COMPARITIVE ANALYSIS OF TRADITIONAL AND 4D SCHEDULING OF THALASSEMIA SPECIAL CHILDREN HOSTEL DHQ BATKHELA IN MALAKAND

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ABSTRACT

Planning a construction project is essential to guaranteeing its timely completion and efficient use of resources. In the context of building project management, this paper does a thorough comparison analysis of the cutting-edge 4D scheduling strategy and conventional scheduling techniques. Conventional scheduling plans and tracks project activities using two-dimensional representations, most commonly in the form of Gantt charts. On the other hand, 4D Scheduling combines time and 3D models to provide a more dynamic and visually appealing depiction of building sequences.

The study explores case studies and practical applications to identify situations in which one methodology performs better than the other. A comparison is made between important indicators including project length, cost effectiveness, and resource usage in order to evaluate how scheduling techniques affect project results. In order to shed light on potential implementation difficulties, the research also looks into the learning curve related to the adoption of 4D scheduling tools and technologies.

The comparison analysis's conclusions add to the body of knowledge in construction project management by illuminating the real-world ramifications of selecting between 4D and traditional scheduling techniques. The study intends to improve the effectiveness and performance of construction projects in a dynamic and constantly changing industry by assisting researchers, project managers, and stakeholders in making educated judgments about scheduling procedures.

KEYWORDS: Construction Project, Traditional scheduling, 4D scheduling, Comparison

UNDERTAKING

I certify that research works titled "COMPARITIVE ANALYSIS OF TRADITIONAL AND 4D SCHEDULING OF THALASSEMIA SPECIAL CHILDREN HOSTEL DHQ BATKHELA IN MALAKAND" is my works.

The work has not been presented elsewhere for the assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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Chapter No.1

Introduction

1.1 Construction:

Construction refers back to the procedure of creating, building, or assembling something, usually a shape or infrastructure. [1] It involves the use of various materials, tools, and techniques to transform raw materials or components into a finished product. Construction projects can range from small-scale residential buildings to large-scale infrastructure projects like bridges, highways, and dams. The construction process typically includes several phases, such as planning, design, financing, and the actual construction or implementation phase. [2] Construction projects are often managed by professionals such as architects, engineers, project managers, and construction workers who work together to ensure that the project is completed successfully and meets the required standards. Construction activities can be broadly categorized into different types, including residential construction, commercial construction, industrial construction, and infrastructure construction. The construction industry plays a crucial role in the development of societies and economies, contributing to the creation of buildings and structures that serve various purposes and enhance the overall quality of life. [3]

1.2 Construction Management

Construction control is an expert carrier that makes use of specialized challenge control strategies to supervise the planning, design, and creation of a challenge from its starting to its end. The primary goal of construction management is to meet a client's requirements in terms of cost, time, and quality while ensuring that the construction project progresses smoothly. [4]

A study comparing 4D scheduling to traditional scheduling methods in project management looks at the advantages, disadvantages, and differences between the two approaches for handling complex projects, particularly those in the engineering and construction industries.

Key aspects of construction management include:

1.2.1 Project Planning:

- Defining project objectives, scope, and constraints.
- Creating a detailed project plan, including schedules, budgets, and resource allocation.

1.2.2 Design Management:

- Coordinating with architects and engineers in the course of the layout phase.
- Ensuring that the design meets the client's requirements and complies with relevant regulations and standards.

1.2.3 Contracting and Procurement:

- Managing the tendering and contracting processes.
- Overseeing the selection and negotiation with contractors and suppliers.

1.2.4 Construction Supervision:

- Monitoring and supervising construction activities on-site.
- Ensuring that the mission remains on schedule, inside budget, and meets great standards.

1.2.5 Cost Management:

- Budgeting and value estimation for the complete project.
- Tracking and controlling project costs to prevent overruns.

1.2.6 Risk Management:

- Identifying ability dangers and growing techniques to mitigate them.
- Responding to unexpected issues or changes in the project.

1.2.7 Communication and Stakeholder Management:

- Facilitating verbal exchange among all events worried within side the project.
- Managing relationships with stakeholders, including clients, contractors, and regulatory authorities.

1.2.8 Quality assurance:

- Implementing quality control measures to ensure that the construction meets specified standards.
- Conducting inspections and testing to verify compliance with requirements.

1.3 Construction Scheduling

Construction scheduling involves the planning and organization of activities to ensure that a construction project is completed on time. [5] A well-developed construction schedule is a critical tool for project managers, helping them coordinate resources, manage tasks, and monitor progress throughout the construction process. Here are key aspects of construction scheduling: [5]

- **Work Breakdown Structure (WBS):**

The first step in production scheduling is breaking down the assignment into smaller, viable tasks. This is called the Work Breakdown Structure (WBS). Each task or activity should be clearly defined and organized hierarchically.

- **Critical Path Method (CPM):**

CPM is a broadly used approach in production scheduling. It identifies the sequence of activities that must be completed on time for the entire project to be completed as scheduled. The vital direction represents the longest period direction thru the project.

- **Gantt Charts:**

Gantt charts are visible representations of a challenge schedule. They display tasks along a timeline, allowing project managers to see the start and finish dates of each task. Gantt charts are useful for understanding task dependencies and identifying the critical path.

- **Resource allocation:**

Once tasks are identified and their durations estimated, project managers allocate resources such as labor, equipment, and materials to each task. This ensures that resources are available when needed and that potential bottlenecks are addressed.

- **Precedence Relationships:**

Understanding the dependencies between tasks is crucial. Some tasks can only start after others are completed, while some can occur simultaneously. Identifying and managing these relationships is essential for a smooth construction process.

- **Duration Estimation:**

Accurate estimation of the time required to complete each task is vital for constructing a realistic schedule. Project managers use historical data, expert judgment, and industry norms to estimate durations.

- **Float (slack):**

Float represents the flexibility within the schedule, indicating how much a task can be delayed without affecting the overall project timeline. Tasks on the critical path typically have zero float, while non-critical tasks may have some flexibility.

- **Schedule Monitoring and Updates:**

Construction schedules are dynamic documents that need regular monitoring and updates. Project managers track progress, identify deviations from the plan, and make adjustments as necessary. Regular communication with the project team is essential for addressing challenges and maintaining schedule integrity.

- **Software Tools:**

Construction scheduling is often facilitated by specialized software tools that help in creating, updating, and visualizing schedules. Common tools include Microsoft Project, Primavera P6, and other project management software.

1.4 Traditional Scheduling

Traditional scheduling of a project refers to the conventional methods and techniques used to plan, organize, and manage the tasks, resources, and timeline of a project. [6]

This approach is often characterized by its structured and sequential nature, where each phase of the project must be completed before the next one begins.

