Webster, 1999). "Agility is relatively a new notion, and the literature varies in its understanding of its fundamentals. Agility is defined by Dove as, an organisation's capability to prosper in an ever-changing, unexpected business environment" (Dove, 1999). Orr (2005) and Owen et al., (Owen et al., 2006) both claim that, agility is, "the capacity to operate proactively in a continuously changing, dynamic, and arbitrary environment". "Additional agility characteristics, such the capacity to react rapidly to change and uncertainty, high-quality and highly specialized products, and the ability to innovate new products and processes, are also highly valued in the literature" (Sherehiy, Karwowski, & Layer, 2007). "Agility is a successful incorporation of the aptitude to react and management of knowledge in order to respond quickly, effectively, and precisely to any unexpected (or unplanned) change in both proactive and reactive business/customer demands and opportunities without compromising the cost or the standard of the product/process" (Ganguly et al., 2009). "The change was accelerating, and it was already surpassing the capabilities of many established organisations. It became evident that much more continuous and rapid progress was on the rise" (Dove, 1999). "Agile is the ability to produce and adapt to change: a method of coping with, and eventually succeeding in, a volatile and uncertain environment. The typical project framework is to plan first and then execute. The APM approach is to adapt to change as you iterate. Agile project management does not have a clearly delineated definition. It comes from the 'agile manifesto' (Agile Alliance, 2015). Refer *table 8* for various definitions of different academicians and researchers.

TABLE 8 Definitions of APM (Source: From Rico, D.F., 2013)

Definitions And Citations
"Repeatable and practical method for building solid yet flexible project processes in environments with high internal and external uncertainty, the need for unique expertise and a significant degree of urgency" (Chin, 2004).
"The process of inspiring, empowering, and allowing project teams to engage customers, learn and adapt to changing demands and environments to produce business value swiftly and consistently" (Sanjiv Augustine, 2005).
"Industrial model created for adaptive projects to give the greatest amount of business value to the client in each iteration cycle while staying within the client's schedule and budget restrictions" (Robert Wysocki, 2010).
"A set of standards, procedures, and performance metrics that enable project managers to keep pace by being quick, adaptable, and realistic about the difficulties of modern product development and customer-focused" (Jim Highsmith, 2010).
"Earlier business value delivery and delivery of well-tested solutions that represent customer needs are all hallmarks of this approach" (Mark Layton, 2012).

"The golden age of agile and adaptable project management has dawned. Nevertheless, at the centre of the bell curve, there are still a fair percentage of middle managers. Most project managers are skeptical that APM falls short of the more disciplined TPM due to misconceptions such as adapting is only for small software projects, disorganised, no specifications, no plans and processes, no record keeping, inadequate quality, not maintainable, not expandable, poor performance, and security. Agile approaches, on the other hand, are highly disciplined but flexible enough to handle the uncertainties of today's projects" (Dr. Rico, 2013). They include

- Explicit requirements
- Plans for releases and iterations
- Just-in-Time architecture, design, and documentation
- Product assurance- workflow
- Configuration management
- Quality assurance
- Automation of testing, certification, and security.

"Agile approaches produce ten times the quality of traditional methods at a quarter of the expense, thus removing 80% of the risk, waste, and defects of unpredictable traditional methods. The project's success determined by TPM are associated with rigid processes, resources, and documentation on the hypothesis that 100% of a project scope is predictable. Customers' needs are concealed, tacit, and inexpressible in 70% to 80% of cases. As a result, APM recognises that user demands must be elicited gradually using human-intensive interactions, lightweight adaptable process and product technologies, and near-term, time-based sense-and-response probes. 80% to 90% of projects now globally adopt APM" (Dr. Rico, 2013).

2.2.2 History and Progression of APM

"Some people believe that the Agile mindset is brand new and that it was just recently found. It does, however, have a long history. Its foundations can be located back to Francis Bacon's development of the scientific method, an empirical and evidence-based method (Pose a question; Gather information; Form a hypothesis; Test the hypothesis; Share knowledge) in the early 17th century (1620). These empirical underpinnings serve as a framework for how we work today in an Agile-minded manner"(Abbas et al., 2008).

Other historical events or notions have contributed to and shaped our worldview since that early period. In 1911, Frederick W. Taylor published a monograph called 'The Principles of Scientific Management'. Because of his separation of 'workers' and 'managers', Taylor's viewpoint is frequently considered as the antithesis of Agile techniques. His purpose, though, was to improve the work, which is something we continue to achieve even today. His management concept was based on regularly reviewing workflows and increasing their efficiency, which is like the present approach.

"In 1930, Walter Shewhart, a physicist and statistician of Bell labs, adopted Taylor's scientific method and displayed the first version of Shewhart Cycle (Refer *figure 13*)" (Moen et al.,2009).

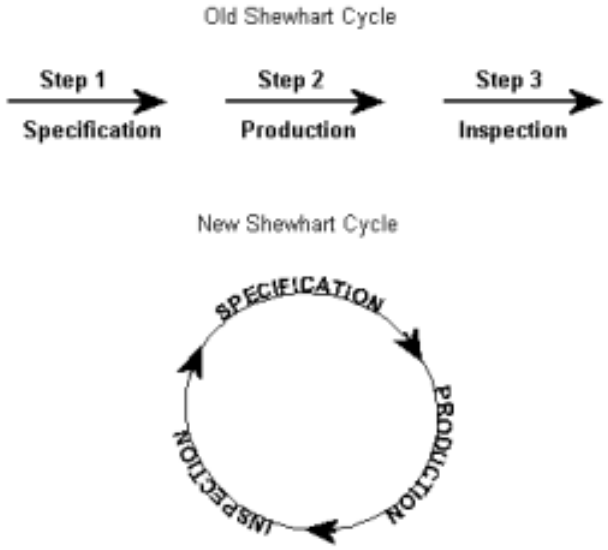
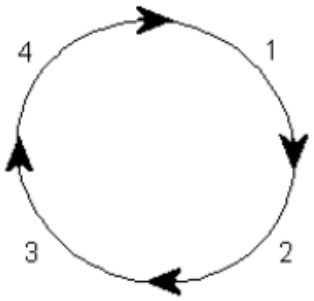


FIGURE 13 Old and New Shewhart Cycle (Source: History of PDCA cycle, Moen et al.,2009)

"In 1950, W. Edwards Deming, a mentee of Walter Shewhart, made changes to Shewhart Cycle and developed the 'Plan Do Check Act' (PDCA) or the Deming wheel, for continuous control and improvements of products and processes (Refer *figure 14*)" (Moen et al.,2009).



1. Design the product (with appropriate tests).
2. Make it; test it in the production line and in the laboratory.
3. Put it on the market.
4. Test it in service, through market research, find out what the user thinks of it, and why the non-user has not bought it.
5. *Re*-design the product, in the light of consumer reactions to quality and price.

Continue around and around the cycle.

FIGURE 14 Deming wheel in 1951(Source: History of PDCA cycle, Moen et al.,2009)

"After WWII, when Toyota employed Deming to establish the famous Toyota Production System, a main basis of today's lean thinking, he used iterative and incremental development technologies in Japan. Later in 1993, after several modifications, Deming reintroduced Plan Do Study Act (PDSA), which emphasized on the 'study' part to 'analyse' results. His work influenced

quality control and management processes, leading Agile to keep a constant focus on technical excellence" (Moen et al.,2009).

1. Design -- Plan	Product design corresponds to the planning phase of management
2. Production -- Do	Production corresponds to doing-making, or working on the product that was designed
3. Sales -- Check	Sales figures confirm whether the customer is satisfied
4. Research --Action	In case of a complaint being filed, it has to be incorporated into the planning phase, and action taken for the next round of efforts

FIGURE 15 Correlation between the Deming wheel and the PDCA Cycle (Japan) (Source: The history of the PDCA cycle, Moen et al.,2009)

"Tom Gilb's book Evolutionary Project Management, published in 1976, was among the initial literatures to promote a method that would later become known as Agile. He advocated for quick iterations that were light and adaptable. According to him, a complicated system would be most successful if it is executed in small increments, with each step having a clear measure of success and the ability to 'retreat' to a previous successful step in the event of failure" (Gilb, 1985). "Barry Boehm introduced a risk-based development model in 1985 (Refer *figure 17*). The core to it all was the idea of an iteration which consists of four steps: determine objectives, risk identification and resolution, developing and testing, and planning the next iteration" (Boehm, 1988). His paper hypothesized agile methods in projects with real options elements (non-linear processes and prototyping) which is still important today" (Nilsson et al., 2012).

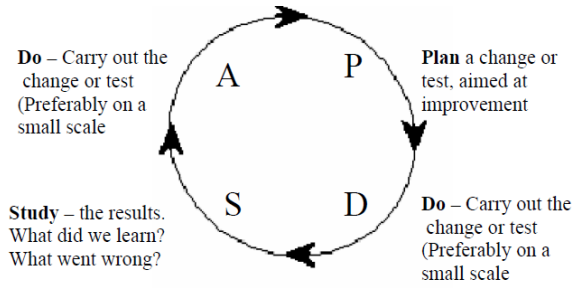


FIGURE 16 PDSA Cycle-1993 (Source: history of PDCA cycle, Moen et al.,2009)

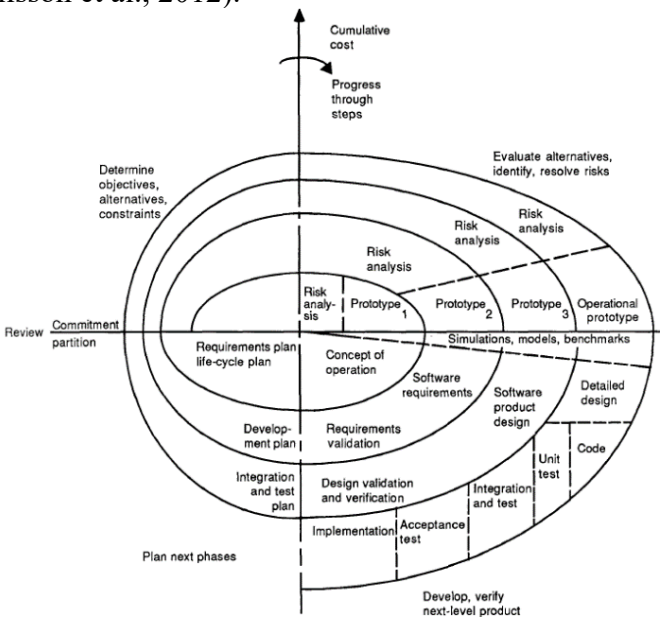
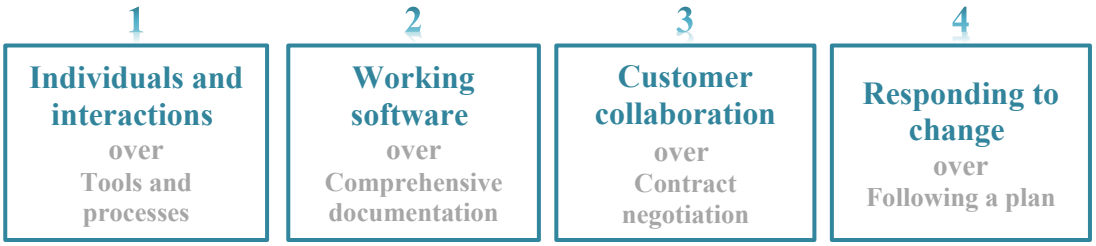


FIGURE 17 The software process represented by Boehm's spiral model (Source: Boehm, 1988)

"In the late 1980s and early 1990s, MIT researchers began researching Japanese manufacturing systems, particularly the TPS. They invented the term "lean" to represent the system's approaches for increasing productivity by reducing waste ('muda'), through reductions in uneven workflows ('mura') and destructive overburdening ('muri')" (Womack et al., 2003). "Meanwhile, The New New Product Development Game, developed by Hirotaka Takeuchi and Ikujiro Nonaka and published in the Harvard Business Review in 1986, served as a direct inspiration for Scrum in the software industry. A teamwork view to product development changed the way products such as copiers at Fuji-Xerox and car engines at Honda were developed, according to a study by Takeuchi and Nonaka. Instead of following conventional 'relay race' methods of product development, these companies were using what they called a 'rugby-style' approach. In 1993, Jeff Sutherland, who had prior knowledge in Rapid Application Development (RAD), Object Oriented Design, PDSA Cycles was tasked to develop a new product for Easel Corporation, a software company within six months; adopting the core principles from the HBR article, he established scrum (reference to the rugby- resuming play after minor infringement), a new technique of developing software. His project was finished successfully on schedule, under budget, and with fewer bugs than any prior release" (Takeuchi & Nonaka, 1986). "He subsequently worked with Ken Schwaber, a colleague to formalize the technique, and the duo first brought scrum to the public in 1995. Scrum innovation was a significant advancement in the evolution of the APM" (SBOK, 2016).

2.2.2.1 Agile manifesto

"The Information Technology was on the verge of erupting. Software was becoming a vital feature of every organisational operation. Many innovative software developers were working hard to improve programming methodologies to boost flexibility. When seventeen software development experts got together, in 2001 to examine alternate project management approaches, the present-day 'agile approach' was officially introduced. The strategies were not as process oriented as previous approaches. They published an adaptable, lightweight, and team-focused software development approach in the 'Manifesto for Agile Software Development' (The Agile Manifesto) which clearly defined four key values" (Beck et al., 2001):



Over the next few months, the authors developed twelve principles which complimented the four key values. The following are the principles of Agile Manifesto (Beck et al., 2001):

1. Pre-eminent priority is customer satisfaction by delivering valuable software early and continuously.
2. Open to changing requirements, even if they occur late in development. Agile processes leverage change for the competitive advantage of customer.
3. Frequent delivery of working software, from a few weeks to a few months, although preference is the shorter time frame.

4. Businesspeople and developers need to work together on a daily basis throughout the project.
5. Build projects around motivated individuals. Trust them to complete the task and provide them with the environment and assistance they require.
6. Face to face interactions is the most effective and productive approach to communicate information within the team.
7. The most crucial indicator of development is working software.
8. Agile methods encourage sustainable growth. Sponsors, developers and users should be able to maintain a steady pace perpetually.
9. Agility is increased through constant focus on technical excellence and good design.
10. Simplicity is a requisite.
11. Self-organising teams produce more value through best designs.
12. The team regularly reflects on how it can become more effective and adjusts its behaviour accordingly.

"The values and principles outline the mindset to be employed in the Agile Methodologies. They adhere to the goal of prioritizing communication among project participants, relationship between project participants, and reactions to changes" (Agile practise guide, 2017). Any framework development synonymous with these principles and key values was termed as agile technique or practise.

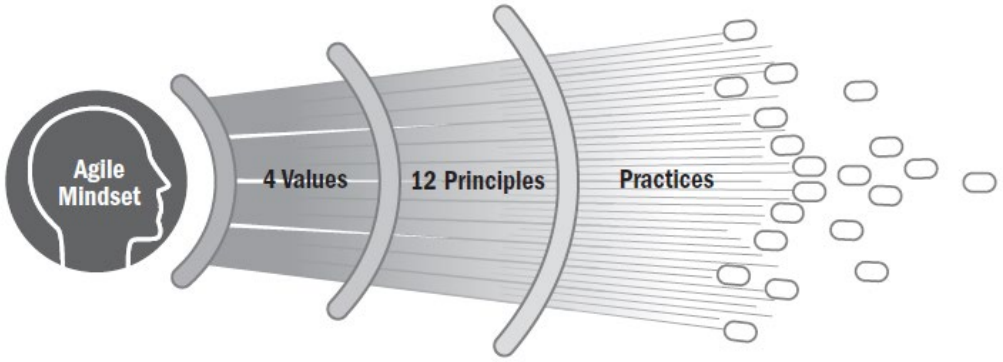


FIGURE 18 Relationship between agile manifesto values, principles, and common practises (Source: Agile practise guide,2017)

"The agile movement's major goal was to produce software swiftly without being constrained by the conventional characteristics of traditional methodologies. Various forms of Agile Software Development focus on different features of the projects, namely eXtreme Programming (XP), Scrum, Feature Driven Development (FDD), Dynamic System Development Methods (DSDM) and Crystal" (Mike, 2010). "Though, agile concepts originated in the software sector, these principles have influenced many other sectors" (Agile Practise Guide, 2017).

2.2.3 Agile Methodology

The methodology or approach is based on short delivery iterations accompanied by continuous learning (Sauer & Reich, 2009). The project team undertakes streamlined planning, requirements definition, and solution design at the start of the project to kick it off. The team then participates in succeeding waves of iterations, which comprise more thorough planning, requirements analysis, design, execution, testing, and delivery to clients and stakeholders. The APM strategy allows the challenge to be changed on the spot as necessities are reviewed and assessed in each iteration. In addition, APM follows a function-driven management approach, i.e., it focuses on defining scope of the project and requirements by prioritizing the list of project functions and requirements according to their value (e.g., revenue increase or market share). Therefore, involving the client in the scope and analysis of the requirements is crucial. Involving the customer ensures that the agile team does not invest too much effort in working on low-value or ineffective, expensive features or specifications. APM emphasises cooperative development and management to deliver results, soliciting customer feedback, and continuous improvement (Hass, 2007). APM has highly iterative and incremental processes where project team members and stakeholders actively collaborate to understand the project scope, identify what needs to be built, and determine priority functions (Salameh, 2014). APM came into practise about a decade ago and quickly became the main standard for managing IT projects. Although APM has only recently been introduced, it has the advantage of greater flexibility and collaboration, which facilitates its diffusion across different sectors, including the public sector (Rico et al., 2009).

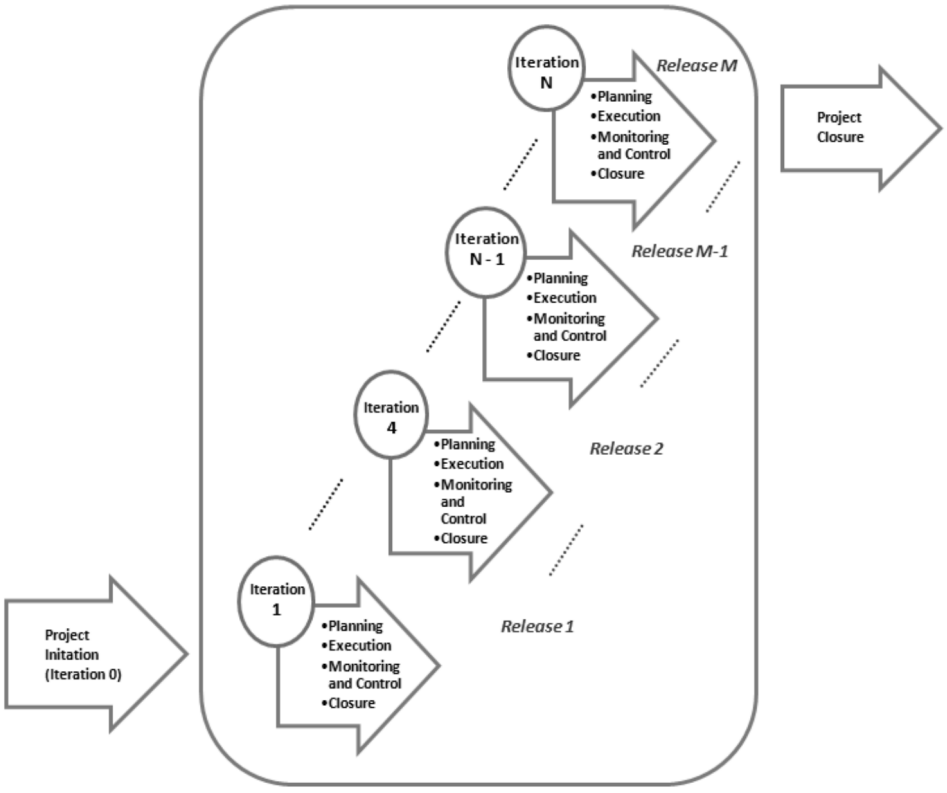


FIGURE 19 APM methodology/process (Source: Sojan et al., 2019)

A distinctive feature of agile management is that each iteration is self-contained, with tasks ranging from requirements analysis through design and implementation to testing. At the end of each iteration, a launch is presented to the client that integrates all software components: The client then presents the necessary comments and refinements in the requirements and facets of the system to be included in future versions or iterations. In agile software development and management, the principle of value-based delivery applies to meet customer needs through the early and continuous delivery of valuable and high-priority software product features. Furthermore, agile management is not opposed to change, but uses it to secure the competitive advantage of customers.

2.2.4 Scrum project management approach

In the mid-1980s, Ikujiro Nonaka and Hirotaka Takeuchi defined a flexible and all-encompassing product development strategy in which the development team works as one to achieve a common goal. They discussed an innovative framework to product development, which they called the holistic or rugby approach, wherein a team tries to go the entire distance together while passing the ball back and forth. They discovered their approach on case studies from different industries and suggested that product development should not be like a sequential relay race, but analogous to the game of rugby, where the team works together and passes the ball back and forth while moving as a unit down the field. Rugby's notion of a scrum (where players are gathered and resume to play after minor infringement) was presented in this article to explain the authors' suggestion product development ought to involve moving the scrum downfield (Takeuchi, H., and Nonaka, I., 1986). In 1995, Jeff Sutherland and Ken Schwaber presented at the OOPSLA conference held in Texas and elaborated scrum's concept and its applicability to software development (Schwaber and Sutherland, 2020). Since then, scrum framework has been further refined by several experts and authors. According to scrum study (2013), the scrum framework can be used on any type of project in any industry. Scrum has gained popularity recently and is now the preferred project management approach for many organisations worldwide.

Scrum is a lightweight structure that assists individuals, teams, and organisations in creating value by providing adaptable solutions quickly throughout the project. It should be interpreted as a philosophy, theory and a structure which helps in achieving goals, creating business value, and controlling risk. Scrum focuses on the essentials: "managing a project that delivers business value" (Schwaber and Sutherland, 2020). Within the framework, several processes, and techniques, can be used. Scrum processes shapes itself through the efficiency of the existing work environment, management, and techniques.

2.2.4.1 Scrum pillars, values and principles

Scrum emphasises on experience-based knowledge and observational decisions (empiricism) and reducing waste (lean thinking). This iterative process is built on by three pillars: (i) Transparency - viewable to all project stakeholders; (ii) Inspection- reviewed regularly to provide changes towards the objective and (iii) Adaptation – retailoring processes when undesirable issues arise. These pillars are supported by five core values and six principles which provides the scrum team guidance on collaboration and continuous improvement. The success of the scrum process depends on the proficient use of the five core values - dedication, fortitude, attention, frankness, and respect (Canty, D., 2015). The scrum team being committed to achieving its goals and

supporting each other. Its main attention is given to the sprint's work in order to advance those objectives as quickly as possible. The Scrum Team and its constituents are transparent about their efforts and difficulties. Scrum team members appreciate one another as competent, independent individuals and are respected in return by their coworkers. Members of Scrum teams have the guts to take the high road and tackle complex issues. The following are the basic six scrum principles, which give the scrum team direction on working together and pursuing continual improvement (Satpathy, 2013):

1. Empirical process control- Experimental and observational decisions over detailed upfront planning.
2. Self-organisation- Delivering greater value as each team member is self-responsible and self-motivated.
3. Collaboration is teamwork, as one to validate the deliverables and meet the goals.
4. Value based prioritization – Highest priority items are managed within a limited span of time.
5. Time boxing- establishing a time limit for each action in a scrum project ensuring less overheads and efficient development process.
6. Iterative development- Development is based on iterative manner (sprints) to focus on producing deliverables best suited for the project over time.

These values and principles drive the scrum teams' structure and functionality in delivering the maximum business value within a minimum time span.

2.2.4.2 Organisation framework

The scrum framework is made up of scrum teams and all of the events, roles, artefacts, and regulations that go along with them. The core values, fundamental principles and the pillars bind together the events, roles, and artifacts, governing the relationships and interaction between them (Deemer et al., 2009). As they participate in scrum planning activities (meetings) and create scrum artefacts, the team members discover and investigate the values and principles (deliverables).

2.2.4.3 Scrum roles

In scrum, there are three core roles: product owner, scrum team, and scrum master. *Table 9* represents the respective responsibilities of the scrum roles and *Figure 20* illustrates the overview of scrum roles. The project's business value must be maximised, and this responsibility falls on the product owner. He or she is in charge of outlining client needs and keeping track of the project's business requirement. The PO represents the Voice of the Customer (VoCs). Six to ten individuals make up the Scrum team, which is in charge of comprehending the business requirements laid forth by the Product Owner, estimating User Stories, and producing the project deliverables in their entirety. A facilitator known as a scrum master makes sure that the scrum team has access to resources that will help it create a successful product. Everyone involved in the project is guided, assisted, and taught Scrum methods by the Scrum Master, who also removes roadblocks for the team and makes sure Scrum procedures are followed.

TABLE 9 Responsibilities and roles of scrum organisation (Source: Canty, D., 2015)

Roles	Responsibilities
Product owner	Creates the product vision for team and stakeholder acceptance
	Accepts or rejects the product increment at the end of each Sprint
	Prioritises requirements (user stories) in the product backlog based on business value
	Clarifies items in the product backlog
	Establishes release dates for the product
	Assesses the feasibility of the product
	Overall responsibility for the product delivery
	Ensures that the product backlog is transparent on the project
	Establishes the goal for each Sprint
	Grooming of the product backlog
	Obtaining the maximum business value
	The Product Owner also shares the Servant Leader role with the scrum master
Scrum team	Completing the work on the product during Sprints
	Understanding the requirements
	Maintaining equality among all team members
	Being generalists across domains and specialists in a minimum of one area
	Grooming of the product backlog with the Product Owner
Scrum master	Protecting and guarding the team from outside interferences
	Not conducting any actual technical work
	Making sure that the team follows the scrum procedures
	Functioning as a change agent; making sure that the change process is obstacle and hassle free
	Maintaining the blocks list (the list of impediments and unresolved issues encountered by the team)
	Servant leader to the scrum team

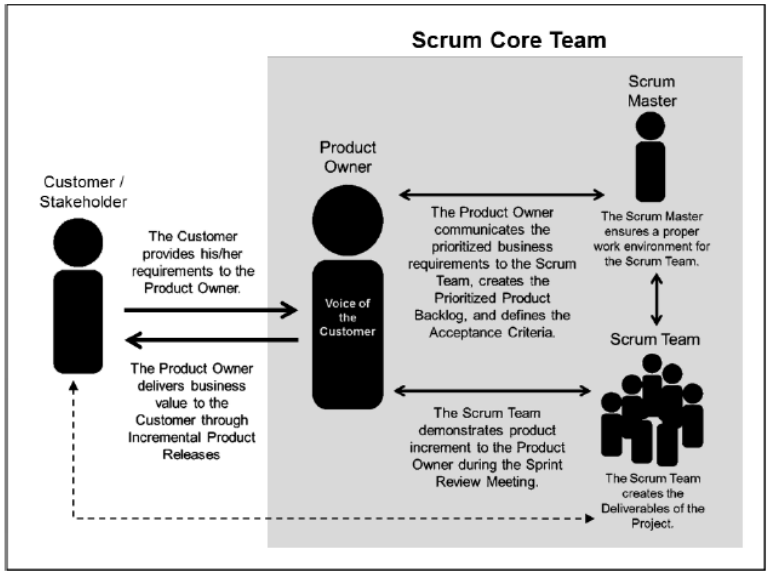


FIGURE 20 Overview of scrum core roles (Source: SBOK^{TM} guide, 2016)

2.2.4.4 Scrum events:

Within Scrum there are several planning events (meetings) to set the goals for each sprint. These important activities are discussed below. A sprint being a time-boxed iteration of two weeks to one month to develop a potentially deliverable product increment. Each sprint is conducted in a similar way to a small project and consists of five main milestones:

1. Sprint Planning meeting - An eight-hour timebox meeting (per one-month sprint) that takes place at the beginning of each sprint. This meeting's objective is to set goals and estimates in order to complete tasks. The product backlog is divided into tasks. Estimates are made for the tasks in terms of complexity, risk and completion times. The sprint backlog contains all of the tasks that were discussed during the sprint planning meeting.
2. Daily Scrum Meeting - A daily 15-minute timebox meeting where development team members discuss progress and issues and provide answers to three important questions:
    - What have I accomplished since our previous meeting?
    - What will I accomplish before the meeting tomorrow?
    - What challenges, if any, do I face?
3. Sprint Review Meeting - A meeting at the conclusion of each sprint to present the product increment to the PO and stakeholders. Backlog items are presented for approval; however, these items can also be rejected by the PO.
4. Release planning meeting: A meeting used to define the duration of the sprints and the planning for multiple sprints within a release. In other words, the function of a release planning meeting is to set the schedule for the product releases.
5. Sprint Retrospective Meeting - A meeting about lessons learned that takes place at the conclusion of each Sprint. The meeting is built on previous Sprint and opportunities for improvement for future Sprints are discussed.

6. Backlog Refinement Meeting - Most Product Backlog Items (PBI) need to be refined first because they are too voluminous and unclear. Teams have found it useful to take a little time out from sprint execution in each sprint to prepare the product backlog for the upcoming sprint planning meeting (F. Al-Muhammadi, 2007).

2.2.4.5 Scrum artifacts:

1. Product Backlog - There are all product requirements in the backlog. Based on the customer-assigned priority levels, these user stories are chosen for development. High-priority things are created first, and low-priority items might be put off for later iterations.
2. Sprint (Iteration) Backlog - These items include the list of user stories that the developers have agreed to complete for a particular iteration. The items in the iteration backlog cannot be changed once the iteration has begun.
3. Sprint burndown - Sprint Burndown Chart is a graph that depicts the amount of work left to do in the ongoing Sprint

2.2.4.6 Scrum process

The unique tasks and workflow of a Scrum project are addressed by the Scrum processes. There are a total of 19 essential Scrum processes that are applicable to all projects. The five phases of these processes are outlined below.

Initiate Phase

1. Create the Project Vision: In this step, the Project Business Case is examined to produce a Project Vision Statement that would assist as the motivation and point of concentration for the whole project. This method identifies the Product Owner.
2. Choose a Scrum Master and any other stakeholders: In this step, the Scrum Master and any other stakeholders are chosen based on predetermined Selection Criteria.
3. Create the Scrum Team: During this step, the team members are chosen. Although the Product Owner and Scrum Master collaborate regularly, the Product Owner is usually in charge of selecting the team members.
4. Create an epic: Using the vision statement as a guide, an epic is created at this phase. User Group Meetings could be conducted to talk about pertinent Epics.
5. Prioritise your product backlog- During this step, the project's epic(s) are enhanced, expanded upon, and prioritised to create a Prioritised Product Backlog. At this step, the done criteria are also documented.
6. Perform release planning: The user stories in the prioritised product backlog are examined by the Scrum Core Team in this phase to develop a Release Planning Schedule, which is essentially a phased deployment plan that can be shared with the project's stakeholders. The Sprint's duration is also determined using this way (SBOK™ Guide, 2016).

Plan and Estimate Phase

7. Create user stories: During this step, stories from users and acceptance criteria that go with them are created. The Product Owner typically creates User Stories, which are intended to guarantee that the customer's requirements are accurately represented and easily understood by all parties. Scrum Team members may participate in user story writing exercises to create the user stories. The Backlog for the Prioritised Product includes User Stories.
8. Estimate User Stories: During this step, the Product Owner specifies User Stories so that the Scrum Team and the Scrum Master may determine how much work will be involved in creating the functionality that each User Story describes.
9. Commit User Stories: During this step, the Scrum Team pledges to deliver User Stories that the Product Owner has approved for a Sprint. Committed User Stories would be the end outcome of this approach.
10. Identify Tasks: In this step, specific tasks are assigned to each of the committed user stories, and a task list is put together.
11. Estimate Tasks: During this step, the Core Scrum Team determines how much work will be needed to complete each item on the Task List. A task list with an estimated effort is what emerges from this approach.
12. Create Sprint Backlog: The Scrum Core Team creates a Sprint Backlog during the Sprint Planning Meeting that includes a list of all the tasks that must be completed within the Sprint.

Implement Phase

13. Create Deliverables: The Scrum Team works to create Sprint Deliverables from the items in the Sprint Backlog during this phase. Teams often use a scrum board to keep track of the work and activities being done. The Scrum Team may update an Impediment Log with problems or problems they are currently facing.
14. Conduct the Daily Standup Gathering: In this method, a tightly focused, time-boxed meeting known much like the daily standup meeting is performed every day. The Scrum Team can update one another here on their progress and any obstacles they may be encountering.
15. Groom Prioritised Product Backlog: This process entails routinely updating and maintaining the Prioritised Product Backlog. During a meeting to review the prioritised product backlog, any updates or changes to the backlog may be taken into account and, if necessary, implemented.

Review and Retrospect Phase:

16. Demonstrate and Validate Sprint: At a Sprint Review Meeting held during this phase, the Scrum Team presents the Sprint Deliverables to the PO and any other relevant parties. Obtaining the PO's approval and acceptance of the Sprint's Deliverables is the aim of this meeting.
17. Retrospect Sprint: Throughout this procedure, the Scrum Master and the Scrum Team get together to talk about the lessons that were discovered during the Sprint. This data is recorded as lessons learned that can be utilised in upcoming sprints. This discussion frequently leads to agreed actionable improvements or updated scrum guidance body recommendations.

Release Phase

18. Ship Deliverables: During this step, accepted deliverables are sent to the necessary parties or transferred to them. A formal working deliverables agreement certifies the completion of the Sprint (SBOK™ Guide, 2016).
19. Retrospect Project: Members of the Scrum Core Team and organisational stakeholders gather during this last phase of the project to reflect on it and to recognise, document, and internalize the lessons learned. As a result of these lessons, agreed-upon actionable improvements are usually documented and implemented in succeeding endeavours.

TABLE 10 Scrum vs TPM (Source: SBOK™ guide, 2016)

	Scrum	**TPM**
Emphasis is on	People	Processes
Documentation	Minimal- only as required	Comprehensive
Process style	Iterative	Linear
Upfront Planning	Low	High
Prioritisation of requirements	Based on business value and regularly updated	Fixed in the Project Plan
Quality assurance	Customer centric	Process centric
Organisation	Self-organised	Managed
Management style	Decentralised	Centralised
Change	Updates to prioritised Product Backlog	Formal change management system
Leadership	Collaborative, Servant Leadership	Command and control
Performance measurement	Business value	Plan conformity
Return on Investment (ROI)	Early/ throughout project life	End of project life
Customer involvement	High throughout the project	Varies depending on the project lifecycle

2.2.5 Kanban project management approach

The TPS inspired the use of Kanban as an operational strategy. The concept was written down on a piece of paper with three sections: information gathering, information transfer, and product information. The kanban system transmits information both vertically and laterally within Toyota and between Toyota and its partners (Ohno, 1988). Ohno (1988) claims that the concept first appeared at American supermarkets in the middle of the 1950s, where boxes of products were handed using a card that listed the quantity and sorts of goods purchased. These cards allowed the purchase department to rapidly replace the items that had been purchased on the shelves after receiving them. The primary benefit of the kanban method, according to (Shingo, 1989), is that it minimises stock by replacing only what was sold by the store rather than using an estimated replacing system. The factory workers start to work for themselves and take the initiative by utilising kanban. Kanban also reduces waste and makes suggestions for enhancements (Ohno, 1988).

Continuous improvement, task management flexibility, and improved workflow are goals of the kanban technique. The progress of the entire project may be quickly and simply comprehended using this illustrative agile technique. Just-in-time (JIT) manufacturing was utilised in manufacturing environments to employ Kanban to manage inventory across the supply chain. By guaranteeing that the amount of work required matches the team's capacity for work, the Kanban methodology for project management adopts the same idea. The kanban board is the centre of the kanban method. It is a tool that helps them track the progress of their project by visualising the complete undertaking. A new member or an external stakeholder can grasp what is going on, what tasks have been done, and what tasks are coming up by using the graphical technique of Kanban boards.

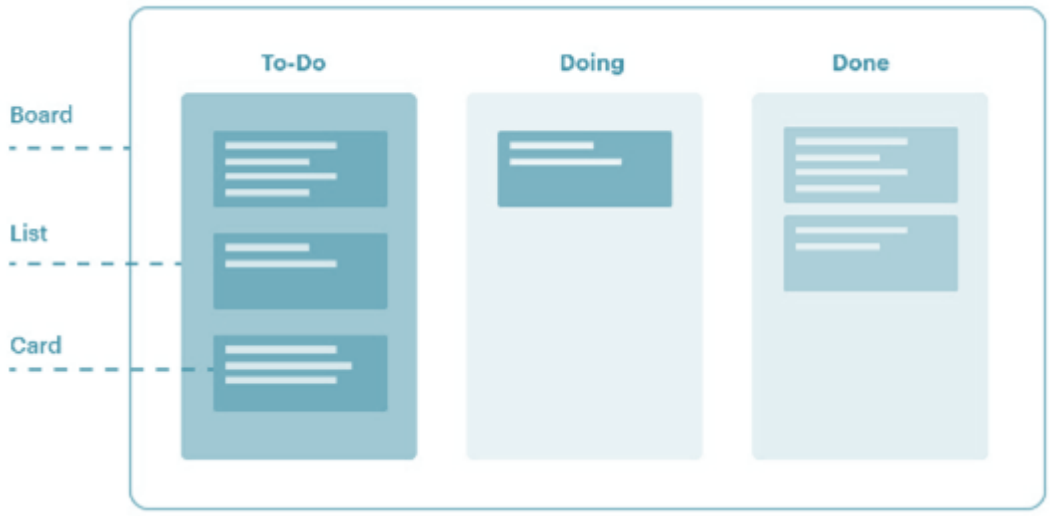


FIGURE 21 Kanban PM framework (Source: Kanbanize.com)

The tasks that are currently being done, the tasks that need to be done in the future, and the tasks that have been finished are all listed on the kanban board. Tasks are gradually moved from the leftmost column (future tasks) to the rightmost column through connections between the separated columns (completed tasks). Utilising the notion of Work in Progress, the Kanban system tracks the progress of each work cycle (WIP). WIP has predefined specific limits and a status. One of the guiding concepts for the Agile Kanban technique is limiting WIP in order to uphold uniform standards. The team's completion of the present tasks in the designated order is crucial.