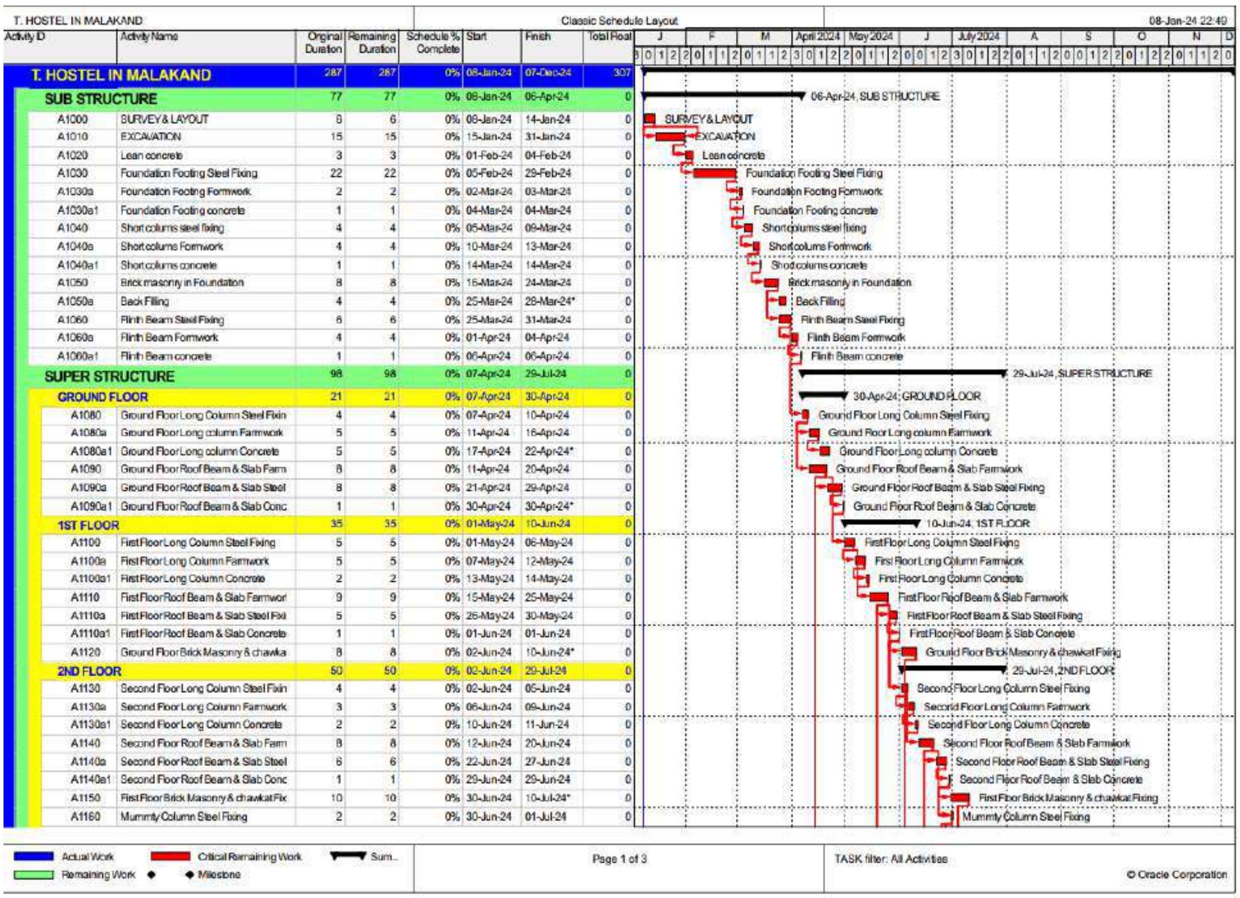
The traditional method (CPM) constitutes the prevailing technique for planning and scheduling of construction projects, since it was introduced in the late 1950s. CPM has confirmed to be a completely effective approach for planning, scheduling and controlling projects, in particular for complicated and non-repetitive work. CPM-primarily based totally schedules which can be graphically represented via way of means of Gantt charts, the conventional graphical illustration of schedules that became delivered via way of means of Gantt and Taylor within side the early 1900, can also additionally end result in Discontinuous useful resource utilization that during flip will cause interruptions within side the manufacturing in which every change suffers from recurrent begins off evolved and forestalls all through the challenge process. [6] [7]

"The scheduling for our Thalassemia Hostel project in Malakand will be conducted using traditional scheduling methodologies, utilizing Primavera P6 as the project management tool."

"We have chosen to employ traditional scheduling methodologies for the planning and execution of our Thalassemia Hostel project in Malakand. This approach involves breaking down the project into well-defined tasks using a Work Breakdown Structure (WBS) and determining the dependencies among these tasks. By utilizing traditional scheduling principles, we aim to create a comprehensive project plan that considers the sequence of activities, task durations, and resource allocations.

In this process, we will be leveraging the capabilities of Primavera P6, a robust project management software tool. Primavera P6 employs the Critical Path Method (CPM) to establish a logical and efficient sequence of tasks, ensuring that the project schedule is realistic and achievable. The software also facilitates resource management, allowing us to allocate personnel, equipment, and materials effectively.

Moreover, the traditional scheduling approach with Primavera P6 will enable us to identify the critical path of the project – the sequence of tasks that determines the overall project duration. This insight will help us prioritize activities and manage potential risks more effectively.