By providing the relevant information about the product, utilising a kanban card with information does have the goal of preventing any doubt regarding the quantity, time, and position throughout the distribution and preventing overproduction (Monden, 1984). According to Burgos, the following information is vital and must be presented within the kanban cards:

- A description of the manufactured or delivered part.
- The volume being produced or shipped.
- The procedure in charge of creating and utilising the specified part (the previous trial and subsequent).
- Storage facility.

Kanbans can be utilised in two diverse ways in construction projects. production and transportation kanbans, or just transportation kanbans (Heineck et al., 2009). The first one refers to the manufacturing and transportation of mortar at the construction site, while the second one refers to the transportation of building materials such as bricks and ceramic tiles that are not created at the construction site (Heineck et al., 2009). The information on the production kanbans, which are made of plastic paper, includes the amount of mortar that needs to be created, the type of mortar, the delivery floor number, and the delivery time. Transportation Kanbans which are similar to those used in production, includes the amount of material to be transported, the delivery floor number, and eventually the draw of the material to be positioned (Heineck et al., 2009). The primary advantages of kanban in the building industry include waste reduction, especially regarding mortar, improved worker and manager engagement due to the decentralisation of decision-making, increased labour autonomy with regard to material distribution and mortar, reductions in operational flow, and better control of material inventory in accordance with demand (Heineck et al., 2009).

The four fundamental principles of lean construction can be highlighted in kanban: just-in-time delivery, continuous flow, continuous improvement, and pull production system.

1. Just-in-time - "The process should be stocked with only the products required in the quantity needed, when needed – at the correct time, without the generation of stock", is what just-in-time refers to (Shingo, 1989).

2. Continuous flow - Continuous flow implies that the construction process should continue uninterrupted. A systematic short, medium, and long-term strategy that establishes when a product should be produced is essential to ensure its continuance (Koskela, 1992).

3. Continuous improvement - When it comes to process control and the creation of administrative, technical, and operational project standards, continuous improvement, which is defined as the pursuit of excellence, is an invaluable instrument that should be used by all employees (Koskela, 1992).

4. Pull production systems - are characterised by requested production, which eliminates the need for inventories and promotes greater and improved work performance (Koskela, 1992).

TABLE 11 Characteristics of Kanban system (Source: Arbulu et al., 2013)

Characteristics of Kanban Systems	
Physical	Physical card that can be held in the hand, moved, and put into or onto something.
Limit WIP	Amount of material, product and activity process is limited.
Continuous flow	Signals requirement for upstream materials or work processes to start before stock completely consumed.
Pull	Downstream process pulls items from the upstream process.
Self-directing	Incorporates all the information on what to do, thereby allowing work to be decentralised and autonomous.
Visual	Stacked or posted to visually show the status and progress.
Signal	Visual status signals the next material movement or process action.
Kaizen	Visual process flow informs and stimulates process improvement.
Attached	Attached to and moves with the product.

Continuous process improvements (optimisations), which are implemented as issues are discovered, lead to increased efficiency. Reducing inventory also assists in exposing issues and compel remedies. Limiting work-in-progress induces a downstream pull of resources and work. This equalises all processes and facilitates the movement of materials and work across the system. Creating a predictable workflow through the system that is based on evidence rather than an external schedule has the effect of improving progress forecasts.

2.2.6 Lean project management approach

This study discusses the principles of lean methodology, implementation of lean PM in construction industry context. A deep understanding of these agile methodologies is key for the development and comprehension of the entire thesis and the following case studies.

2.2.6.1 History of Lean

The term 'lean' was first introduced in 1988 in the article "The triumph of the lean production system" by John Krafcik in the Sloan Management Review MIT (Netland et al., 2016). But the genesis of lean production lies in the 1950s in a Japanese company that had just decided to expand its scope of operations, from the manufacture of textile looms to the manufacture of automobiles. The company was Toyota. Toyota wanted to design and develop its own cars instead of outsourcing these activities to foreign companies and was also determined to finance these activities itself without relying on banks for funding (Womack et al., 1990). The answer to this challenge was the Toyota Development System (TDS): a development and production system that was able to improve product design and process efficiency in less time and with fewer resources in order to compete in a global automotive industry. Between the 1950s and 1970s, Taiichi Ohno conducted several experiments to achieve the goal of building many different products with the limited equipment available in Japan at the time. This challenge led to the development of a set of practices known as the TPS which is considered an important precursor to todays 'lean manufacturing' (Womack et al., 1990).

2.2.6.2 Lean principles

The five Lean principles are Value, Value Stream Identification, Flow, Pull and Perfection. This section discusses the details of these principles.

1. Value:

The first lean thinking principle is value. One of lean's primary objectives equates to avoid muda: this is a Japanese word that can be translated as "waste". Taiichi Ohno identified seven types of waste: Over-production before demand, awaiting for the successive machining step, unnecessary transportation of materials, over-machining of parts due to inferior wearing out of tools and product design, inventory beyond the bare minimum, unnecessary worker activity while working, and the production of defective parts. Womack and Jones (2003) added one more thing: producing the wrong product or service in the right way. So, the first important step in avoiding this waste is to define value from the customer's point of view in terms of a service or product with certain characteristics and at certain prices. To achieve this goal, interacting with the respective customer is crucial (Womack et al., 2003).

2. Identify the value stream:

The value stream advocates the path a product takes through the 3 critical management tasks: the problem-solving task, which begins with the concept of the idea and ends with the start of production; the task of managing information, which extends from order acceptance to delivery; and the physical transformation task, which involves turning the raw material into a finished product. Three types of activities emerge from the value stream analysis: Value-Adding activities, Non-Value-adding but unavoidable (at least in the short term) activities, and NVAs that are immediately avoidable. The latter activities include those are unprofitable and should be pulled out of the flow (Womack et al., 2003).

3. Flow:

After defining a clear value and eliminating wasteful steps, it is important to get the Value-Adding activities flowing. The difficulty with this is, understanding what flow means, and this is counterintuitive. The common misconception to believe that making value creation flow means being efficient and employing all resources (people and resources) at their maximum capacity (Womack et al., 2003). This approach leads to resource efficiency, but not efficiency in the flow of value. Instead, the goal is to prioritise flow efficiency over resource efficiency. This means reducing the number of NVAs for the product, such as waiting for the successive processing step (Modig et al., 2012). What TPS has done is to switch production activities from batch production into continuous flow by reducing the batch size and learning to quickly switch tools from one product to the next so that all steps of the production process can be carried out in immediate succession (Womack et al., 2003).

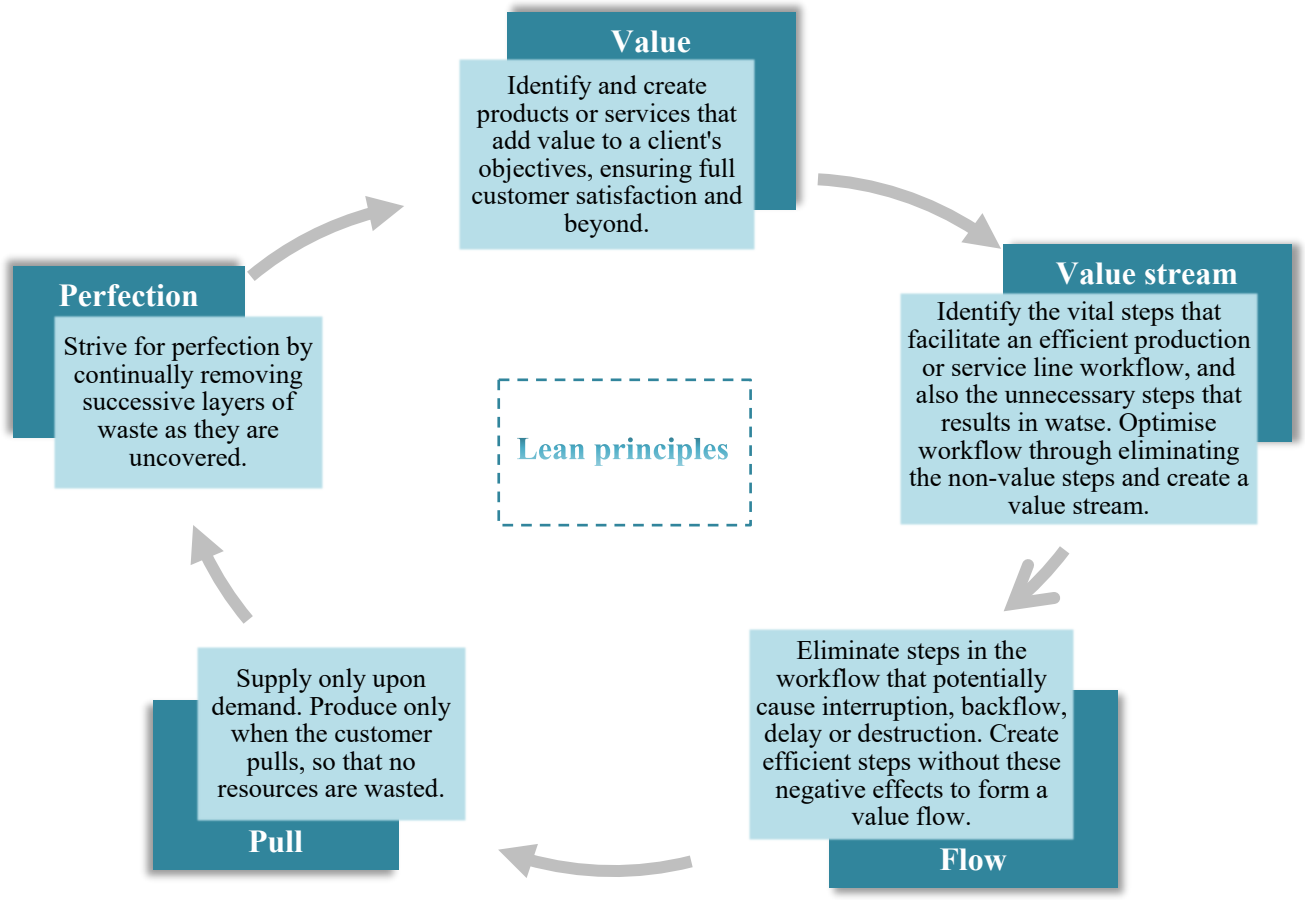


FIGURE 22 Five key principles of lean (Source: Olesen et al., 2015)

4. Pull:

The immediate benefit of continuous flow is that the time taken from concept to production, from sales to delivery, and from raw material to finished product is rapidly decreasing. This means

that it is now possible to let demand pull the product as needed rather than having to plan production far in advance and push the items (perhaps the wrong product) to the client. In fact, one of the fundamental pillars of this methodology is "just in time": giving the customer exactly what they want, and when they want it. This system can be set up with the help of Kanban cards: These cards move products through the manufacturing process so that information flows backwards at the same pace as the products flow forwards (Womack et al., 2003).

5. Perfection:

Once the first corrections are made to processes, the effort to lessen costs, waste, time, effort, and errors does not stop, while at the same time offering a product that is ever closer to the needs of the customer. The path to a lean enterprise is far from over with this initial step. The last principle can be achieved through the practise of continuous improvement (Kaizen), a self-explanatory term that refers to the constant pursuit of perfection (Womack et al., 2003).

NVAs are divided into seven main categories by Lean as waste. As in manufacturing, non-value-added activities can be associated with project management. The seven different categories of waste include:

1. Overproduction, i.e., producing more or earlier than required: Misalignment of project activities can result in excess resources being acquired before they are needed.
2. Waiting: processes/activities wait for resources, technology, maintenance, designs, quality assurance results, material, or information. While waiting, products are not moved and can therefore increase the lead time and overall cost of the project.
3. Transport: the moment when materials or equipment are moved within the construction site or between different construction sites.
4. Excessive processing: this term generally refers to unnecessary steps in the planning, operation and execution phases, such as reprocessing, inspection, etc.
5. Excessive inventory: excessive raw material, finished products, redundant project plans and information are all examples of excessive inventory.
6. Excessive movement: Moving information or project plans between different departments to get approvals can lead to excessive movement.
7. Defects: Finished products do not meet the required quality standards. This includes unaccepted project bids because the bids did not line up the project requirements, unsuccessful project plans that did not deliver the expected result in terms of cost, quality, and time, etc.

2.2.6.3 Lean and demand correlation in reality:

This section is about the application of this methodology in the main business areas of a general company. The TPS is described as a systematic approach to production planning to reduce waste. This system is the origin of the success of lean in production (Found et al., 2016). Implementing lean in production means implementing an operating system for production, organisation and control. The main objective of this approach is to lower operating costs by reducing all forms of waste and eliminating Non-Value Adding activities. This improvement in processes can be achieved by managers through the utilization of tools and practises typical of lean methods: Value

Stream Management, Spaghetti Diagram, 5S (Sort, Set in order, Shine, Standardize, Sustain) and pull systems through Kanban cards (Found et al., 2016). One of the most important requirements for the successful implementation of a pull system is that demand is as stable as possible. If demand is not stable and has high and unpredictable peaks, it becomes difficult to ensure a smooth flow of product through the supply chain, resulting in high inventory levels and affecting costs (Found et al., 2016). For these reasons, it is challenging to successfully operate a lean manufacturing unit in contexts characterized by non-standardized products and unstable demand.

2.2.6.4 Lean in Construction industry:

In the 1990s, there was widespread dissatisfaction with the performance of the construction companies. There was an urgent need to reduce costs, defects and accidents while increasing the speed of delivery. For these reasons, the construction industry began to try to implement Lean principles and adapt them to the specificities of this industry (Fosse, R and Ballard, G., 2016). Artifacts in construction are usually created through what is called a project production system. There are also other approaches of project production systems, such as new product development or software development. However, in order to apply Lean principles to the construction industry, it is necessary to understand some characteristics that set it apart from other project production systems. (Fosse, R and Ballard, G., 2016). Examples of these constraints could be availability of materials, laws, culture, meteorological and geological variables. Due to the dimensions of the assembled components, they cannot be moved through workstations, so the workstations have to be moved through the components. “The customers are individuals, and the projects are started in response to an order; furthermore, the customer who placed the order cannot be involved in the whole construction process. This means that, more than in other industries, it is crucial to comprehend what the particular client really wants. The lean vision is to deliver value to the customer without waste. Instance of the construction industry, the value is instrumental, meaning that the value consists of something that enables the customer to achieve their goals. The customer is not the only one who pays or places the order, but there are many project stakeholders involved who have a stake in the achievement of the construction project” (Fosse, R and Ballard, G., 2016).

“The difference in Lean Construction can be seen in the different key principles. The first principle that highlights the difference between Lean Construction and other industries is optimizing the project, not the part. Construction projects are usually complex and uncertain. For this reason, it is essential to link compensation to the achievement of the owner's desired outcome. In this way, funds and resources can be freely moved across contract boundaries to find the best investment at the project level. Under these conditions, fixed-price contracts no longer make sense. The second principle is target value design” (Fosse, R and Ballard, G., 2016). Since the customer is a unique individual and not a type, target costing, typical of manufacturing, has been replaced by target value design. In the former, design is driven by cost; in the latter, cost is a result of design. This principle makes it clear that Lean construction’s focus is to deliver value to a particular customer, with cost being a constraint rather than a value (Fosse, R and Ballard, G., 2016). It’s interesting to see that it is always possible to adapt Lean principles and use them for the purpose, even if the industry is very peculiar and different from others. Indeed, lean is increasingly perceived as a mindset rather than a set of tools and strict rules.

Lean PM is among one of the strategies to improve construction performance. The lean approach to construction project management prioritises removing all forms of waste from construction processes to enable greater efficiency. Existing studies have proposed theories that reinforce lean as a method to optimise resources, improve safety, productivity, working conditions and overall social, environmental, and economic balance. These principles bring out sustainable change by emphasising efficient, waste-free and safe flow, storage and handling of materials to minimise costs, energy and resource consumption and provide value to customers and end users (Nahmens et al., 2012). Consequently, Mossman in 2009 reports that some of the potential benefits of using lean in a construction project are as follows:

- More satisfied customers
- Productivity gains
- Greater predictability
- Shorter construction times
- Better earning capacity of employees
- Better earning potential for subcontractors
- Improved design
- Lower costs, less waste
- Improved health and safety
- Improved quality, fewer defects.

Accordingly, (Koranda et al., 2012) developed a structure for implementing Lean techniques in a construction project, as depicted in *figure 23*. Lean could be applied to any aspect of a business and provides a method for achieving business goals (Soltero, 2007). These goals can relate to cost reduction, quality improvement, reducing environmental impact and improving safety. It is important to remember that leadership in the construction organisation is among the most crucial factors that can provide an overarching vision, direction, and vision for achieving successful construction projects. Therefore, in order for leaders to effectively lead their organisations, it is imperative that they have a good grasp of the notion of lean PM (Opoku et al., 2011). This suggests that a thorough understanding of these concepts and principles is necessary for proper application to a construction project.

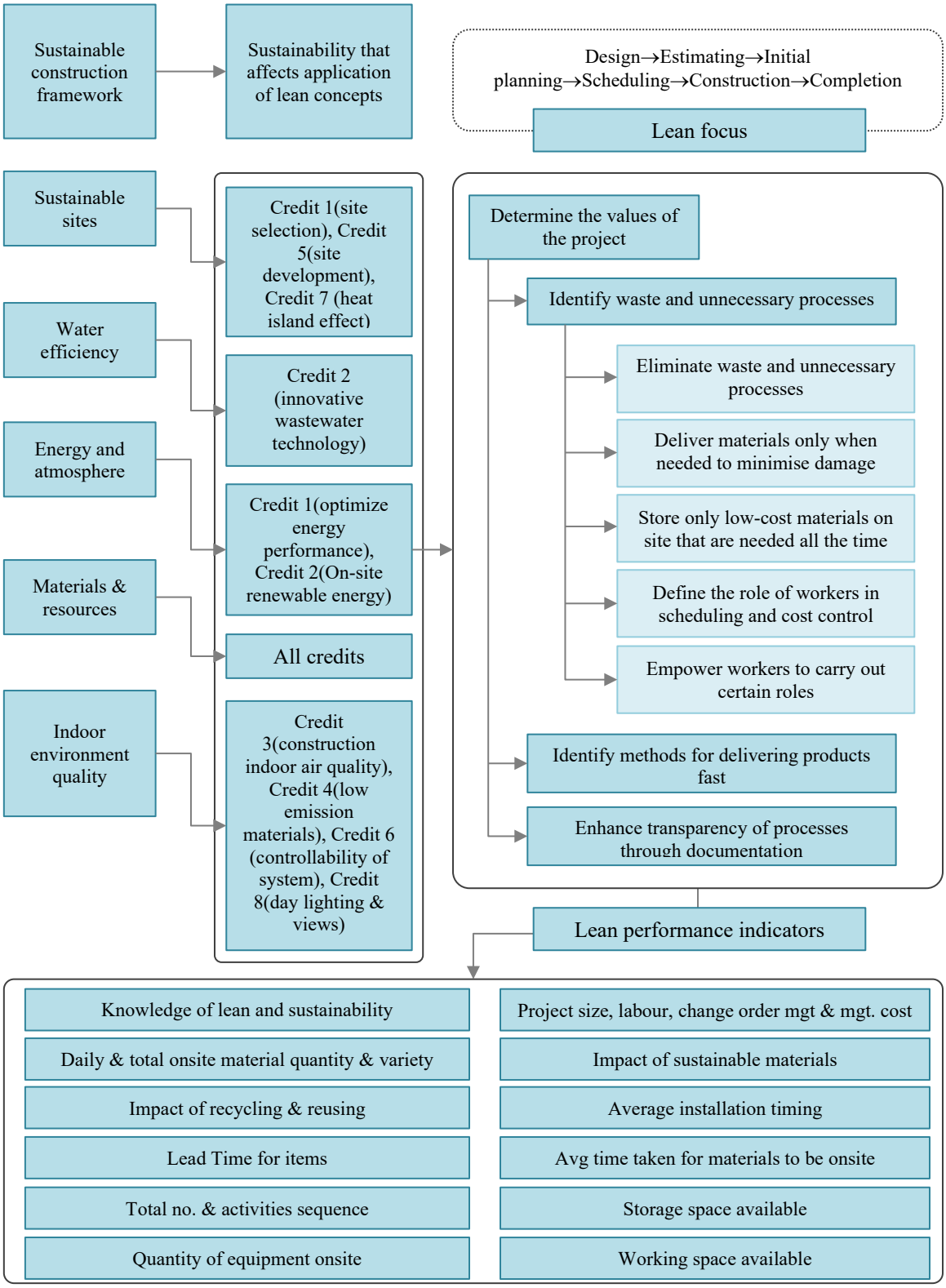


FIGURE 23 Framework to accomplish lean in construction projects (Source: Koranda et al., 2012)

2.2.6.5 Limitations of lean management:

When starting a lean journey, it is crucial to remember the context in which the lean methods have been developed. These tools have been created within a manufacturing industry which was in that time characterized by high volumes and relatively standardized product's basic design (Modig et al., 2012). The ideology of lean PM aims to minimize waste, but this is achieved through different approaches. Those involved in construction need to set their priorities before a project starts in order to achieve better integration. The lean approach should be emphasized more in a construction project. However, the application of lean in construction project management is not only possible at the operational level but could also be applied at the strategic level.

2.2.7 Strengths and weaknesses of APM

Existing literature suggests that there are numerous benefits associated by utilizing agile methodology in construction projects. According to (Turner, 2014), embracing agile methods in project management has a significant impact in reducing the costs associated with the implementation process. Hoda, Noble, and Marshall (2008) note that the agile methodology offers a clearly outlined procedure that a management should adhere to and that the processes help to prevent errors that can raise the cost of a project. Therefore, the different phases of agile management, such as design, play a crucial part in reducing potential unplanned problems that can lead to high project costs. In addition, (Chin, 2004) demonstrates how using agile methods plays an important role in improving the quality of the final product. The steps followed in agile methodology ensure that certain standards are met during project implementation, which help to guarantee that the final product is of high quality (Turner, 2014). (Gustavsson, 2013) argues that the application of agile management in building projects is crucial for ensuring both client and business satisfaction. He goes on to portray that the aim of any project management procedure is to guarantee that the interests of the business and the client are adequately addressed. As a result, project managers have the chance to take actions that help meeting client needs within the PM process when they employ agile management (Chin, 2004). (Turner, 2014) also demonstrates how using agile management plays a pivotal role in ensuring that projects are highly productive. It assures that the employees' requirements are well addressed in a project by implementing communications and other strategies, targeted in creating an appeased and highly motivated personnel (Drury et al., 2012).

Agile Project Management represents a departure from traditional project management approaches, where the project team plans the entire project and then executes the plan while controlling changes. The agile approach recognises that change is an apparent part of projects; therefore, there is less emphasis on developing strict project requirements and plans. The method emphasises implementing the project in iterations and revising the project requirements after each cycle. It also articulates the need for collaboration between project teams and other stakeholders throughout the process of project development and implementation. The goal of the agile attitude is to make the project implementation process responsive to the variations in the project environment. The agile view is associated with a number of benefits for the organisation, project teams, clients and stakeholders. These benefits include faster project completion, increased client satisfaction, individual and team development, reduced rework costs, improved performance transparency, and increased creativity and innovation.

Despite all these benefits, APM cannot be characterized as a flawless approach to managing projects. This approach has its own difficulties, such as difficulties in planning tasks, controlling quality, managing knowledge, managing large projects, managing distributed teams and managing people-related issues. To overcome these challenges, the project team and organisation should consider combining some elements of traditional project management, such as documenting project activities and developing a formal project organisational structure. Increased documentation in APM will simplify things for project organisations to manage quality, knowledge and schedules. A formal organisational structure will improve coordination, especially for large projects and projects with multiple sites.

TABLE 12 Strengths and weakness of APM approaches (Source: Author)

APM Approach	Strength	Weakness
Scrum (Suits best for fast paced development projects)	• Achieve deliverables rapidly and efficiently. • Complex projects are split into manageable sprints. • In daily scrum sessions, each team member's unique commitment is evident. • It is significantly simpler to adapt during sprints in response to feedback.	• Scrum causes to scope creep since there is no set end date. • Lack of intermediate layers of aggression makes it harder to divide up tasks and allocate duties • Mandatory need for experienced team members for this framework's success. • Large teams find implementation of the Scrum framework difficult. • If any team member is not committed there is a good chance the project will fail.
Kanban	• Ease of use & detection of potential bottlenecks where additional focus is needed. • Adaptability & less expense and waste. • Low overheads – simple output analysis.	• Lack of timing and inability to iterate • Unsuitable for environments with change. • Cannot be used independently – used along with JIT.

APM Approach	Strength	Weakness
Lean	• Reduction in cost. • Speed and overall effective efficiency. • Productivity improvement and safety. • Boost in quality, value-based flow & eliminates waste.	• All team members must be committed and focused, which will require additional training. • Results come gradually and implementation is challenging. • Cut Corners – less than appropriate materials are being used. • Time consuming to plan everything ahead of time.

2.2.8 Critical Success Factors

Existing literature sites numerous CSFs related to APM in other industries. Interestingly a recent article by Mounir Ajam states seven CSFs for APM in construction industry. Interesting CSFs among the seven are described below. Achieving Consensus Among Contractors: It is essential for them to cooperate while working with other contractors and other parties, which is typically the case with any project. If the contractors involved not adequately engaged and not brought up to speed, it is arduous to carry out the project using the agile project management. Top Management executives: APM needs leaders in the top management who are prepared to push change, challenge the status quo, and give project teams the freedom they need to succeed. Leverage Existing Knowledge: Organisations should comprehend and use existing lessons of agile, during agile planning rather than reinventing to make sure possible obstacles to project success are removed early. More dashboards and verbal communication: Clear channels for verbal and visual communication must be established by organisations. Agile management strongly depends on a project manager's capacity to monitor progress often and give guidance as needed. Project managers must create a thorough communication strategy, with the weekly meeting as its centrepiece.

These handful set of CSFs pertaining to APM are discussed in this section. The five primary areas for agile success are organisation, people, processes, projects, and technology. Early in the 1990s, agile principles were developed to address the flaws in waterfall technique. This broad spectrum is further classified into unique sub success factors. *Table 13* depicts these CSFs.

TABLE 13 APM - CSF (Source: Darwish, 2015)

Dimension	Main Success Factors	Sub Success Factors
Organisational	Corporate culture	Support from top management
		Team environment
People	User involvement	Handling commercial pressures
		Stakeholder politics
	Team capability	Effective project management skills
		Ability to handle the project's complexity.
		Decision time
		Effective communication and feedback
Process	Project Management process	Minimum change in requirements
		Simplicity in process
		Good reporting of project status
	Project definition process	Risk management
		Time allocation
		Accurate estimates of project resources
	Active testing	Code review
Project	Clear objectives and goals	Project type
		Project nature
	Realistic schedule	
	Realistic budget	Team distribution
		Team size
	Clear requirements and specifications	
Technical	Selecting proper agile method	Configuring the necessary tools and infrastructure
	Using advanced technology	Familiarity with technology

2.2.9 APM in Construction Sector

Although it is well known that the Agile Manifesto was developed for the software business, our goal is to find out if it could also be used in the construction sector. The second value could be "Working product above thorough documentation". Now that we have seen how each of these values applies to construction, we may discuss them individually.

1. Construction engineers place a higher importance on tools and processes which they defend at any means.

   This is due to their profound understanding that there is no other way to complete this particular task. Despite all of this, the construction business has evolved over time, embracing innovative thinking and adjusting to new processes, tools, and procedures. What if we make the purposeful decision to encourage creativity in engineering and let our stakeholders and team members recommend how to handle a specific construction task? Location Based Management System (LBMS) is a fantastic example of construction engineers accepting that not all locations may be amenable to traditional project management and that they would need to plan differently for each project. Though it is challenging to comprehend, fortunately, there is some hope that beginning to prioritise people and interactions over procedures and systems is very much feasible.

2. Working product over comprehensive documentation:

   I guess building engineers want a product that will work, but they are so obsessed with perfection that they keep improving it until it meets the minimum requirements. We must understand that we are creating waste and not even coming close to achieving the goal of being lean if this is not done due to the customer's shifting expectations. The schedule itself is arranged into five layers, as proposed by the LP method, with the first two layers obligatory but not detailed and constrictive for subsequent planning. There is concurrence from literature that LP has already taught us to pare down paperwork and take it all the way down to the last planner level (Owen et al, 2006). Once more, there is a chance that this value will be attained for construction projects.

3. Collaboration with the client over contract negotiation:

   We are aware that in any construction project, the contract serves as the legally enforceable agreement between the client and the builder. Engineers won't ever consent to put customer collaboration ahead of the contract. Let's consider this from the standpoint of the customer. After much commotion and several contract amendments, changes do take place. It is better if we could get eliminate this obstacle and collaborate with our client so they can adjust things as needed in a flexible way. For that, we must once more learn things from the LP system, where the final planner tweaks their bottom-level plan in response to client comments.

4. Responding to change over following a plan:

   If the prior point's discussion is understood and accepted, it aids in our ability to defend this value. We must be prepared to adapt when change is called for. Making our construction phases more iterative and compact is the straightforward solution. In the LP

system, where weekly plans are created and customer engagement is encouraged, we have a comparable situation. It's possible that we could use this value in construction.

Among the primary objectives of APM is early and consistent value delivery, as perceived by the customer or stakeholder. The dynamic realization of client value, which must be provided at each timebox conclusion, depends on feedback and learning. The client has received their dynamically prioritised value deliveries, not what the supplier and the customer would have initially identified using traditional techniques. The value delivery framework for APM is illustrated in *figure 24*. APM keeps the onus of value on the contractor until the client is prepared to accept the phase or project as complete, this stands in stark contrast to TPM.

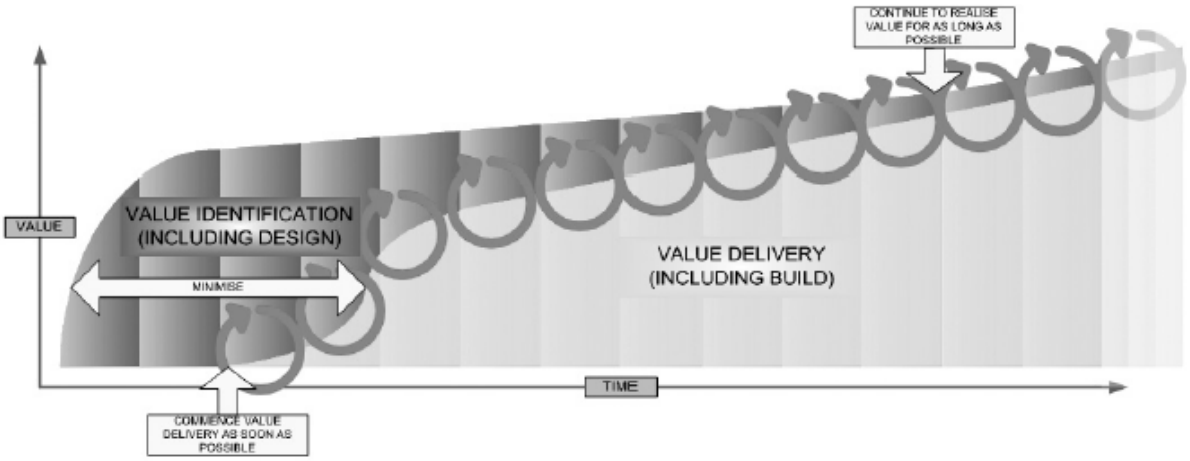


FIGURE 24 APM Value delivery (Source: Owen et al., 2006)

It is feasible to separate the pre-design, design, and construction phases in the construction sector. These have been compared to the aforementioned APM analysis in order to determine how valuable APM might be to the construction sector.

2.2.9.1 Pre-design phase:

The three main concerns in the pre-design phase of a construction project are idea development, planning for procurement strategy, time & cost, and the creation of a brief (Best and Valence, 1999). Even though larger customers have established standard procedures for this phase, the contents, organisation, and management approaches employed in this phase vary significantly among projects and client companies. The pre-design stage is frequently very complicated (Pennanen and Koskela, 2005). The output of pre-design should be thorough, integrated, and consistent because it serves as the foundation for other stages (Morris, 1991).

The main conclusions from past research on the pre-design phase show that, in practise, the pre-design paradigm tends to be either overly planned or excessively anarchic (Mintzberg, 1983). As a result, the project's future phases receive partial, inconsistent, or otherwise subpar guidance.

Considering three factors that are provided in diminishing order of validity, it is examined if agile concepts are appropriate before the design phase:

- Implicit or explicit application of agile principles has been successful.
- Prior literature has identified issues that agile principles may help to address.
- Based on understanding about the pre-design stage in general, it can be argued that agile principles are applicable.

Based on the aforementioned concepts, the application of a variety agile principles to the pre-design phase is examined in the sections that follow. Any word or piece of advice should be understood in its sharp contextual context making this thesis research comprehensive.

Many issues are in flux throughout the pre-design stage, and the entire process is emergent. Thus, it is beneficial to conceptualise this phase. Chaordic-related attitudes shift. The construction environment is marked by chaordic change as new possibilities and threats are continuously found (Blomberg, 1998). The hierarchical organisational structure is found cause problems. Any significant pre-design project should be managed by a strong team that communicates often with one another. Problems with hierarchical decision making have been identified, for instance, in the pre-design stage of primary healthcare facilities (Tzortzopoulos et al., 2006).

Customer involvement, Stakeholder engagement is unquestionably highly advised, if not required, as requirements capturing is a key responsibility in the pre-design phase. Planning approach, anything other than lightweight planning is generally pointless because of the difficulties and uncertainties that are present throughout the pre-design process. In fact, Blomberg (1998) finds that formal planning occurs very little in the initial stages of successful enterprises. Development strategy, an incremental and iterative development strategy can be used, and is frequently advised during the pre-design phase, due to the requirements for integration and client participation. Requirements capture, construction projects are a great place to use the distinction between stable requirements (to be captured upfront), volatile requirements (for which options need to be kept open) and developing requirements (for which learning is to be developed). Tzortzopoulos, et al. report the findings of failing to categorize requirements in this way and relying on immature requirements (2006). Agile methods and principles may, in theory, lead to a better pre-design approach since they are both adequately organised and flexible enough to allow for the exploitation of possibilities and the development of novel solutions.

2.2.9.2 Design phase:

The concept created while the pre-design phase will be developed and translated into solutions (specifications and prescriptions) to guide construction, operation, and maintenance of the building during the design phase, which is the intermediate phase (Kagioglou et al., 1998). As a result, the integration of design and execution as well as the dynamic requirements capture process become the two major aspects. Although the fundamental steps in the design process can potentially be generalized, the work produced during this phase differs from project to project and is also altered through the intrinsic iteration of designing. It is believed that APM can benefit these two important factors. Concurrent Engineering and Last Planner are two examples of contemporary methods and approaches that are largely focused on providing value throughout the design phase (Kamara et al., 1997); (Codinhoto, 2003). The identification of trade-offs, analysis and synthesis processes, as well as decision-making, are all in motion (Koskela et al., 2005). Organisational values and Methods, the construction sector is defined by the formation of a new group of businesses for each

new project. Because the design team differs from project to project, it is difficult to apply categories Y, X, and Z to construction. However, some Type Z traits, such as enhanced employee-employer relationships and joint decision-making, can be seen in some long-term partnerships (Kamara et al., 1997); these characteristics were also seen in the Heathrow airport Terminal project (College, 2005).

It appears that gradual and iterative value building is a natural process during the design stage. However, in the construction scenario, as it is currently built up with its discrete phases, delaying choices until the "last responsible moment" would be troublesome. Such a mindset could also point to coordination issues with product development (Clark et al., 1991). The process of design is quite interactive, so before making any changes, the team should think about how they will affect both the final product and the design process itself (Crawford et al., 2000). Planning, in manufacturing and construction, design planning has received a lot of attention. Tools, methods, and approaches differ widely. As a result, a variety of solutions exist that fall into one of the two categories of "light" or "heavyweight". On the one hand, heavyweight planning is exemplified by the Design Structure Matrix (DSM) and Analytical Design Plan Technique (ADePT) (Austin et al., 2000). However, Last Planner (Ballard, 2000) can be viewed as light weight. It appears that a sizable number of techniques, such as Quality Function Deployment (QFD), are concentrated on capturing customer needs in-depth and at the beginning of this phase. Studies present (Miron and Formoso, 2003) and demonstrate that there is still a gap in the requirements capture process throughout the entire design phase. In actuality, research shows that there is still a great deal of uncertainty about what will be built even at the start of construction (Howell et al., 1993).