T. HOSTEL IN MALAKAND — Classic Schedule Layout — 08-Jan-24 22:49

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
T. HOSTEL IN MALAKAND		287	287	0%	08-Jan-24	07-Dec-24	307
SUB STRUCTURE		77	77	0%	08-Jan-24	06-Apr-24	0
A1000	SURVEY & LAYOUT	6	6	0%	08-Jan-24	14-Jan-24	0
A1010	EXCAVATION	15	15	0%	15-Jan-24	31-Jan-24	0
A1020	Lean concrete	3	3	0%	01-Feb-24	04-Feb-24	0
A1030	Foundation Footing Steel Fixing	22	22	0%	05-Feb-24	29-Feb-24	0
A1030a	Foundation Footing Formwork	2	2	0%	02-Mar-24	03-Mar-24	0
A1030a1	Foundation Footing concrete	1	1	0%	04-Mar-24	04-Mar-24	0
A1040	Short colums steel fixing	4	4	0%	05-Mar-24	09-Mar-24	0
A1040a	Short colums Formwork	4	4	0%	10-Mar-24	13-Mar-24	0
A1040a1	Short colums concrete	1	1	0%	14-Mar-24	14-Mar-24	0
A1050	Brick masonry in Foundation	8	8	0%	16-Mar-24	24-Mar-24	0
A1050a	Back Filling	4	4	0%	25-Mar-24	28-Mar-24*	0
A1060	Plinth Beam Steel Fixing	6	6	0%	25-Mar-24	31-Mar-24	0
A1060a	Plinth Beam Formwork	4	4	0%	01-Apr-24	04-Apr-24	0
A1060a1	Plinth Beam concrete	1	1	0%	06-Apr-24	06-Apr-24	0
SUPER STRUCTURE		98	98	0%	07-Apr-24	29-Jul-24	0
GROUND FLOOR		21	21	0%	07-Apr-24	30-Apr-24	0
A1080	Ground Floor Long Column Steel Fixin	4	4	0%	07-Apr-24	10-Apr-24	0
A1080a	Ground Floor Long column Farmwork	5	5	0%	11-Apr-24	16-Apr-24	0
A1080a1	Ground Floor Long column Concrete	5	5	0%	17-Apr-24	22-Apr-24*	0
A1090	Ground Floor Roof Beam & Slab Farm	8	8	0%	11-Apr-24	20-Apr-24	0
A1090a	Ground Floor Roof Beam & Slab Steel	8	8	0%	21-Apr-24	29-Apr-24	0
A1090a1	Ground Floor Roof Beam & Slab Conc	1	1	0%	30-Apr-24	30-Apr-24*	0
1ST FLOOR		35	35	0%	01-May-24	10-Jun-24	0
A1100	First Floor Long Column Steel Fixing	5	5	0%	01-May-24	06-May-24	0
A1100a	First Floor Long Column Farmwork	5	5	0%	07-May-24	12-May-24	0
A1100a1	First Floor Long Column Concrete	2	2	0%	13-May-24	14-May-24	0
A1110	First Floor Roof Beam & Slab Farmwor	9	9	0%	15-May-24	25-May-24	0
A1110a	First Floor Roof Beam & Slab Steel Fixi	5	5	0%	26-May-24	30-May-24	0
A1110a1	First Floor Roof Beam & Slab Concrete	1	1	0%	01-Jun-24	01-Jun-24	0
A1120	Ground Floor Brick Masonry & chawka	8	8	0%	02-Jun-24	10-Jun-24*	0
2ND FLOOR		50	50	0%	02-Jun-24	29-Jul-24	0
A1130	Second Floor Long Column Steel Fixin	4	4	0%	02-Jun-24	05-Jun-24	0
A1130a	Second Floor Long Column Farmwork	3	3	0%	06-Jun-24	09-Jun-24	0
A1130a1	Second Floor Long Column Concrete	2	2	0%	10-Jun-24	11-Jun-24	0
A1140	Second Floor Roof Beam & Slab Farm	8	8	0%	12-Jun-24	20-Jun-24	0
A1140a	Second Floor Roof Beam & Slab Steel	6	6	0%	22-Jun-24	27-Jun-24	0
A1140a1	Second Floor Roof Beam & Slab Conc	1	1	0%	29-Jun-24	29-Jun-24	0
A1150	First Floor Brick Masonry & chawkat Fix	10	10	0%	30-Jun-24	10-Jul-24*	0
A1160	Mummy Column Steel Fixing	2	2	0%	30-Jun-24	01-Jul-24	0

Actual Work · Critical Remaining Work · Sum... · Remaining Work · Milestone — Page 1 of 3 — TASK filter: All Activities — © Oracle Corporation

Figure 1 Traditional Scheduling of Thalassemia Hostel Malakand

1.5 Definition of BIM

It is vital to have thorough knowledge and understanding of the definitions of a Building Information Model and Building Information Modelling, in order to apply the same in the construction industry. According to Kymmel (2008), using software and hardware related to computer application in order to identify a virtual representation of a building in a manner which promotes identification of physical traits of the mission is the idea of a Building Information Model. [8] This model conveys all of the records that's contained or connected to the additives of the version. Such a version offers statistics of any or all of the subsequent features including 2D image, 3D image, and time scheduling using 4D, cost information identity associated with 5D or nD associated with different components like sustainability, energy, and management of available facilities. [8] [9]

1.5.1 Use of Bim in Construction Management

Building Information Modeling (BIM) is a virtual illustration of the bodily and useful traits of a constructing or infrastructure. It is a powerful tool that has transformed the construction industry and plays a significant role in construction management. Here's how BIM is utilized in construction management: [10] [9]

- **Design and Visualization:**

  BIM allows architects and designers to create detailed 3D models of the project, providing a visual representation of the entire structure. This aids in better communication and understanding among stakeholders.

- **Collaboration and Coordination:**

  BIM facilitates collaboration among different disciplines involved in a construction project, including architects, engineers, contractors, and subcontractors. It helps in coordinating the various aspects of design and construction, reducing conflicts and errors.

- **Clash Detection:**

BIM software includes clash detection capabilities, which identify potential conflicts or clashes between different building elements before construction begins. This facilitates in averting steeply-priced remodel and delays at some point of the development phase.

- **Quantities and Cost Estimation:**

  BIM models contain detailed information about the quantities and specifications of materials. Construction managers can use this data for accurate cost estimation, helping in budget planning and control.

- **Construction Scheduling:**

  BIM can be integrated with construction scheduling tools to create 4D simulations. This allows project managers to visualize the construction sequence over time, helping in better scheduling and resource allocation.

- **Facility Management:**

  Beyond construction, BIM is valuable for facility management during the building's lifecycle. The information embedded in the BIM model, including maintenance schedules and equipment specifications, aids in efficient facility management.

- **Data Management and Documentation:**

  BIM serves as a centralized repository for project information. This helps in effective data management, ensuring that all stakeholders have access to the latest and most accurate information. It also simplifies documentation processes.

- **Regulatory Compliance:**

  BIM models can be used to ensure compliance with building codes and regulations. The software can perform checks against local building standards, helping construction managers ensure that the project meets all necessary requirements.

- **Risk Analysis:**

  BIM supports risk analysis by providing a comprehensive understanding of the project. This includes identifying potential issues, analyzing their impact, and implementing mitigation strategies.

- **Visualization for Stakeholders:**

  BIM fashions may be used to create practical visualizations and walkthroughs. This is beneficial for presenting the project to clients, investors, and other stakeholders, helping them understand the design and construction processes.

- **Sustainability Analysis:**

  BIM can be used to assess the environmental impact of the construction project. This includes analyzing energy consumption, material efficiency, and other factors contributing to sustainable construction practices.

1.5.2 4D Scheduling

4D scheduling (BIM-based scheduling), also referred to as 4D-modeling or 4D CAD, in which the time schedule is linked to and visually presented by a 3D-model, is however widely recognized in research studies and literature. [9] [11]4D scheduling, also known as 4D construction simulation or 4D modeling, is an extension of traditional project scheduling (typically using Critical Path Method - CPM) that incorporates the element of time into the 3D Building Information Modeling (BIM) environment. The fourth dimension, time, is added to the spatial dimensions (length, width, and height) in a 3D model. [11] This provides a comprehensive visualization of the construction project's progression over time. Here's a breakdown of the key components and benefits of 4D scheduling:

- **Integration of Schedule and 3D Model:**
  4D scheduling integrates the project schedule directly with the 3D model of the construction project. Each element in the 3D model is linked to its respective task or activity in the construction schedule.