The present foundation for work packages in construction is the utilization of work breakdown structures. In the construction industry, it is common practise to divide tasks into categories based on the products and subproducts that must be supplied. One illustration is the process protocol created by Salford University (Kagioglou et al., 1998). Execution, the design process can be sequential or iterative depending on the method of development. According to the project, one or the other will be adopted, as mentioned by Kamara et al (1997). On the one hand, using iterative methods will enable clients to receive value on a regular basis. Contrarily, sequential techniques are characterized by the delivery of the final product, which makes mistakes and revisions more common (Prasad, 1996). Additionally, quality is delivered taking into account defect reduction as well as how the customer and other stakeholders perceive value (e.g., Design for Manufacturing and constructability analysis). Construction frequently involves the client in the design process. Control and training, the cost, maintainability, and sustainability of solutions are only a few examples of the several criteria that are regularly used to evaluate the construction design. The relationships between various indicators are not fully understood, though. With regard to learning attitudes, each new project would include different approach. As a result, it is strongly dependent to change management inside the temporary organisation, with knowledge retention concentrated more at the person level than at the level of entire organisation.

In conclusion, the use of APM principles during design phase is particularly suited for the issues that the construction industry faces, such as the creation of complex products of the highest quality at the most affordable prices. Its acceptance would vary depending on the project's complexity and level of uncertainty; in cases where needs are likely to change or evolve over the project, it would be especially suited. Therefore, projects with an abundance of clients involved, conflicting

requirements that frequently result in trade-offs, and projects where the early delivery of value is a priority will benefit the most from APM.

2.2.9.3 Construction phase:

The significant ways in which the construction phase differs from the design phase will be highlighted in order to examine how well APM can be applied here. First of all, acknowledging the fact that the building phase employs a bigger imbalance of employers and employees, as well as a workforce that is among the least qualified in terms of professional preparation and receives some of the lowest comparable salaries (Koch, 2005). As a result, when trying to put into practise new management methodologies in the construction industry, we encounter a significant cultural issue that should be resolved in order to facilitate training and learning in order to create multi-skilled and self-managing teams, as suggested by the APM philosophy. Additionally, a big barrier to cultivating strong employee loyalty is the prevalence of subcontractors and casual workers in the construction industry (Howell and Koskela, 2000).

Despite all of these issues with the construction industry's culture, APM can be applied to the industry at the site level, at least for planning, if managers are able to react fast to changes in the project's scope. However, there is much resistance to cultural progress in construction. Since modifications might have significant effects and come at a high cost that this incoherent workforce may not be able to bear, an APM deployment is likely to be more difficult at the lowest levels of execution. But as was already said, the applicability of APM will also rely on the project's size and the nature of the organisation. By incorporating more human factors into some production management techniques, such as the Last Planner System (Ballard, 2000), construction has begun to advance with a positive change in mindset. The APM approach is based on early and continual value delivery to consumers as well as upfront value definition. APM is ideal for design, but because there are so many more interdependent tasks during execution, it is more difficult to implement. In short, APM ideas and believe that it might be an effective tool for construction managers, particularly for planning during the construction process' production phase. However, a lot more Work would need to be put in to manage construction execution, starting with a shift in the sector’s culture.

2.2.10 Limitations of APM in construction sector

An essential concern from a higher management level is whether the project is in line with organisational core competencies before it is extended for implementation. Although it is more difficult than in the development of software to implement an agile framework in a construction project, it can have a significant positive impact where it is applied. The agile approach needs to be used during each phase of a construction project, but there are some important limitations and pitfalls that need to be addressed first: Many adjustments cannot be made after the execution phase or, if made, would significantly increase the project's cost. Recommended resolve: Careful and accurate preparation is required to prevent changes from being made during the execution stage.

In contrast to software development initiatives, meetings cannot be decreased. Integrated meetings with many stakeholders and on various project phases are necessary. Suggestion of a fix: To enhance communication, data sharing, reduce meeting time, and improve communication, all stakeholders want more centralized and organised platforms.

Agile software development deliverables are, by definition, incremental chunks that provide value to the project and, as a result, to the client/product owner. An incremental portion of a construction project cannot be given to the consumer. Proposed fix: Deliverables must be specifically stated and explained so that customers can recognise their value even before receiving them.

For easier understanding, visual representation and an overview dashboard can be useful. Due to the intricacy of construction projects compared to other industries that employ the technique, agile for construction management requires extraordinary organising, administration, and proper application of the methodology. Delays resulting from such complexity can significantly raise project costs. Proposed fix: Either Agile is executed well, or it isn't.

It is obvious that the aforementioned limitations make it much harder to adopt pure Agile over the entirety of a construction project. However, this procedure can be made more effective by implementing an Agile methodology at the planning and initiation phases. It may also prove useful in later phases of a project to some extent. Agile can aid with work prioritization and planning, progress measurement and monitoring, collaboration improvement and enhancement, and continuous development. By assigning clearly defined duties to employees, lowering unnecessary stress, encouraging collaboration, preventing missed deadlines, and reducing an unnecessary workload, it enables an organisation to operate more efficiently. These are all factors that could cause a project to succumb failure in an organisation.

2.3 Traditional PM vs Agile PM

2.3.1 Key management and leadership aspects

In this section, the previous research based on APM vs TPM in terms of key management and leadership aspects related to the type of leadership style used, communication management, change management, and risk management.

2.3.1.1 Leadership Styles

In contrast to the conventional management approach, which is founded on command and control, as in TPM, APM promotes a collaborative leadership and management style. The project manager is expected by both APM and TPM to collaborate with the client management, the project team, and important stakeholders to make sure they are aware of the project's status. The A project manager is thought of as a leader rather than a taskmaster because to the ideals of servant leadership, which are further emphasized by APM. The driving force for project success in APM is this ongoing cooperation between the team and the client. In conclusion, there is a key distinction between the roles of assignment manager in APM and TPM.

2.3.1.2 Communication Management

Co-located teams, which include customers and end users, are given a lot of attention by APM since it is thought that this is a crucial element in creating a cohesive and high-performing team. APM supports continuous, frequent, and face-to-face communication among project stakeholders by nature. For this reason, APM has tested successfully when used as a project-management

framework. The PMI Pulse communications research found that effective communication results enabling organisations to become high performers by participating in more fruitful projects. Transparency in communication and making critical project information accessible to the entire team have shown to be helpful in achieving project success because they enable project team members to make wise and informed decisions.

2.3.1.3 Change and Scope of Management

As described by TPM, alternate administration is the process and set of tools used to prevent scope creep or tradeoffs. TPM views any change to a project's specifics and well-defined scope as a threat that should be controlled (PMI). By giving a platform for seeking, assessing, planning, and executing changes to a project scope, change management does this. APM focuses on defining high levels yet limited scope in the form of user stories that are scheduled to be released with the stated project release plan, as opposed to the broad and extensively defined project scope in TPM. In conclusion, the focus on fixing the scope that TPM places as the primary requirement for fixing a project's resources explains the difference between APM and TPM regarding scope change management.

2.3.1.4 Risk Management:

The project manager and project team must be dedicated to addressing risk management proactively and consistently throughout the project for TPM to be successful. Due to the iterative, constrained, and controlled nature of APM, there is not universal consensus on the necessity of formal risk management. The risks register and risk burn-down chart are two risk-related artifacts that are the focus of APM. Risk management is incorporated into the APM process and artifacts in this way. An APM artifact used to track a project's risk exposure rate over the course of iterations is the risk burn-down chart.

TABLE 14 TPM vs APM- Overview (Source: Augustine and Woodcock, 2008; Hoda et al., 2008)

Traditional Project Management	Agile Project Management
Focus on process and plan	Focus on people
Focus on developing all parts of the scope first	Focus on the most important part of the scope first and then proceed to the next.
Regulation of changes is based on rigid procedures.	Regulation of changes depends on flexible and adaptable procedures.
Members work individually within teams i.e. less collaboration.	Team members collaborate in all aspects
Order establishment is facilitated by hierarchical organisational structures	Order is established as a result of continuous and voluntary interaction in complex systems
Increased order is a result of increased control	Self organization, interaction and simple rules result in increased order.
Organisations must be rigid and static hierarchies	Organisations must be flexible and eliminate unnecessary bureaucracy.
Controlling type of management	Management role is to facilitate and give support
Employees are interchangeable 'parts' in the organisational 'machine'	Employees are an important part of the organisation whose contribution is necessary.
Customer is mainly involved during requirements gathering and delivery phases	Customer is continuously involved throughout the project lifecycle
The reductionist task breakdown and allocation is necessary for solving problems (e.g. Work Breakdown Structure (WBS) and the Project Breakdown Structure (PBS)).	Iterative approaches to selected tasks with continuous feedback from team members and stakeholders result in valuable incremental progress in a short time.
Projects and risks are adequately predictable and it is possible to manage them through detailed and complex advance planning.	It is impossible to control the future because projects and risks are unpredictable due to uncertainties; therefore there is no need for detailed advance planning.
Testing is done at the end of the project cycle	Testing is iterative and done more frequently
Documentation is thorough	Documentation is done only when needed

Given that construction projects have continued to underperform, the question of construction methods remain open to enquiry. In particular, it is instructive to understand whether agile methods hold advantages compared to conventional methods (TPM), what benefits do they yield, and whether their practise requires establishment of any supporting mechanisms. This motivates our enquiry.

2.4 The Aftermath Of COVID-19

The global spread of COVID-19 was not far off when it first appeared. This new form of coronavirus targeted numerous nations, infecting millions of individuals in a short amount of time (Bong et al., 2020; Chowdhury et al., 2020). The gravity of the circumstance compelled government agencies to immediately develop and implement the necessary measures (Ogunnusi et al., 2020; Rokooei et al., 2022). These activities weren't just for urgent care situations (Imani-Saber et al., 2020). Indeed, COVID-19 had an impact on various sectors and businesses, but the construction industry was particularly unusual. The company size, type, interactions, sub-sectors,

production time, and diversity of the nation's economies are some attributes that impacted (Gamil & Alhagar, 2020). With regard to these aspects, It is crucial to understand the difficulties brought on by construction projects (Amoah & Simpeh, 2020).

Additionally, the consequences of the pandemic on construction stakeholders including managers, engineers, and suppliers were evaluated (Araya & Sierra, 2021). The insights from that study reveal that guidelines are required for the researchers and practitioners to react quickly to the short- and long-term effects of the construction business (Assaad & El-adaway, 2021). However, in addition to the guidelines' considerations, developing models to study the spread of novel Coronavirus on construction sites were found to be useful (Araya, 2021). Understanding how the epidemic is perceived by construction professionals and how it affects their performance in this situation is very helpful for construction managers.

In the meantime, it is clear that the construction sector in developed and developing nations has reacted differently to new trends including globalization, emerging technology, and sustainability (Ofori, 2007). The key aspects of the construction sector, such as project management and performance, business organisation, and industry culture, differ between industrialized and developing nations (Ofori, 2007). Consequently, the pandemic's effects might be viewed differently by industry professionals in developed and developing nations. The following sections provide an overview of the findings and their interpretations. This thesis adds to the corpus of knowledge by evaluating how construction experts perceived on, how COVID-19 will affect many areas of construction organisations, projects, and people. It also emphasises how professional perspectives have changed over time and emphasises the value of agile construction models for handling unforeseen circumstances like pandemics.

2.4.1 Challenges faced

The viral pandemic had an enormous negative impact on the world economy. The International Monetary Fund (IMF, 2020) had predicted that the global economy will significantly decline with negative rate in 2020, with developed and emerging economies experiencing declines of 6.1 and 1.0 percent, respectively. The 2008 Global Financial Crisis was roughly four times worse than a 3.0 percent decline in global production (Lachmann, 2020). The International Labour Organisation (ILO) claims that, the first quarter of 2020 saw a reduction in the number of full-time jobs by almost 130 million, with U.S.A. taking the lead (Holshue et al., 2020). The construction industry had immediate and long-term impact on the economy (Lachmann, 2020). Due to its dependence, this industry is vital to the growth of many jobs, which would otherwise not be sustained if the construction projects ceased to function. The construction sector makes a contribution close to 7% of the GDP in both Australia and the United Kingdom (Holshue et al., 2020). As a result, the decrease in unemployment rate is associated to the promotion and progression of construction projects. Due to its significance, this issue not only affects employment incomes in metropolitan regions but also regulates wages in rural areas due to the shortage of labor. Before the widespread outbreak of the new Coronavirus, India saw a sharp decline in the number of immigrant workers, which had a considerable negative impact on the growth of construction projects (Rabin, 2020). Construction-related projects are classed as face-to-face tasks and cannot be carried out remotely (Boseley, 2020). Therefore, when pandemic situation emerges, specific components or the complete project may be suspended. Additionally, a notable decline will occur with new

construction projects (Lachmann, 2020). 22 percent of new home contracts in Australia were negatively impacted by the 2008 Global Financial Crisis, according to research from the Australian Bureau of Statistics from 2010. (Holshue et al., 2020). In addition to costing construction companies' money, the virus outbreak made it difficult to attract Foreign Direct Investment (FDI) for investments in current or future built environment projects. Using the right measures, the economy's FDI flows can be increased, fading the economic slowdown, boosting employment rates and job possibilities (Boseley, 2020). Every country has experienced a particular pattern of COVID-19 spread. However, these findings are grounded on the daily information released by the official health agencies of all the nations in the world. These data could be inaccurate due to the novel Coronavirus' confusing behavior and economic considerations, whether on purpose or accidentally (Lachmann, 2020). However, the only option for the academics may have been to rely on these legitimate daily updates to assess the virus's behavior.

The governments were obliged to halt numerous development projects because of the COVID-19 outbreak (Amponsah & Frimpong, 2020). Many large construction enterprises in this situation experienced financial losses. Negatively impacted were small construction firms (Amoah et al., 2021). A discussion of the early effects of COVID-19's widespread effects on the U.S. construction sector (Alsharef et al., 2021). Researchers have been working to find a solution to boost the likelihood of returning to normal life as the situation is improving and the limits are progressively being eased day by day. Additionally, Jallow et al. demonstrated how controlling activities while working remotely caused delays in the United Kingdom's infrastructure projects (Jallow et al., 2020). Agyekum et al. observed that the pandemic's main effects on Ghanaian construction projects in 2021 were "lower work rate", "delays in payments", and "rise of material costs" (Agyekum et al., 2021). Studies into the UAE construction industry demonstrated the importance of government assistance, such as fee and fine waivers, in helping businesses recover from pandemics (Rehman et al., 2021). When deciding which sources to prioritise and how to overcome COVID-19 epidemic, these insights can be very helpful (King et al., 2021). Also affected by COVID-19 was the supply chain system. Operational and disruption risks are the two categories used to categorize supply chain risk (Choi et al., 2019; Ivanov, 2018, 2020; Xu et al., 2020).

As a disruption risk, the COVID-19 pandemic caused a significant supply shock in several nations, leading to "supply chain contagion", or a supply shock in all nations included in the chain; nevertheless, some of them did not experience any disruption or were less affected (Baldwin & Tomiura, 2020). This shock struck both the supply and the demanders hard (Guerrieri et al., 2020). Many well-established supply networks experienced significant slowdowns or even interruptions. For instance, a German gift operator firm reported that COVID-19 had caused significant supply and demand interruptions (Ivanov, 2020). However, because certain chains were growing swiftly, they were compelled to expand quickly and add additional capacity (Baldwin & Tomiura, 2020). During this time, it could result in irreparable harm if medical supplies including test kits, ventilators, masks, and personal protection equipment (PPE) are not provided. For instance, it was anticipated that USA would experience a shortage of essential medical supplies like ventilators due to the rapid spread of the Coronavirus (Ranney et al., 2020). In addition, many supply chains may be interconnected so that disruption to one can have detrimental impacts on another. Because of the coronavirus outbreak and the drop in employment, the food supply chain has been significantly influenced. This, in turn, has caused a severe disruption in the labor supply chain, which has resulted in additional job closures (Hobbs, 2020). Additionally, Inoue and Todo

presented a simulation-based model that demonstrated how vital and non-essential production operations throughout the COVID-19 outage significantly impacted the economics of a megacity (Inoue, H & Todo, Y., 2020). Although COVID-19 was a brand-new phenomenon with unknown effects on the construction industry, over time, professionals in the field learned more about these effects and eventually changed the way they conducted business. Construction managers could implement appropriate policy and mitigation techniques in potential comparable situations by carefully considering how the construction sector has changed and responded to the pandemic over time. Employees believed that COVID-19 had a profound effect on many dimensions of their professional careers. The perceived impact, however, diminished over time. Although different companies or sectors were thought to have varying degrees of impact, the construction industry was unprepared for COVID-19.

2.5 Hybrid approach

The word "hybrid" informs us that the idea involves fusing two or more distinct elements. Combining Traditional and Agile, two of the most well-known approaches, is a typical practice in project management. Choosing the best methodology for each project phase is the goal of the hybrid project management strategy. This enables project managers to make the most of the positive aspects of their selected strategies while also avoiding any negative aspects or potential problems. The in-depth method involves using TPM for planning and requirement definition along with agile for design, development, and testing. A hybrid approach is also common, despite the fact that Traditional and Agile sound more familiar. According to research by the PMI, 23 percent of projects were managed by 'hybrid' methods in the IT, telecom, energy, healthcare, construction, and government sectors.

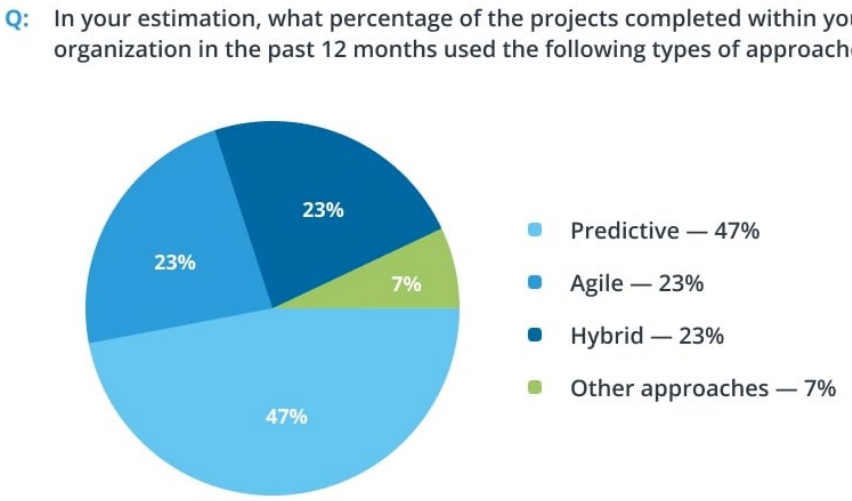


FIGURE 25 PM Approaches used in industries (Source: PMI, 2021)

The key is to use techniques. Understanding the fundamentals and utilizing the best elements of both approaches is achievable and essential. The hybrid approach is beneficial because it enables you to plan and define requirements with Traditional, design, develop, and implement for Agile, organize work more predictably, and adapt processes to changing conditions as the built

environment develops. This approach works well for large, complicated projects that need to frequently deliver new features, adjust to opaque requirements, adhere to stringent deadlines, and consider the customer's desire for a minimal involvement in the project.

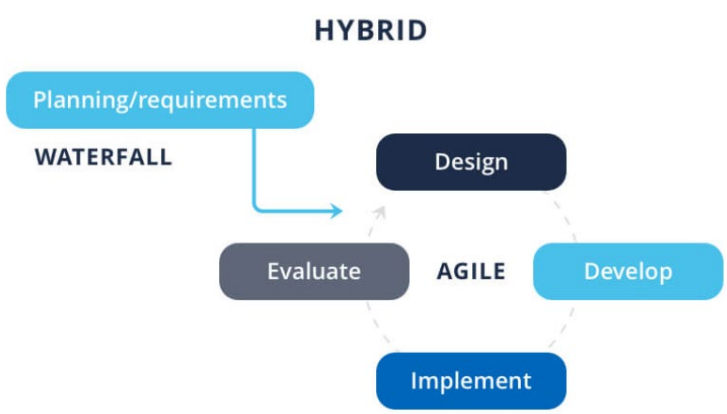


FIGURE 26 Organising processes with hybrid approach (Source: Nerur et al., 2005)

The great majority who use APM approach think that doing so has improved business satisfaction, quality, and productivity (Shine, 2003). However, despite saying they will continue employing these techniques, many firms also hold the opinion that agile techniques are not appropriate for all projects (Methods & Tools, 2005; Shine, 2003). Instead, most firms are making case-by-case attempts to use both APM and TPM. APM requires a particular organisational culture to be sustained, one that is fundamentally different from the organisational culture required for TPM, according to academics and practitioners (Boehm & Turner, 2004; Lindvall et al., 2002; Nerur et al., 2005).

However, it can be exceedingly challenging and take years to change an organisational culture (Adler & Shenhar, 1990), and these conflicting cultures cannot coexist in the same organisational structure (March,1991). Therefore, in order for construction firms to fully benefit from both agile and traditional project management, new organisational structures are required to support two conflicting cultures. (Tushman et al., 1996) suggest that the difficulties of sustaining the two cultures can be overcome by an ambidextrous structure of organization.

There are effectively two different types of subunits in the ambidextrous organisation: one with an organisational culture that supports APM, the other with one that supports TPM. These two organisational entities differ from one another in four areas: management, people, process, and technology. The two subunits are structurally separated from one another to preserve these two opposing cultures, enabling each to coexist independently. To enable a shared organisational vision and avoid the two subunits from competing with one another, information system management for the two subunits must be strongly connected (Boehm & Turner, 2004).

3 RESEARCH METHODOLOGY

Chapter summary: This chapter presents and explains the research method chosen for this thesis and its considerations. It also gives reader a comprehension of the case study selection and research ethics. Thereby follows the next chapter which examines and analyses the empirical findings from the case study.

3.1 Chosen research methodology

The research methodology chosen for this thesis is qualitative and is conducted through semi-structured interviews to elicit specific information. The qualitative research methodology was chosen because it is suitable for investigating new areas of study and theorising prominent topics. It is also useful in gaining a better understanding of a particular topic (Ghauri & Grønhaug, 2010). It tends to be less structured and more empirical than the quantitative approach. It is suitable for studying organisations, groups, and individuals. The research method chosen has made it possible to explore new areas relevant to the topic of this thesis. These semi-structured interviews were conducted with individuals (refer *Interviewees* and *Results from the interviews* section) from the Construction Management department of Lodha Group.

Prior to the interviews, the focus of this thesis was to gain existing theoretical knowledge about the APM approach and practises in the construction sector. Both primary and secondary data were used in the preparation of this thesis. The primary data are the results of the case study and the interviews conducted, while the secondary data are literature reviews and findings from academic reports. The combination of notes taken during the interviews and the recordings reduced the loss of data collected. A thesis, however, has its delimitations (refer *Chap 5*) and due to this, some areas has not been elaborated on.

3.2 Selection and Evaluation of Case Study

The organisation was selected using the following keywords with inverted commas (i.e., “”): “Agile Project Management”, “Agile Construction Projects”, “Project Management”, “Scrum Master”, “Construction Projects”, and “Agile Infrastructure Projects” on LinkedIn. Along with the keywords, these location filters were applied in the sequential order:

1. India
2. The states that constitute India
3. Main cities in India.

In addition to locations, “Firm/corporate” and “Group” filters were applied.

Followed by the research on LinkedIn, similar research was carried out on Twitter using the relevant hashtags (since the research on twitter is conducted using #): #agile project management + #India, #Agile construction projects + #India, #agile management + #India, #constructionbusiness + #India, #Construction projects + #India. These same keywords were used once again replacing #India with Indian main cities.

Subsequent research was performed adding “India”, “name of each of the states”, and “name of each of the cities” on the main search engines Google and Yahoo. This search narrowed down to articles and/or websites that refer to/ or mention agile organisations in construction industry. After these research techniques, the companies were delineated further to a handful set. Out of which Lodha Group offered immediate support for taking part in educational research. The interviews were scheduled through the company secretary as per the requirements of the thesis.

3.2.1 Lodha Group

Lodha Group is one of the largest multinational real estate developers based in Mumbai, India, known for prime residential and commercial properties (Anarock report, 2022). Its businesses can be divided into (i) residential portfolio, (ii) commercial portfolio, and (iii) logistics and industrial park portfolio in Mumbai, Hyderabad, Pune, and London (Lodha Group, 2022). The core business is the residential portfolio, which can be divided into (i) affordable and mid- income housing and (ii) premium and luxury housing, with the former being the primary focus. The company employs more than 5,000 people and about one hundred senior executives senior level management. Three projects were taken into account to understand and compare the organisational level management practices at different periods (Refer *chapter 4*).

3.3 Interviews

As mentioned earlier, the interviews were semi-structured, which is common in qualitative research approaches (Ghauri & Grønhaug, 2010). This means that the questions were predetermined, but the interviewee could formulate and answer them in his or her own words. In addition, it was possible to ask further questions during the interviews that were not predetermined. The reason for choosing this type of interview was to create a more discussion-oriented interview, which is not possible in a structured interview approach. Semi-structured interviews are frequently used when the researcher wants to explore more about the topic and comprehend the answers given in detail. Compared to an unstructured interview, the semi-structured interview allows the interviewer to ask more direct questions. Furthermore, the interviewees were informed about the topic and purpose of this thesis prior to the interview. However, they were not told what the APM approach is and its meaning. The reason for this is that their answers should only reflect how they currently manage and work on the project, and not be influenced by how they could or would do it instead. These interviews contributed to the contextual awareness of the thesis topic.

All interviews were conducted and recorded online via Zoom meetings in English. Notes were taken during each interview, and the notes were used to aid in the analysis of the data collected in the interviews. The results of the interviews were used to investigate the experiences of the interviewees in specific projects at different points in time. The obstacles, difficulties or shortcomings in the construction projects carried out today in India were investigated. It also explored what opportunities there are to improve the execution of the design phase. The analysis examined the results in relation to theory about the construction industry, agile project management, and other relevant topics addressed in the literature review.

3.3.1 Choice of interviewees

The main parameters for the choice of interviewees were their role and responsibility, prior subject knowledge and current practices in the construction sector. As previously mentioned, the interviewees were from Construction Management department of Lodha Group. The following roles were interviewed for the projects:

- Vice President (VP)
- Deputy Vice President (DVP)
- Assistant Vice President (AVP)
- General Manager (GM)
- Chief Operating Officer (COO)
- Project Manager
- Head Architect

The aim was to exercise maximum participation of senior managerial level executives to understand the traditional practices, organisational change, COVID-19 impact on the company and how as an organisation they managed to be resilient in the particular geographic region. The maximum participation was ensured through the discussion- oriented interviews. A minimum of two individuals and corresponding roles were interviewed per project. The interviewees were also asked to recommend other crucial supporting roles for further interviews.

4 CASE STUDY- EMPIRICAL FINDINGS, SYNTHESIS AND ANALYSIS

Chapter summary: This chapter begins with the brief overview of Indian real estate sector, real estate market in the Mumbai Metropolitan Region where Lodha group mainly operates. Finally presents the findings and analysis from the interviews conducted on account of the case studies where APM was used in their pre and post covid construction projects. Following chapter provides with the conclusion of the thesis.

4.1 Overview of the Indian Real Estate Sector and Indian Economy

India has been one of the fastest growing economies of the world over the last few years and is now among the top ten economies of the world. Despite the slowdown in 2020, the IMF expects the Indian economy to bounce back in 2021 with a growth rate of 8.8% and regain its position as one of the fastest growing emerging economies in 2021. With consistent quarter-over-quarter growth and implementation of COVID-19 related vaccinations in place, the Indian economy is projected to show a sharp rise in the real GDP growth in 2021 at 8.8%, as per the IMF. The following graph sets forth GDP growth rate of India from 2014 to 2021:

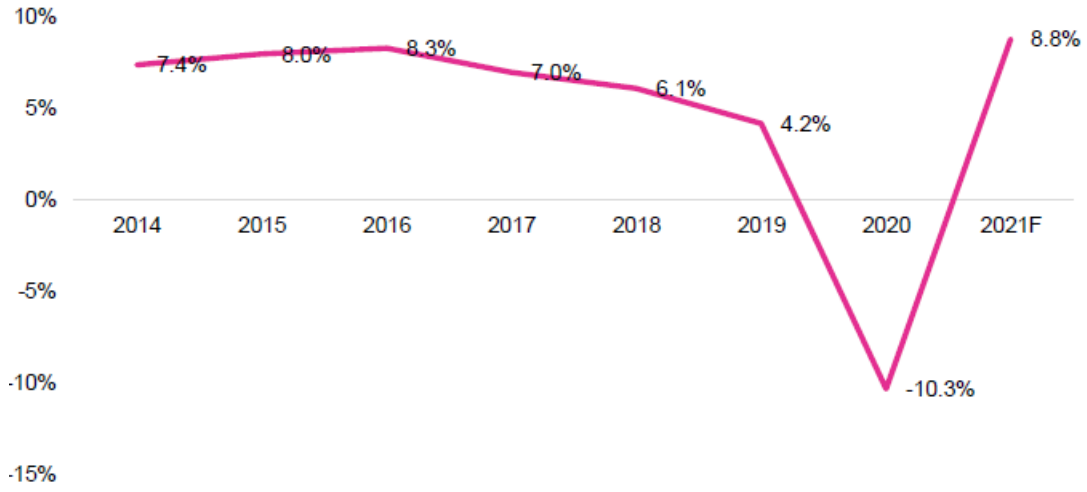


FIGURE 27 India GDP growth rate - 2014 to 2021 (Source: IMF; Anarock report, 2021)

The real estate market in India has grown at a CAGR of about 10% from USD 50 billion in 2008 to USD 120 billion in 2017 and is expected to grow further at a CAGR of 17.7% to reach USD 1 trillion by 2030. The real estate market contributed around 6% to India's GDP in 2017 and is expected to contribute around 13% to India's GDP by 2025. Residential, commercial, and retail are the top three asset classes that have primarily contributed to the growth of the Indian real estate market (Anarock Real Estate Industry Report, 2021).

4.1.1 Impact of Covid-19 on Real Estate Sector

During the first wave of the COVID-19 lockdown in second quarter of 2020, there was an impact on the economic activity in India as there was restriction on labour movements, construction and developer site were stopped and the employment rate reduced to an all-time low as a result of which, there was minimal activity in the real estate market.

During the second wave of COVID-19 in the second quarter of 2021, there was an impact on the physical and mental health of people. There was a minimal economic impact, as there was no restriction on labour movement, construction and developer site was allowed due to which there was no impact on demand.

4.1.2 The MMR Residential Real Estate Market

Supply and absorption declined in 2016 and 2017 in the MMR, primarily on account of the impact of demonetization, RERA and GST. Post 2017, absorption of units grew steadily and outpaced supply of units. In 2020, the units launched were lower than the units sold. Between September 1, 2020, and December 31, 2020, Mumbai recorded registrations of 41,681 units, with numbers growing incrementally month-on-month, according to the Department of Registration and Stamps, Government of Maharashtra. In December 2020, the figure grew two times over the same period last year. While December 2019 recorded registration of 6,433 units, December 2020 recorded registration of 18,854 units. Total sales in the MMR during 2020 were 44,323 units (approximately INR 53,150 Crores), of which Lodha group sold 4,475 units (which attributed 10% of the market share, the largest in the MMR) at approximately INR 4,522 Crores (which attributed 8.5% of the total sales value of the sold units in the MMR). The following graph sets forth supply and absorption trends (in units) in the MMR from 2015 to 2020:

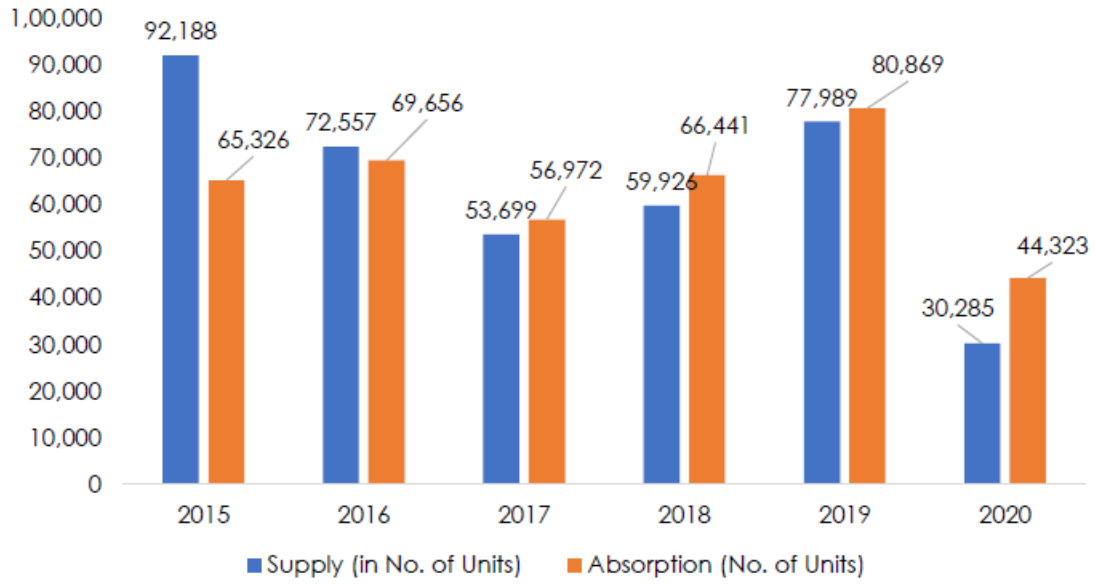


FIGURE 28 Supply and absorption trends in MMR (Source: Anarock report, 2021)

The overall unsold inventory gradually decreased from 2017 and is at its lowest in the last six years, on account of strong absorption trends, which was higher than newly launched units and previously unsold inventory. The annual absorption in the MMR in 2021 is expected to be similar to that of 2019. Anarock expects that post 2021, there will be a gradual increase in absorption until 2025. New launches are likely to be lower than that of 2019, but are expected to gradually increase year-on-year.

4.2 Lodha Group

Lodha Group is an Indian transnational real estate company founded in 1980 by Mangal Prabhat Lodha. It was incorporated in Mumbai in 1995 as a Private Limited Company under the Companies Act, 1956 and later converted into a Public Limited Company in 2018 (Lodha Group, 2022). The company is headquartered in Mumbai; has built residential and commercial properties in Mumbai, Thane, Hyderabad, Pune, and London. The organisation is also well-known for building many integrated smart cities. World Crest, one of The World Towers, and Upper Thane, an integrated township, are discussed and analysed in this chapter. The aesthetics behind the best residential and commercial projects is "Building a better life and homes transform lives". Each Lodha project offers the highest level of design and craftsmanship, uncompromising quality and unparalleled service that places them in the league of the best in the world (Lodha Group, 2022). The homes are nestled in developments where they offer a variety of experiences - all designed to help people live their best lives. The carefully landscaped large open spaces, manicured green spaces, world-class gyms, sports arenas and even houses of worship are built to enrich lives. Their vision is that "A home is a springboard for dreams and aspirations, for a healthier and more fulfilling life" (Lodha Group, 2022). By building the best global partnerships and leveraging the best people and processes, the company is able to create the best value for its customers in all regions, markets, price points and consumer segments. Lodha Group has succeeded in developing landmark projects in the residential, retail and office sectors, consistently earning the trust and recognition of its customers. The company is one of the self-sustaining players in India and the highest revenue earner for three consecutive years. It achieved net sales of INR 7,790 Cr for FY 14-15 and INR 7,520 Cr for FY 13-14 with INR 8,092 Cr in FY 12-13 and INR 3,911 Cr in FY 11-12 (Each property, 2017). Some of the data about Lodha Group (as of March31, 2022) are (Each property India, 2017):

(i) 85 million square feet of developed land area
(ii) 40 ongoing projects; 30 upcoming projects
(iii) INR 50,000 Cr^{+} pre-sales from FY 16- 22
(iv) 95 million square feet under planning and development
(v) More than 50,000 apartments delivered between FY 16- 22

4.2.1 Residential portfolio

Businesses can be classified as residential portfolio (affordable & mid-income housing projects and premium and luxury housing projects), logistics and industrial park portfolio, and commercial portfolio (office and retail projects). Their primary focus has been on the residential portfolio, as there are significant growth opportunities in this portfolio. As of December 31, 2020, their residential portfolio constituted 91.62% of Developable Area of ongoing projects. In affordable and mid-income housing projects, the focus is to provide optimally designed apartments at affordable prices along with social amenities. In this category, they also develop large format townships or gated communities that provide physical and social infrastructure.