- **Visualization of Construction Sequences:**

  With 4D scheduling, project managers and stakeholders can visualize the construction sequences in a dynamic and animated format. This visual representation helps in understanding the planned construction activities over time. [12]

- **Construction Simulation:**

  The 4D model allows for the creation of construction simulations or animations that show how the project evolves over time. This can include the installation of different components, movement of construction equipment, and other construction-related activities.

- **Clash Detection and Conflict Resolution:**

  Clash detection, a feature commonly found in 3D BIM, can be extended to 4D. This means that the software can identify clashes not only in the physical space but also in the construction schedule. It helps in preventing scheduling conflicts and optimizing construction sequences.

- **Improved Communication and Stakeholder Engagement:**

  4D scheduling provides a more intuitive and communicative way to present the construction schedule to various stakeholders, including clients, contractors, and project teams. The visual representation enhances communication and understanding.

- **Enhanced Decision-Making:**

  By visualizing the construction process in 4D, project managers can make more informed decisions regarding sequencing, resource allocation, and potential issues that may arise during construction. It lets in for proactive making plans and problem-solving.

- **Time-cost analysis:**

  4D scheduling enables the analysis of the time and cost implications of different construction scenarios. Project managers can assess the impact of changes to the schedule on the overall project timeline and budget.

- **Improved Project Control:**

  The dynamic nature of the 4D model facilitates better project control. Project managers can track the progress of construction activities in real-time, identify delays, and implement corrective actions to keep the project on schedule.

- **Quantification and Resource Planning:**

  4D scheduling can assist in quantifying materials and resources required at different stages of the construction process. This aids in more accurate resource planning and procurement.

- **Client Engagement and Marketing:**

  The visual appeal of 4D models is valuable for client engagement and marketing purposes. Clients can better understand the construction process, visualize the project's evolution, and provide feedback based on realistic simulations.

"The scheduling for our Thalassemia Hostel project in Malakand will be executed using advanced 4D scheduling methodologies, leveraging state-of-the-art software. This innovative approach integrates the traditional project schedule with a three-dimensional (3D) Building Information Model (BIM) and introduces the fourth dimension, time, to create a dynamic and animated representation of the construction process. To facilitate this, we will be employing specialized software designed for 4D scheduling. This software seamlessly integrates the project schedule with the 3D model, enabling us to visualize and simulate the construction sequences over time. This sophisticated tool provides a comprehensive view of the project's evolution, aiding in better understanding, communication, and decision-making. The utilization of 4D scheduling software aligns with our commitment to employing cutting-edge technologies to ensure the successful and efficient completion of the Thalassemia Hostel project in Malakand. This approach not only enhances project visualization but also contributes to proactive planning, resource optimization, and improved decision-making throughout the construction lifecycle.

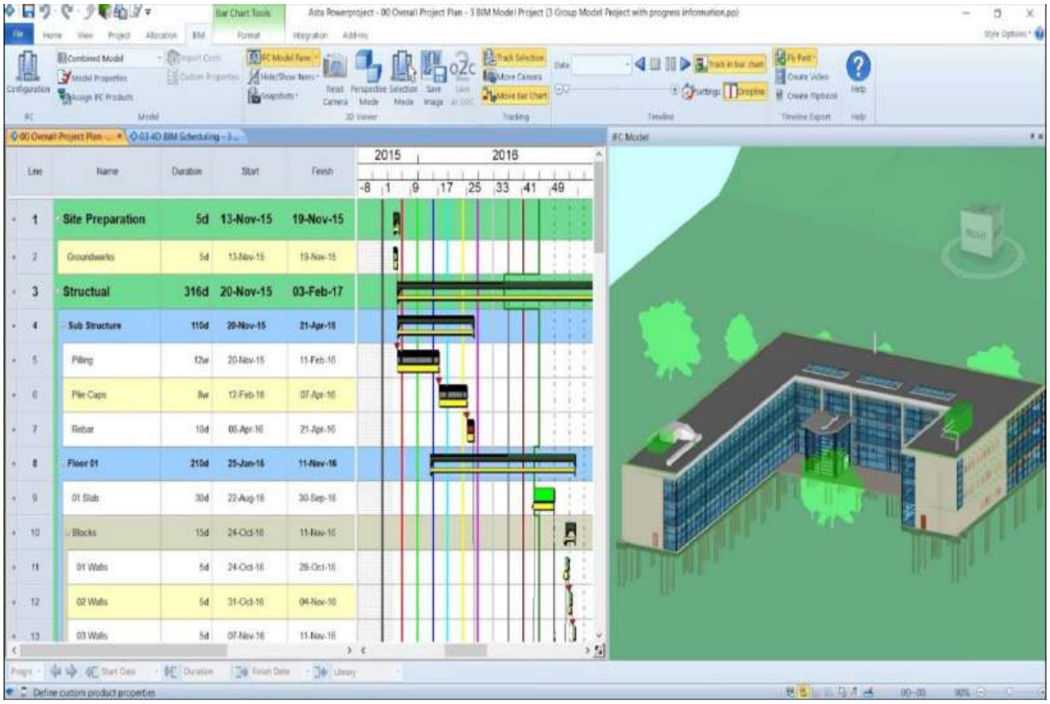


Figure 2 scheduling of Project

1.6 Problem Statement

The construction industry plays a pivotal role in the global economy, with projects ranging from residential buildings to complex infrastructure developments.

Effective project scheduling is crucial for ensuring timely project completion, efficient resource allocation, and cost-effective execution. A lot of issues addresses in management while completing a project especially in scheduling of project.

Traditional scheduling methods have long been the industry standard, focusing primarily on temporal aspects, while 4D scheduling methods integrate the temporal and spatial dimensions, offering the potential for enhanced project management.

Therefore, there is a pressing need for a comprehensive comparative analysis of traditional and 4D scheduling in construction projects to determine their impact on project performance.

1.7 Objectives

- To identify the issues that hinders the adoption of scheduling in construction industry of Pakistan.
- To addresses the issues in construction scheduling through the comparison of the Traditional and 4d scheduling.

1.8 Thesis Organization

- **Chapter 1 (Introduction)**

The introduction section provides an overview of the project, setting the context for the study. It introduces the importance of effective landfill liners and the potential of local bentonite as a solution. The introduction highlights the need for the research, outlines the structure of the thesis, and presents the research questions or hypotheses.

- **Chapter 2 (Literature Review)**

In the literature review, the existing body of knowledge and research related to landfill liners, bentonite properties, and commercialization strategies are reviewed. This segment affords a complete review of relevant theories, studies, and findings from previous research.

- **Chapter 3 (Methodology)**

The methodology section provides a detailed explanation of the research methods used to collect and analyze data. The methodology section ensures the study can be replicated by listing the steps we took to achieve our conclusion.

- **Chapter 4 (Results and Discussion)**

  This section presents the findings obtained from the research and provides a comprehensive analysis and interpretation of the results. It includes tables, graphs, and figures to support the findings. The results are discussed considering the research objectives and previous literature.

- **Chapter 5 (Commercialization)**

  The commercialization section focuses on the business aspects of the project. It discusses the market potential, target customers, competitive landscape, and potential barriers or challenges for commercializing the locally converted bentonite liner. Reasons for pricing, distribution, and marketing are considered.

- **Chapter 6 (Conclusions and Future Recommendations)**

  The conclusions section summarizes the key findings of the study, highlighting their significance and implications. Future recommendations are provided, suggesting areas for further research, potential improvements in methodology, and practical actions to enhance the commercialization and implementation of the locally converted bentonite liner.

Chapter 2

Literature Review

2.1 Planning and Scheduling

Planning and scheduling are crucial components of project management, playing a pivotal role in ensuring that projects are completed successfully, on time, and within budget. [13]

Planning is the process of defining the project's goals, objectives, tasks, and resources needed to achieve those goals. It involves creating a roadmap that outlines how the project will proceed from initiation to completion.

Scheduling is the process of determining the sequence and timing of tasks and activities within the project. It involves creating a timeline that outlines when each task should start and finish meeting the project's overall goals. [13]

2.2 Construction Scheduling

Construction scheduling is a critical aspect of project management, directly influencing the success and efficiency of construction projects. Over the years, traditional scheduling methodologies have been the norm in the construction industry. However, with the advent of advanced technologies, the integration of the fourth dimension (4D) into scheduling has gained prominence. [13] [5] This literature review aims to explore the comparative analysis of traditional and 4D scheduling, shedding light on their respective advantages, challenges, and applicability, with a specific focus on issues pertinent to construction scheduling in Pakistan.

2.2.1 Why schedule project

Scheduling a project is a crucial aspect of project management, and it serves several important purposes. [13] Here are some key reasons why scheduling is essential for successful project execution:

- **Time Management:**

  Scheduling helps allocate time efficiently to different tasks and activities within the project. It ensures that each component is given the appropriate amount of time for completion, preventing delays and optimizing project timelines.

- **Resource Allocation:**

  By creating a schedule, project managers can allocate resources effectively. This consists of human resources, equipment, materials, and finances. It helps in avoiding over allocation or underutilization of resources, contributing to cost-effectiveness.

- **Task Sequencing:**

  Scheduling establishes the sequence in which tasks need to be performed. It defines the logical order of activities, ensuring that dependencies are considered and tasks are executed in a coherent and efficient manner.

- **Critical Path Identification:**

  The schedule helps identify the critical path in a project, which is the sequence of tasks that determines the project's overall duration. Knowing the critical path is crucial for focusing efforts on tasks that have the most significant impact on project completion.

- **Risk Management:**

  Scheduling allows project managers to anticipate potential risks and uncertainties related to time constraints. By identifying critical tasks and potential delays, proactive risk management strategies can be implemented to mitigate the impact on the project timeline.

- **Coordination and Communication:**

  A well-defined schedule enhances communication and coordination among project team members. Everyone involved understands the sequence of activities and their timelines, promoting a collaborative and organized work environment.

- **Client and Stakeholder Expectations:**

  Scheduling helps manage and meet client and stakeholder expectations regarding project delivery. Having a clear timeline enables transparent communication about project milestones, progress, and potential delays.

- **Efficient Use of Resources:**

  Efficient scheduling ensures that resources are utilized optimally. This includes minimizing downtime, avoiding bottlenecks, and ensuring that resources are available when needed, contributing to overall project efficiency.

- **Monitoring and Control:**

  A schedule serves as a baseline against which actual progress can be compared. Regular monitoring of the project's actual progress against the schedule allows project managers to identify variances, address issues promptly, and maintain control over the project.

- **Project Success Criteria:**

  Scheduling establishes measurable criteria for project success. Meeting deadlines, achieving milestones, and adhering to the planned timeline are critical factors in determining the overall success of a project.

2.3 Traditional Construction Scheduling

Traditional construction scheduling, often based on the Critical Path Method (CPM) or Program Evaluation and Review Technique (PERT), has long been the standard in the industry. [7] [6] This approach focuses on sequencing activities, determining their dependencies, and establishing a critical path for project completion. The literature suggests that traditional scheduling provides a solid foundation for project planning, enabling project managers to allocate resources efficiently and manage construction timelines effectively. [14]

However, criticisms have been raised regarding the limitations of traditional scheduling, particularly in capturing the dynamic and time-dependent nature of construction projects. The linear representation may not adequately address the complexities and uncertainties inherent in construction processes, leading to challenges in adapting to changes and unforeseen events. [7]

2.3.1 Critical Path Method (CPM)

Critical Path Method is referred to as CPM in construction management. This kind of project management aids in the planning, scheduling, and administration of challenging projects. The construction industry uses CPM extensively to identify the most important tasks that affect the total project length. [7] An outline of the construction management Critical Path Method is provided below:

- **Definition of an Activity:**

  Organizing the project into discrete activities or tasks is the first stage in the CPM process. Every activity needs to have a start and end time that is specified.

- **Sequencing of Activities:**

  It is essential to establish the logical connections between the various activities. Dependencies arise when certain tasks can only begin after others are finished. The sequence in which tasks need to be completed is determined by activity sequencing.

- **Estimating Time:**

  For each activity, an estimate of the time required for completion is determined. This can be based on historical data, expert judgment, or other estimation techniques.

- **Critical Path Calculation:**

  The critical path is the longest sequence of dependent activities that determines the minimum time needed for project completion. Activities at the essential course have zero glide or slack, which means any put-off in those sports without delay affects the general challenge timeline.

- **Float or Slack Analysis:**

  Float or slack refers to the flexibility in the start and finish times of non-critical path activities without affecting the project's completion date. Activities with float can be delayed without impacting the project's overall schedule.