4.2.2 Competitive strengths

Lodha Group is well positioned to capitalize on the Indian real estate market's growth potential. The interviewees identified their key competitive strengths as following:

- One of India's largest residential real estate developers with a leadership position in the attractive MMR market.
- Well-established brand with the competence to sell at premium prices from the start of the construction phase.
- Proved execution capabilities with continuous innovation and ability to deliver projects at competitive cost.
- Strong focus on sustainable development.
- A highly diverse portfolio across price ranges and micromarkets in MMR with a focus on affordable and middle-income housing.
- Significant inventory of completed ready-to-move units.
- Unique capacity to build townships with contemporary marketing and sales tactics to multiply the continual operating cash flows.
- High quality management team.

4.2.3 Organisation strategy

The primary focus is to strengthen the position as a top developer across product categories and customer segments, maintain reputation for quality and innovation and enhance the brand in the RE business. The following are the key elements of their business strategy:

- Focus on enhancing leadership position in residential developments by growing in the MMR and gradually diversifying in selective Indian cities.
- Leverage their leadership position to act as a partner of choice for landowners and grow using a joint development or joint venture approach.
- Pursue a value-accretive land acquisition strategy.
- Develop large-scale industrial parks.
- Focus on development of commercial projects as part of mixed-use developments.

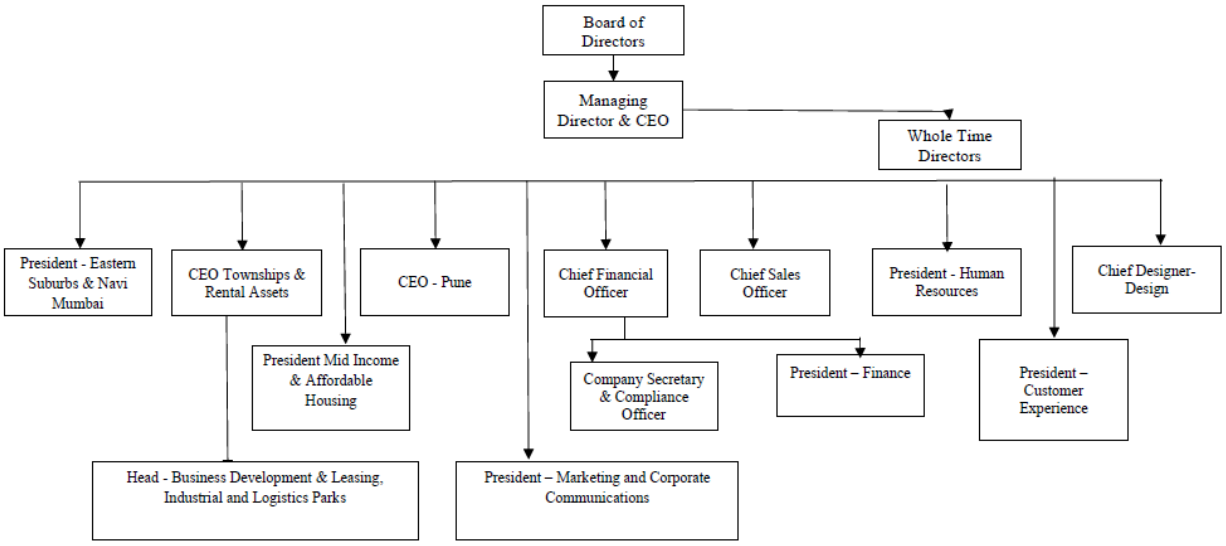


FIGURE 29 Top Management level organisation chart (Source: Author)

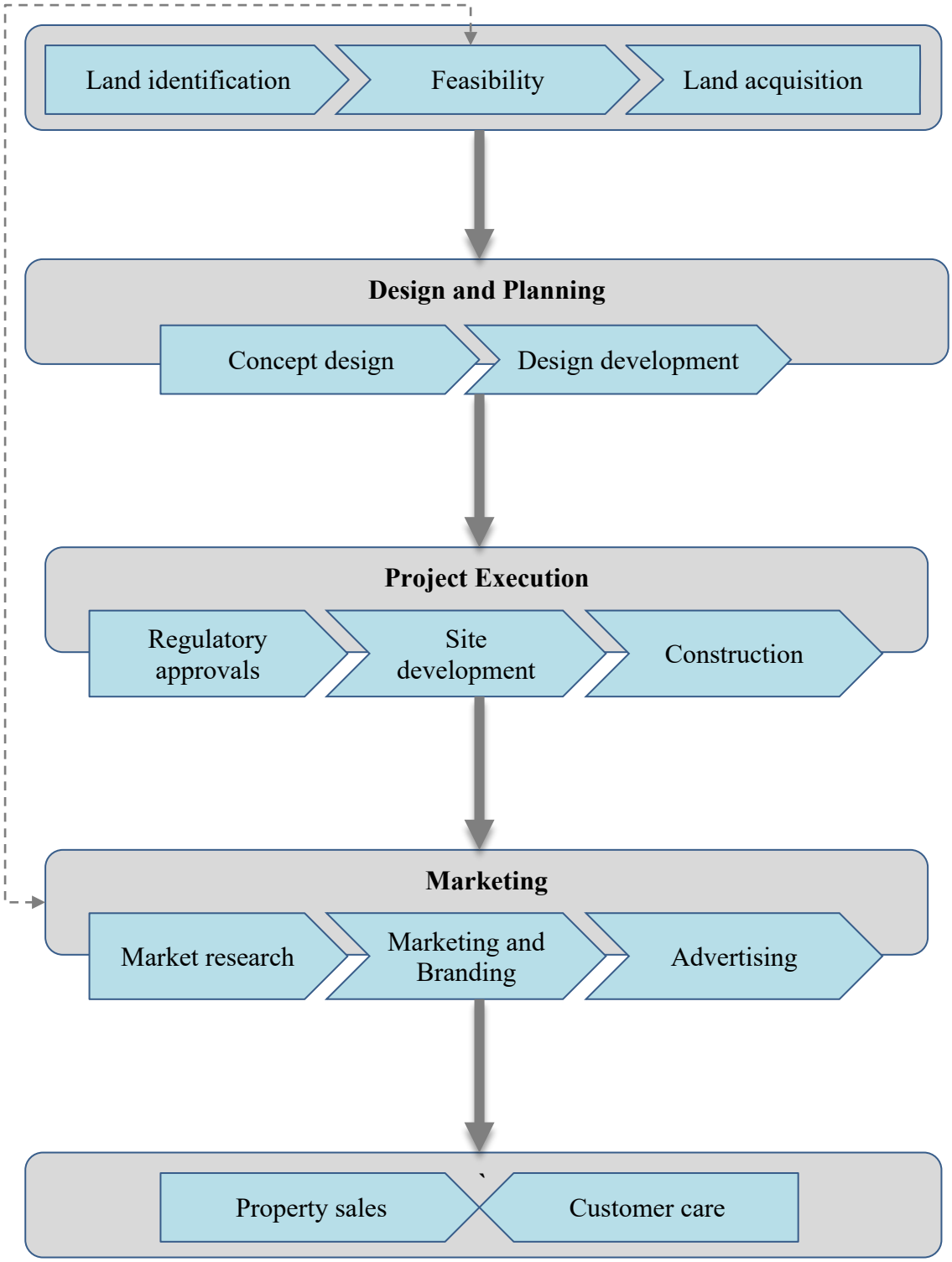
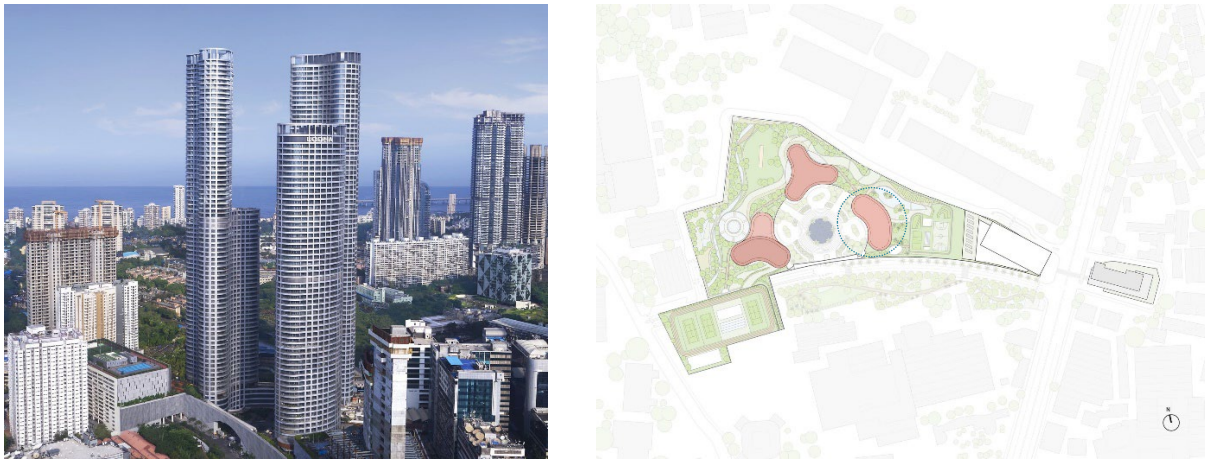


FIGURE 30 Core business processes of Lodha Group (Source: Author)

4.3 World Crest (2010 - 2016)

The World Crest is a 57-floor residential skyscraper with a height of 222.5 m (730 ft). It is located in lower Parel, Mumbai India having an iconic presence on the city's skyline. It is one of the skyscrapers in the world towers complex composed of world one, world view, and world crest. The World crest was designed by Pei Cobb Freed & Partners Architects LLP. The interiors were designed by Armani/Casa, a globally renowned designer and the landscape was designed by Ken Smith Workshop Landscape Architecture. The world crest has a consistent kidney shaped plan. Other amenities include a spa managed by a globally renowned spa chain.



(a) **(b)**

FIGURE 31 **(a)** Lodha world towers (Source: Lodha Group, 2022) **(b)** Master plan (Source: Pei Cobb Freed & Partners Architects, 2022)

4.3.1 Organisational Framework

In this project, the in-house PMC team of the company acted as the main contractor and controlled other subcontractors such as civil contractor, MEP contractor, and finishing contractor etc. The design was outsourced (Design consultant - PCF-P New York) but was completely managed by the company which helped in increasing the share value of the organization. In this project, the MEP manager and finishing manager reported to the dedicated project manager. A planning engineer was functionally reporting to the project manager but operationally reported to the deputy project manager. The deputy project manager overlooked the project and controlled the project. This model ensured that the learning from each project was carried on to the current projects and the learning from current projects would be transferred successfully to future projects. Consultants of World Crest project included:

- Design consultant – PCF-P, New York
- Structural consultant - LERA Consulting Structural Engineers, New York
- Building services engineering consultant - Buro Happold, New York

I had the opportunity to interview Lodha group's Deputy Vice president, the head of southern Mumbai which is characterized to be a luxury region with a huge market for luxury and premium products. The interviewee belongs to the planning department responsible for project management

and coordination between various teams for the entire Southern Mumbai region. He was responsible for the planning of World Crest involving the design and timely completion of World Crest.

I also had the opportunity to interview the design manager of the project. Her responsibility was to brief the project and coordinated with respective consultants on what the company intended to do while anchoring the design process. In this role, she was inclined toward design. She acted as a bridge between the management and the consultants. Made sure that the outcome of the consultants matched with what the management wanted. There was a transition from anchoring the design to identifying and providing solutions in the bottlenecks of the project.

4.3.2 Operational Framework

The project was initiated 6 months prior to February 2011 with concept design. In February 2011, construction started as there was the liberty to begin construction work right after the possession of the land reducing the time to market (TTM) of the product. Since there was not much time for the complete design, construction and the design took place almost parallelly “hand in hand”.

In February 2011 World Tower’s (all 3 towers including the world crest) excavation process started. The structural consultant required 45 to 60 days of study to analyze if there is a requirement for piling for the area or not. While the contractor required only 30 days for piling 160 piles, Lodha group decided to begin with the piling to save time. After the completion of the Piling, the structural consultant concurred that there is no requirement for piling the area. The cost of piling was wasted but the company took advantage of timesaving which was considered more valuable in the volatile construction industry. As World Crest’s design required a lot of time. Yet, the market leader Lodha did not wait for the complete design to start the construction work. But with a set of thumb rules, the design team was required to provide the substructure drawings which included 2 basements and 1 to 1.5 years of duration. The design team was able to provide the substructure drawings with swiftly to start with the 2 basements. While the substructure was complete, the design team finalized the design structure drawings, and the contractor was appointed & awarded. The initiation (setting up offices) and construction processes were done parallelly. This was done as the market was fluctuating with variable demands. By the time they wait for the complete design to start the construction, the product might become obsolete. The construction difficulties were cited in the design stage. In the design phase feasibility study, market research, design, concept, schematics, design development and working drawings were done.

Primavera P6 was used in this project with traditional CPM and Gantt charts. The tendering process involved 2 months before the start of project initiation. The design manager anchored the design, MEP team, and experts (internal stakeholders). Delivery schedules were done first which in turn mapped the construction schedule. With the final target to hand over the project at the said time. So, the construction team worked backwards. Based on that the design team worked backwards in line with the delivery time. The design team ensured to deliver the drawings ahead of time as the drawings went to the procurement and the budget team who also work backwards. This was one tracker which allowed to set priorities or check whether the design team had been missing out on something important. From the schedule, the time for delivering the drawings was

captured. This in turn captured a time for the procurement. 3 months were required for tendering, appointing and mobilization of the vendor. The design team had started 3 months (slack) in advance to complete their work. This slack/float was transferred to the successive teams to get enough time for their structured processes. Lodha had approached Autodesk and other software companies to help them convert the entire building onto Revit and BIM, but it was not efficient as the vendor could not use them at the time. In any construction project, once the structure is up, the design flexibility is limited drastically. Based on the market study the management, initially had planned for 60 stories. But as the demand increased world crest was accommodated with 62 stories. Instead of using ceramic tiles, it was changed to marbles (product finishing) and interior finishing was altered in this project. Incorporating these changes, the project ended up in a positive benefit scenario (profit). The design manager also managed escalations with internal stakeholders, the finishing team, the procurement team, the construction team, and the liaison team (for approvals). After the design approval stage, the procurement took place for the entire project followed by the construction stage and then the final handover. So, the schedule was the primary tool which allowed to plan and control the successive processes. Impact analysis was done when there was an issue in the progress of the project with the consideration of the intensity of the impact and what it impacts. Additionally, group discussions (budget and time analysis) with stakeholders were held to discuss the analysis and concur on the decision. Lodha group was learning and evolving during the World crest project. It is one of the tallest buildings in India. World Crest was done completely using the traditional project management method. They hired experts who worked in Burj Khalifa for the transformation of knowledge (conceptualised world tower - 2009 to 2011). Each dept used the tool which was helping them to facilitate, get the process in the right way or control the process. Getting the right people on board was crucial for the success of this project. Then they started implementing the knowledge that they had gained. During the initiation process, the project management plan was finalized, and all departments were assigned. A quality plan, safety plan, project plan, and procurement Strategy were put in place. After signing the project management plan, the quality plan was reviewed with the quality team. The EHS team monitored the quality and safety of the construction. The Deputy Vice President team monitored the construction process and generated a monthly report. It included solutions for mitigating risks and allocation of resources. In India when the project is approved and initiated the product could be sold to the customers for monetary advances reducing the financial burden of the management. This was the scenario in the world crest. The company secured money from the market right at the initiation of the project. As this project was in the luxury segment customers wanted their apartments to be unique and were willing to pay for the extra charges. Lodha provided an option of customizing the apartments according to the needs and interests of the customer after completion of the outer shell of the apartment.

4.3.3 Communication framework

Main decisions were taken by top management. With the help of meetings and communication. Important things were put first to start with, and they were put in the prioritised backlog and conveyed it to respective persons.

- In-person meetings – with internal stakeholders (daily)
- Mail communication – soft communication (daily)
- Firm communication – official letters.

- Aconex - for all project-related documents. An international documentation system was used. All the project documentation was communicated to stakeholders across the globe.

Weekly meetings with the project, design, procurement, construction teams and contractors were conducted. Contractor meetings were weekly or bi-weekly depending on the amount of info to be passed on to the management. Prior to these meetings daily, weekly, and monthly reports were circulated with the latter being of the highest importance. Initially, internal communication happened once a week with the dedicated team. As the project progressed this increased to thrice-a-week interactions. Dedicated weekly meetings, brainstorming takeaways and task-oriented meetings resulted to success of the project. Important things were documented in the mail. Video conferencing helped them a lot to connect with the consultants. After the design stage, the meetings happened at the site. The construction team played an important role in quality control and value engineering. The meeting at the site really helped with their challenges faced.

4.3.4 Shift from TPM to APM

Change in the mindset was very crucial, there was a lot of resistance as they had to learn and unlearn a lot of things. Then the organization's leadership gave employees the push to the agile mindset. Lodha had set up war rooms to transfer the knowledge individual employees gained. These war rooms were held every week where the employees shared their thoughts, the areas they fell short and exchanged remedies. The entire organization worked together to get out of the resistance. The developer format and market-driven conditions do not allow time. This was a roadblock as it takes time to adopt and adapt to agile methodology. The war room culture really helped Lodha group to become an agile organization. Lodha group has evolved from TPM to APM now. They understood the right way to build the world crest and linked it forward on how to manage the fluidic customer demand. It took 3 to 4 years to embrace agility in the organization. Of course, the building structure could not be altered but they changed their approach to the amenities of the world crest. "Agile is a thought process"

4.3.5 Strengths and limitations

Agile is all about flexibility. The organization had the intention to change the methodology based on the returns. A flexible attitude with the sole intention to complete the project. Uncertainties were a part and parcel of a project. The management had ordered materials from all parts of the world. They had to plan and order the material in advance. Most materials were delivered from Italy. Planning played a major role in risk management. "Agile practice – many of the practices are agile but people are not calling it as agile".

4.3.6 KPI's of World Crest that added business value to the company

- The world crest was a trend and brand setter for the entire market as earlier to this there was no icon of luxury homes. With this project, people across the globe understood Lodha's competencies and that they could deliver the project on time.
- Pricing and profitability – The pricing of the world crest apartments was set to be high, yet all the 249 apartments in 62 stories were sold out making the project a huge success.

- Other benefits of the project included using the same in-house project management team for all future projects with learnings being passed on.
- Lodha upgraded its brand with World Crest.

Having a B2C model, Lodha sold their product to individual customers with their own sales and marketing team, securing their profitability. External stakeholders (Financial partners) of the project were provided with profits during the project and it was settled after the completion of the project.