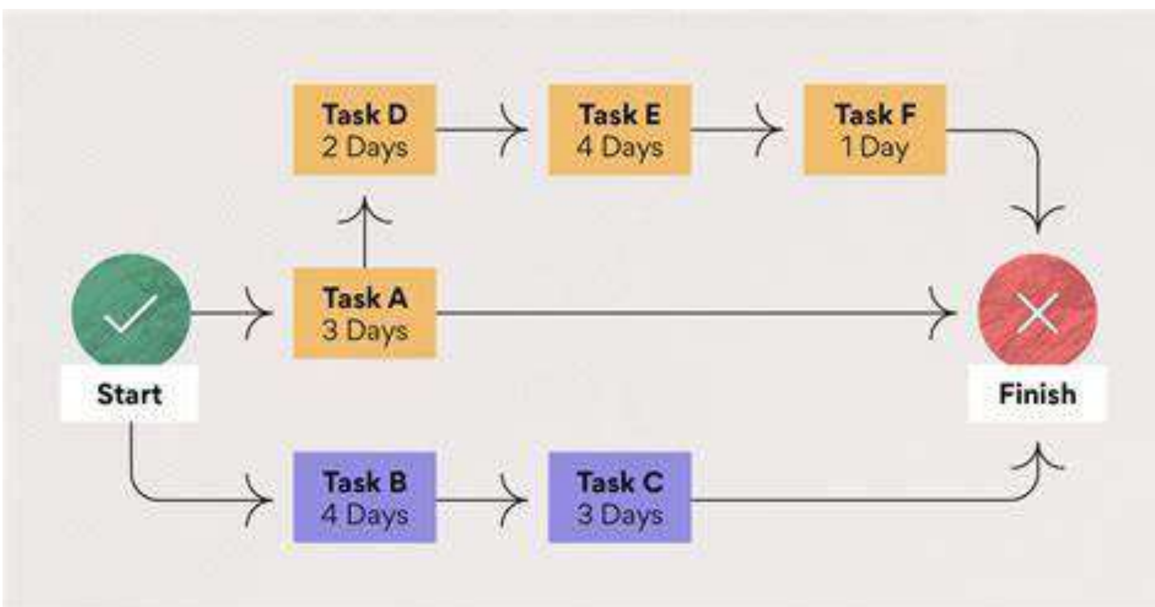


Figure 3 Flow chart of Critical Path Method

2.3.2 Gantt Charts

A Gantt chart is a visible illustration of an assignment time table that illustrates begin and end dates of numerous factors in a project. [13] [7] It provides a graphical depiction of a project's timeline, showing tasks, their durations, and the dependencies between them. Named after its creator, Henry L. Gantt, this chart is widely used in project management for planning and scheduling purposes. The Gantt chart is particularly effective in conveying complex project schedules in a simple and easy-to-understand format.

While not exclusive to CPM, Gantt charts are often used in conjunction with CPM to provide a visual representation of project activities over time. Gantt charts help project managers communicate the project schedule to stakeholders.

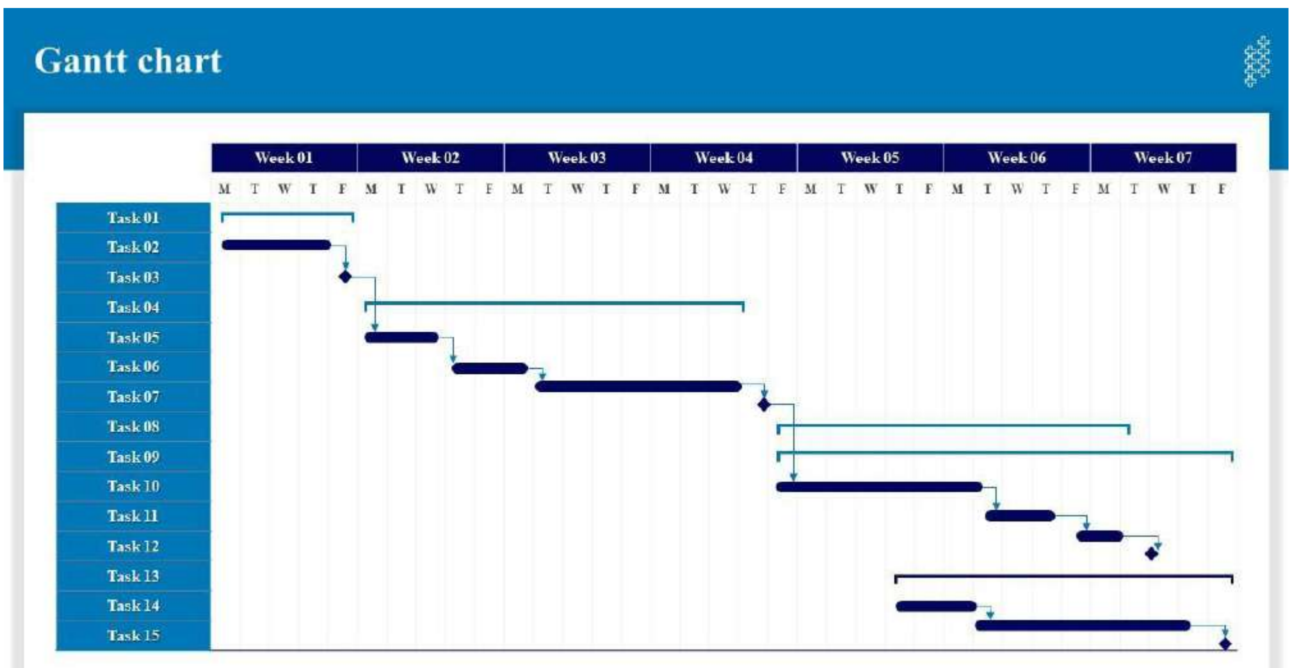


Figure 4 Gantt Charts

2.4 4D Construction Scheduling

The integration of the fourth dimension, time, into 3D Building Information Modeling (BIM) has given rise to 4D scheduling. [9] [8] This approach offers a dynamic and visual representation of the construction process over time, allowing for enhanced project visualization and management. Studies have shown that 4D scheduling facilitates better communication among project stakeholders, improves clash detection, and enables more accurate resource allocation. [15]

While the benefits of 4D scheduling are evident, challenges persist. The implementation requires advanced technological infrastructure, skilled personnel, and a significant initial investment. Additionally, concerns have been raised regarding the learning curve associated with 4D modeling and the potential resistance to change within the industry. [10]

2.4.1 Following are 4D Scheduling Software

- **Navisworks**

  Autodesk's Navisworks Manage is an all-inclusive project review tool that combines 4D and 3D project models for simulation and visualization. It combines 3D models into a unified project model from several design disciplines and allows for the sequencing and visualization of projects using time-based animations. It’s make it easier to recognize and address problems between various project aspects by facilitating clash detection.

- **Synchro Pro**

  Synchro PRO is a 4D BIM program made especially for scheduling and visualizing building projects. Sync with well-known scheduling programs like as Microsoft Project and Primavera P6.Facilitates instantaneous cooperation amongst project participants. Provide sophisticated modeling and visualization tools for project sequencing.

2.5 Construction Scheduling Issues in Pakistan

Construction scheduling in Pakistan, like in many other countries, faces various challenges and issues that impact project timelines, efficiency, and overall success. [16]

2.6 Construction Scheduling Issues in Pakistan

- **Regulatory and Permitting Delays**

  Obtaining necessary permits and approvals from regulatory authorities can be a time-consuming process in Pakistan. Delays in the approval of construction plans and permits can significantly impact project timelines.

- **Infrastructure Constraints**

  Inadequate infrastructure, including transportation and logistics, can lead to delays in the delivery of construction materials and equipment. Poor road conditions and limited transportation options may hinder the timely movement of resources to and from construction sites.

- **Land Acquisition and Ownership Issues**

  Land acquisition can be a complex and time-consuming process in Pakistan. Ownership disputes, unclear land titles, and resistance from local communities can lead to delays in initiating construction projects.

- **Funding and Financial Challenges**

  Securing funding for construction projects can be challenging. Financing issues, including delays in project funding approval, fluctuations in interest rates, and economic uncertainties, can impact the availability of financial resources for construction activities.

- **Skilled Labor Shortage**

  There is often a shortage of skilled labor in the construction industry in Pakistan. The lack of qualified and experienced workers can lead to delays and compromises in the quality of construction work.

- **Weather Conditions**

  Extreme weather conditions, such as heavy rainfall or extreme heat, can affect construction schedules. Seasonal variations and unpredictable weather patterns may lead to project delays and disruptions.

- **Political and Security Concerns**

  Political instability and security concerns in certain regions of Pakistan can pose challenges to construction projects. These issues may impact the movement of personnel, materials, and equipment, leading to project delays.

- **Technology Adoption**

  The adoption of advanced construction technologies and project management tools may be slower in some areas of Pakistan. Limited use of Building Information Modeling (BIM), project management software, and other technological solutions can impact project efficiency.

- **Contractual Disputes**

  Disputes and conflicts arising from contractual issues, including changes in project scope, payment delays, and disagreements between stakeholders, can lead to project delays and legal complications.

- **Lack of Project Management Expertise**

  In some cases, there may be a lack of project management expertise and formalized project management processes. This can result in inefficiencies, miscommunications, and difficulties in coordinating and executing construction projects on schedule.

  In Pakistan, construction scheduling faces unique challenges. The literature highlights issues such as inadequate infrastructure, resource constraints, regulatory complexities, and a dynamic socio-economic environment. [16] Traditional scheduling methodologies may struggle to address these challenges effectively, contributing to project delays and cost overruns.

  The need for adopting advanced scheduling techniques, including 4D modeling, is emphasized in the Pakistani construction industry to enhance project efficiency, mitigate risks, and align with global best practices.

Chapter 3

Methodology

3.1 Targeted SDGs

My Final Year Project is designed to contribute towards achieving Sustainable Development Goals 8 and 9. It focuses on promoting inclusive economic growth, full employment, and creating decent work opportunities (SDG 8), as well as building resilient infrastructure, fostering sustainable industrialization, and encouraging innovation (SDG 9).

3.1.1 SDG 8: Decent Work and Economic Growth

SDG 8 aims to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

3.1.2 SDG 9: Industry, Innovation, and Infrastructure

SDG 9 recognizes the crucial role of infrastructure, industrialization, and innovation in fostering economic growth, reducing inequalities, and promoting sustainable development.

3.2 Site Selection

I have selected the Thalassemia special Children Hostel DHQ in Malakand as the subject of my study for the comparative analysis of traditional and 4D scheduling methodologies. This project will allow me to assess and compare the effectiveness of both scheduling approaches in the context of the unique requirements and challenges associated with the construction of the Thalassemia Special Children Hostel in Malakand.

- **Location**

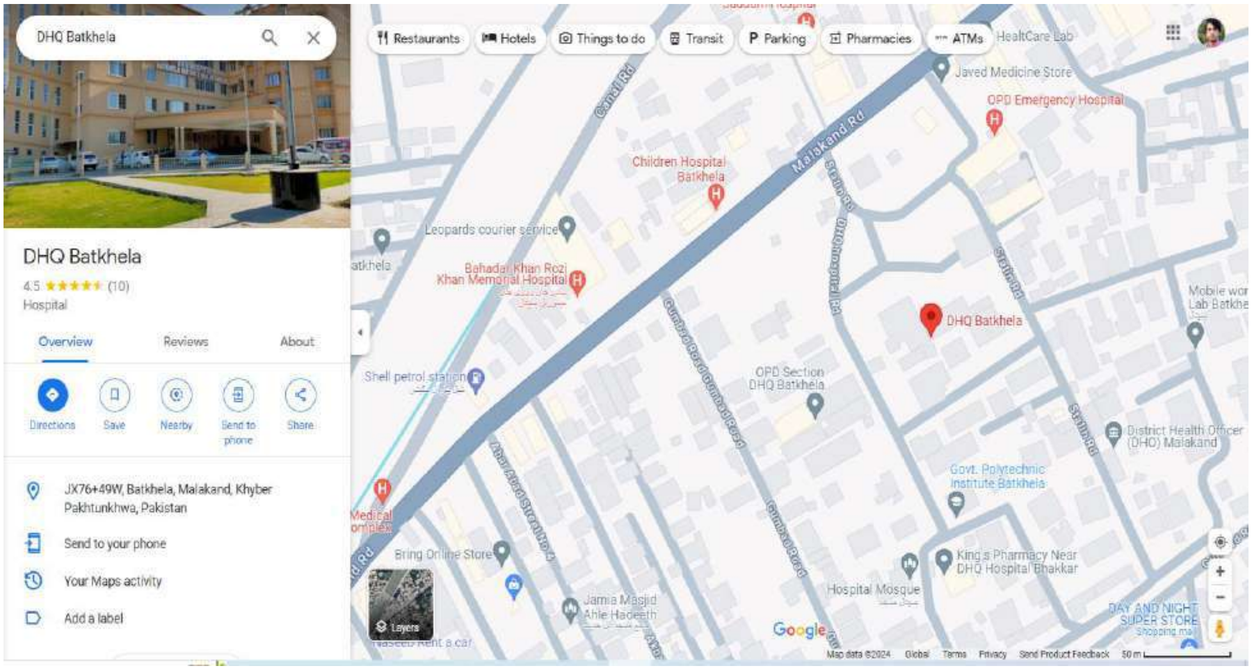


Figure 5 Location of Thalassemia Special Children Hostel DHQ Batkhela

3.3 Primavera Scheduling

Oracle Primavera P6 is one of the key tools in the Primavera suite. It's known for its robust project management capabilities and advanced features and used for the scheduling of project. [17] [18] Steps for using Primavera P6:

- **Project Creation:**

Start by creating a new project in Primavera P6, defining project details such as project name, start date, end date, and project structure.

- **Work Breakdown Structure (WBS):**

  Develop the Work Breakdown Structure, breaking down the project into hierarchical phases, deliverables, and work packages.

- **Activity Definition:**

  Define project activities within each work package, specifying details such as activity name, duration, resources, and relationships with other activities.

- **Resource Allocation:**

  Allocate resources to each activity, ensuring that the necessary personnel, equipment, and materials are available when needed.

- **Dependencies and Relationships:**

  Establish dependencies between activities to define the sequence in which they should be executed. Primavera P6 supports various relationship types, including finish-to-start, start-to-start, finish-to-finish, and start-to-finish.

- **Scheduling:**

  Use Primavera P6's scheduling engine to calculate the project's critical path, which identifies the sequence of activities that determines the project's overall duration.

- **Baseline Creation:**

  Set a baseline to capture the initial project plan. This baseline becomes a reference point for comparing planned versus actual progress.

- **Resource Leveling:**

  Optimize resource usage by resolving over allocation issues and ensuring a more realistic distribution of resources throughout the project.