4.4 Upper Thane (2017 -2020 ; 2020 -2022)

Upper Thane is one of the largest ongoing portfolios of affordable and mid-income housing projects, located in Mumbai Metropolitan Region (MMR), India. The project commenced in April 2017 and is expected to complete by December 2022. Phase 1 consists of twenty-four buildings- Casa Greenville, Casa Tree tops, Casa Ecopolis and Casa Tiara. It was executed before COVID-19 and handed over during COVID-19 in December 2020. As of September 2021, the gross collection of this project was estimated to be INR 11,771.8 in million, 2,719 units were sold. Phase 2 started during COVID-19 and is expected to be handed over in December 2022 with 3,669 units. The interviewees described the changes in function and activities- before, during and after COVID-19. Upper Thane is a 200+ acre integrated township, under Inspection and Test Plan (ITP) rules, with more than 80% of the development devoted to open spaces. It has been designed by visionary Indian architect Hafeez Contractor and landscaped by renowned design firm, Prabhakar B. Bhagwat & Associates (Lodha Group, 2022). Upper Thane is an integrated walk-to-everything development. The neighbourhood is self-contained in many ways; provision of school, retail and medical facilities within is planned. Proposed amenities include a clubhouse, swimming pools, party hall and cinema, and indoor games have also been planned for the prospective residents.

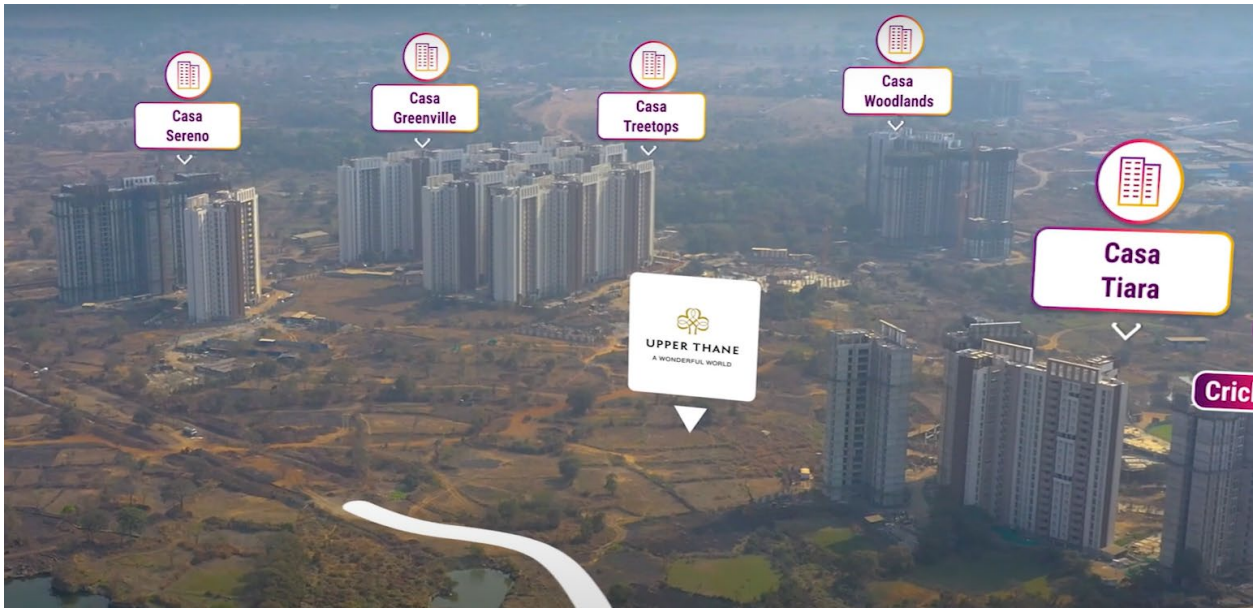


FIGURE 32 Upper Thane township (Source: YouTube video, Lodha group, 2022)

Sports facilities, such as football, cricket, tennis and basketball courts, are planned to be a part of this development.

FIGURE 33 Upper Thane Phase Master Plan (Source: Lodha group,2022)

4.4.1 Organisational framework

In this project, Vice President was the project in charge. Other departments such as planning, design, procurement, execution, quality control, finance, Environmental Health and Safety (EHS), Human Resources, Facility Management and Sales and Marketing ranks just below the Project in charge. The second tier in the hierarchy reports to the Vice President Project in charge. Each of these departments has a separate in charge and a team. The third tier in the hierarchy reports to the second tier in charge. Planning department has PMO in charge and is supported by at least four or five people. As there are 24 buildings, they are grouped into clusters. Each PMO will be in charge of a cluster. A cluster typically consists of 8 to 10 buildings or more. The number of buildings in the cluster corresponds to the seniority level of the PMO. The PMO will follow up with the breakdown planning.

4.4.2 Operational framework

The project started with feasibility, concept, design development, preconstruction, construction and handover to the customer followed. Individuals involved in feasibility and concept stage are the sales marketing team, strategic leadership team, head architect along with the Managing Director (MD) and the Chief Executive Officer (CEO). The feasibility study was done by the teams mentioned above, for the head of architect who derives the concept with the consulting architects, the MD and the CEO. The top management finalized the concept based on the feasibility study and the configuration of the whole area was decided (residential, commercial, industrial buildings). After concept finalisation, the architects appointed the consultants and further development of the concept continued. During the design development phase, Construction Management team took over to ensure the constructability and output to be aligned with the project goals (Because many times, consultant architects may give certain ideas that are not feasible or possible or maybe very expensive). Therefore, the involvement of the construction management team during the design development was very critical for this project's success. All the final drawings and the layout were created in the design development stage. These documents were sent to the MMRDA for the approval seal of GFC – Good For Construction and VFC- Valid For Construction. The GFC approved drawings were reverted to the site and the project execution started.

At operational level, this process is categorized into three parts, pre-construction, construction and post construction (handover). Pre-construction phase included formulation of the budgets, the Project Execution Strategy (PES), finalization of the milestones and logistics plan, and was transferred to the construction site. Employees at the construction site executed the project adhering to the Project Execution Strategy (PES) and logistics plan. The location of the steel yard, tower, Ready-mix Concrete (RMC), radius of the steel ducts, area of circulation for the 40 feet containers, construction of temporary roads, calculation and location of dumping area, loading and unloading of materials and equipment were some of the examples construed in the pre-construction phase to be implemented at the site.

After this phase, selection of vendors and the commercial phase began. In this phase, quantity surveying was done by Design and Cost Optimization department (DCO) and an estimate was prepared. They uploaded that estimate and Bill of Quantities (BOQ) in the system, which was accessible to the Operations team and the Central Procurement Team (CPT). With the provided estimate, the construction management team had to do Service Request (SR) for the work orders and Purchase Request (PR) for purchase orders. The Central Procurement Team (CPT) proceeded with the bidding and tender process with the SR and PR.

Tender process began with the selection of minimum of 3 contractors or 3 vendors; quotations were taken based on the specifications and the best economic and advantageous bid won the work order. After the selection of the tenderer, the vendor approached the construction management team to kick start the project at site. In the project kick off meeting, the planning team, quality team, EHS team, execution team, billing team, commercial team along with the vendor were present. The work processes and its methods to follow, bill processes, safety practices were explained in the kickoff meeting. The quality team explained the type of quality, the quality processes and the quality check the management were looking at. Everything was explained to the vendor in the kickoff meeting. The planning team provided the vendor with construction

management's targets, major plan and minor milestones. The start and end of an activity and breakup of the minor milestones followed. Upon these kickoff meeting, the vendor began with the work at the site as per the instructions given by the Construction Management team. All processes defined in the work order were followed.

Every month, the bill for the completed work within the said schedule was sent to the management team, which prompted the quality team, EHS team and site team to check the work done. Occasionally, external consultant visited to check the progress. Setting of the first slab was invariably checked by the consultants. Daily and weekly based monitoring and control was also performed by the team at the site during the execution phase. The completed work by the particular vendor was certified and the billing is closed. Similarly, the buildings were constructed with various vendors, which led to the project close out (reconciliation and final billing was done). The first phase of the buildings (24) was handed over to the in-house Facility Management team to hand over the units to the end customers.

For the project to be successful, hands-on experience on the best practices was required to be more flexible. APM techniques were used in different levels of management. With the evolvement of digitization, as an organization, it was important for them to understand and adapt to the changing needs. Initially, for planning, Gant chart, Excel and MS project were used. Primavera P7 was used for this project.

4.4.3 Communication framework

Daily scrum meetings were conducted at the site at cluster level. Daily labour report, daily material report and other supporting reports were gathered and accumulated into a progress chart. Employees at the site updated the progress chart and the data directly transferred into Primavera (updated every day).

Weekly sprint review meetings were conducted with internal and external stakeholders (two types of meetings) focused on monitoring the progress and milestones achieved. As this was a huge project, the management followed a Standard Operating Procedure (SOP). Internal stakeholders included the PMO team, commercial team, material management team, EHS team and quality team. Weekly or fortnightly meetings were held both at the head office and at the site for site coordination. These two types of meetings provided a complete picture of the actual progress and had a positive effect in project coordination. There was also coordination with architects and consultants etc. (external stakeholders) every week involving discussions on DDS, drawing schedule, deliverables. The problems were addressed and resolved.

Meetings took place every week or fortnight, depending on the severity of the problems. One example is, during the COVID-19 pandemic, there was an issue with the availability of semi-conductors. The unavailability of the material was going to affect the total project cycle. This increased the frequency of the meetings. The PMO team had to derive this effect on the overall project deliverables, developed alternative solutions and a risk mitigation plan based on the available resources. Emails with proper format were used to communicate with external stakeholders for official work. Generally, exchange of unnecessarily mails was avoided to prevent data leaking. Regular meetings and their updates were circulated through MOM (Minutes Of the Meeting).

Although, in case of emergencies meetings were called upon. Notices were issued to the contractors in case of any discrepancies or delays in the project execution. A delay register and daily register were maintained by both the contractors and the organisation which helped in mitigation of any inconsistencies during the project execution.

4.4.4 Impact of COVID-19 on project Upper Thane

Initially phase 1 was to be completed in May 2020, but the outbreak of COVID-19 delayed the project delivery. The envelop was closed, painting, and building topping out was completed before the outbreak. Only few things were remaining - internal finishing, city sanitary fitting, wiring etc. On 22nd of March 2020, nationwide lockdown was announced by the government and there was a halt for two months. Again, on May 8, 2020, the permission was given to restart the work by the Government. The labourers were working on the remaining execution. The labour force was in the camp at the site due to the travel restrictions. After three months, the intercity rails were functioning, and the labourers preferred to go home. This caused a set back again for further three months. The labour force returned in October 2020 and the work resumed again. The first phase was completed by December 2020. The Occupancy Certificate (OC) was issued in March 2021 and by September 2021 more than 2500 units were sold.

Phase 2 is still in execution. It started during the COVID-19. Initially, there was an issue with the labourers regarding masks, social distancing and vaccination. Educational training on hygienic sanitization and social distancing was provided for the entire organization to ensure maximum safety. Free vaccination was provided by the organisation for the labourers and the employees. For any construction project, labour force and materials availability at the site are critical for project execution. Whenever labourers were not available, work was executed with the reduced manpower. The priorities were changed, and program was realigned to be adaptable to execute the construction, with the existing manpower. Some materials were not available due to China's closed port and suspended transportation services. The organisation's strategy changed during the pandemic with optimisation of available resources. The strategy changed again on relaxation of COVID-19 restrictions. Resources and materials were available again. During COVID-19, the planning was dynamic as to achieve a maximised output as per the existing conditions. Initially, it was a push mechanism as all the resources were available. In phase 2, it was a pull mechanism strategy. The mindset changed from a normal thinking process to embrace adaptive solutions. This was due to the unavailability of resources and materials from time to time.

Head office was closed, and they were working from home. Operations team had to go to the site and work. Passes were acquired for the travel purposes (E-pass was required during the pandemic to travel). Transportation (carpooling) was arranged as the public and local transportation services were temporarily suspended by the government to limit the social gathering in public places. Offices were set up according to the social distancing and sanitisation norms. Head office employees were given the VPN access and were accessing the server from home. Even the payments and banking were dealt from home. Bills were scanned, uploaded in the cloud and checking was done from home. Design team was also working from home, but they were coordinating with Construction Management team. Communication started to take place through online platforms - google meetings and zoom meetings. Employees were working from home and from site, depending on their nature of work and coordination was key to keep up the pace of work.

Even suppliers started to open their warehouses and others managed with online businesses. The impact of COVID -19 had a gradual recovery. These were the major changes observed during the pandemic. During the COVID-19 everything was uncertain and there was a need to be agile. whoever was agile was successful during this situation.

4.4.4.1 Organisation's takeaway from the impact of COVID-19:

On hindsight, it was a beneficial situation for the real estate industry as everybody underlined to stay safe in home. People had movement restrictions within the building complex. At Lodha, most of the projects are large townships with self-sustainable amenities. There was an increase in demand and absorption rate as customers wanted to be not feel restricted inside their homes.

"Demand and the absorption rate increased many folds after the pandemic".

As a well-managed organisation, they were able to meet the changing demand requirements within the planned timeline. People came to realization that these types of projects are important. The work from home culture made this evident. COVID-19 not only impacted the organisations strategy but also changed the mindset of customers. The core values of agile helped to gain competitive advantage in the construction industry. The competitive advantage was achieved through continuous attention to the changing customer demands and satisfying it. For instance, through the feasibility study, the organisation realized that the customers perceived a study and office room with high bandwidth in Upper Thane project. And the organisation provided with the perceived needs and delivered value. This would have not been possible if the organisation had followed only the traditional processes. "The management's agility increased the sales after COVID-19", stated the interviewee.

4.4.5 KPIs aiding the success of the project

Defining the KPIs was crucial to achieve the project's goal. Changes does not affect the organisations milestones as there are flexible monitoring techniques in place. The buildings' height was decided to be 70m (low rise building category- norms change with each category) during the feasibility and concept study. The timeline to complete the project for up to 70 m building category is fixed as 26 months. This timeline is broken down into Annual Operating Plan (AOP) milestones. In this case, it is 2 years. For example, the first milestone would be on plinth, second milestone on the third slab and third milestone on the sixth slab and so on. There were also other interim milestones such as – when to start the internal block work, plumbing, plaster, painting. But the real estate market in India is a dynamic market. As the market demand changes continuously, the feasibility study goes on. Project Upper Thane started with four typologies initially - A, B, C, D and the current typology is K. It had changed after the pandemic. Initially, the feasibility study showed that, there was no requirement for balcony in 1 BHK apartments. Later, the feasibility study showed that 1BHK apartments required balcony. This was accommodated into the planning and the executions were changed accordingly. Additionally, regulations and CFO requirements changed. Upper Thane was a voluminous project, yet with a fast-paced progress. Planning and execution phase is always overlapped to generate more value to all the stakeholders. There was also a DCU check to verify the quality, after the execution of first unit of each apartment, to ensure

that there are no changes in the design and execution. This was done to mitigate the changes that might occur at a later stage, which would reflect in overall project delay and the project cost. If any drawing was not available at the needed time, a backup plan was considered. In the meetings the backup plan was renewed with adjusted resources and manpower as to not affect the AOP milestones. There were also buffer, and contingencies plan to not waste material, manpower and time. Thus, the strategy included lean principles.

Agile approaches are widely adopted in the IT, production and manufacturing sectors. Construction industry is different as it is dealing with 75% manpower (in India). Mechanization was present, but comparatively less than the other parts of the world. Tailored agile techniques along with the traditional method suited best for construction industry. One to one special training was facilitated by the organisation when there was a shift from TPM to APM. Currently the best practices of agile project management are not widely spread in the real estate sector.

5 CONCLUSION

Chapter summary: This chapter concludes the thesis with presenting the final recommendations, strengths and delimitations of the thesis topic. Finally, ends with suggestions in future research and scope area.

One of the real estate specialists stated in a presentation titled "The Impact of Real Estate in Economic Development", that the real estate industry has played a crucial role in the development of various economies throughout the world for many years and globally, it is one of the most profitable of every economy (Egole, A., 2022). The goal of this research thesis was to investigate the application of APM techniques in the construction sector, which majorly contributes to the GDP of a country. This was primarily done through qualitative descriptive analysis using semi-structured interviews. From the literature study it was evident that effective application of PM processes enables business organisations to execute construction projects efficiently. In addition, the study discussed in detail the traditional and agile project management approaches and its CSFs. The values they deliver are key to attain competitive advantage in the construction industry.

From the case study, World Crest was executed using traditional project management techniques. The top management's leadership push helped the organization to overcome resistance and adopt APM. It took 3-4 years for the organisation to shift to APM as the developer format and market -driven conditions did not allow facilitate time.

From the case study Upper Thane, the use of APM principles in the design phase reduced the issues faced in the construction execution. APM best suits for projects where customer needs (variable demand) are likely to change or evolve over the project. Reducing the TTM of the product while adopting the changing perceptible needs of the customer positively reflected on the organisations market share in the construction industry.

It is also worth mentioning that currently architects anchor the role of project manager. From this analysis, it is evident that the absorption rate (demand) increased after the outbreak of COVID-19. The top management leveraged Scrum and Lean methodology to make the best use of manpower, material and resources in the Upper Thane project. Their methodology and operating style are evolving with time. As a result, it is necessary to stay updated in the project management in construction industry.

5.1 Final Recommendations

The interviews generated additional topics that needed to be addressed in this thesis, which is why the literature review was extended. Application of APM would be beneficial to sustain and scale an organization. The adoption of APM in construction industry requires facilitated training sessions such as one to one training at the managerial level, war room discussions involving internal stakeholders to transfer gained knowledge throughout the organisation, and a strong leadership to guide and push the teams. Project managers should focus on continuous attention to the changing customer demands and must satisfy them deriving the utmost business value to the customers.

However, adoption of APM is visible in the construction industry. The author recommends using the hybrid approach for the construction industry (refer literature study *pg.73, 74*). This could also be beneficial to the organisations' struggling to make the jump from TPM to APM due to competence destroying and cultural resistance.

Traditional methods could not be completely disowned in the construction industry. Change is inevitable. Project teams should embrace and adapt to the changes. The mindset of the employees should also be agile as to know when and what to adopt. Agile techniques with the mindset deliver success in the construction industry.

5.2 Limitations and Future Research

Future research scope this thesis will be defined in this section. Before doing so, however, the study's limitations must be acknowledged. Despite the positive decent outcome of this project, the analysis and research method have some shortcomings.

First and foremost, this is a qualitative descriptive analysis report. This provides to a less detailed picture. The lack of generalizability or lack of falsifiability are applicable. The focus of this thesis being specific to a geographical region is another downfall.

However, this thesis research could be extended to other case studies in the construction industry there by increasing the comparability rate. This would provide more insights on the practices and techniques in the construction industry which will help the organisations and individuals to embrace the changes in future with much ease. Finally, more research could be extended to focus on comparative studies with other countries from various geographical regions.

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