- **Reporting:**

  Generate various reports and visual representations of the project schedule, including Gantt charts, resource histograms, and progress reports.

- **Monitoring and Updating:**

  Regularly monitor the project's progress, update actual data, and compare it with the baseline. Adjust the schedule as needed to address changes or delays.

  Primavera P6 offers a comprehensive set of tools for project planning, scheduling, and management, making it a powerful choice for handling complex projects with intricate requirements.

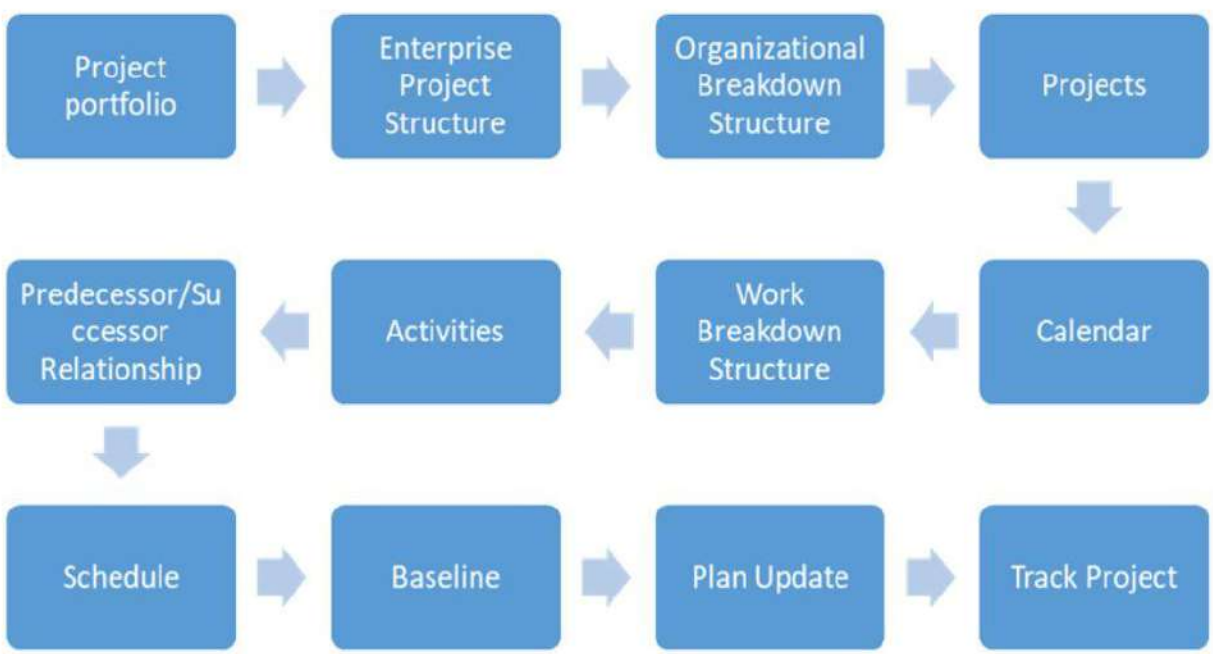


Figure 6 Steps of Primavera

3.4 Autodesk Revit

Autodesk Revit is Building Information Modeling (BIM) software designed for architecture, engineering, and construction. It enables users to create intelligent 3D models, facilitating collaboration, design exploration, and accurate construction documentation. Revit supports parametric design, multidisciplinary collaboration, and provides tools for visualization, analysis, and simulation. [19] It automates construction documentation and offers interoperability with other design tools. The software is widely used for its efficiency in streamlining the entire building lifecycle, from conceptual design to construction and maintenance.

- **BIM Technology:** Facilitates Building Information Modeling, enabling a comprehensive digital representation of a project.
- **Parametric Design:** Uses parameters to control and update elements in the model, ensuring consistency.
- **Multidisciplinary Collaboration:** Supports collaboration among different project disciplines in real-time.
- **Comprehensive Design Tools:** Offers tools for architectural, structural, and MEP design in a 3D environment.
- **Construction Documentation:** Automates the creation of accurate 2D plans, sections, and schedules from the 3D model.
- **Visualization and Rendering**: Allows 3D visualization and realistic rendering for design exploration.
- **Analysis and Simulation:** Provides tools for structural, energy, and lighting analysis to optimize designs.
- **BIM Collaboration Format (BCF):** Supports communication and issue management during the design and construction process.

3.5 Statistical Analysis

Statistical analysis involves using mathematical methods to analyze, interpret, and draw conclusions from data. It includes techniques like descriptive statistics (summarizing data), inferential statistics (making predictions), exploratory data analysis (visual exploration), and hypothesis testing. The goal is to uncover patterns, relationships, and trends within datasets, enabling informed decision-making in various fields.

3.5.1 Relative Importance Index (RII):

In statistical analysis, particularly in surveys and market research, RII is often used to calculate the relative importance of different factors. It is a method to assess the significance of variables within a set by assigning weights based on respondents' ratings or preferences.

3.5.2 Normality and Reliability

Normality refers to the distribution pattern of data points in a dataset. A normal distribution, also known as a Gaussian distribution or bell curve, is characterized by a symmetrical shape with the majority of data points clustered around the mean, forming a bell-shaped curve.

Reliability in the context of data refers to the consistency or dependability of measurements. It assesses the extent to which a measurement or test produces consistent results over multiple administrations.

3.5.3 Shapiro-Wilk Test

The Shapiro-Wilk test is a speculation test that is applied to a sample with an invalid theory that the sample has been created from an ordinary circulation. If the p-value is low, we can reject such an invalid hypothesis and say that the model has not been created from an ordinary distribution. It's a simple to-utilize statistical tool that can assist us with finding a response to the normality check we really want, however it has one imperfection. It doesn't function admirably with huge informational indexes. The greatest permitted size for an informational index relies upon the execution, yet in Python, we see that a sample size bigger than 5,000 will give us an estimated computation for the p-value.

Shapiro Wilk Test Formula

$$W = \frac{(\sum_{i=1}^{n} aiyi)^2}{(\sum_{i=1}^{n}(yi-\overline{y})^2} \quad \textbf{(1)}$$

3.5.4 Wilcoxon Test

The Wilcoxon test (Wilcoxon marked rank test) tests whether the mean values of two dependent groups vary fundamentally from one another. The Wilcoxon test is a non-parametric test and is consequently dependent upon extensively less presumptions than its parametric partner, the t-test for subordinate examples. [20] Subsequently, when the limit conditions for the t-test for subordinate examples are not generally satisfied, the Wilcoxon test is utilized.

Wilcoxon Test Formula

$$W = \sum_{i=1}^{Nr}(\text{sgn}\ (\text{x2}, \text{i} - \text{x1}, \text{i})\ .\, \text{Ri}) \quad \textbf{(2)}$$

3.5.5 T-Tests & Z-Tests

T-Test:

A t-test is a hypothetic test utilized by the researcher to look at populace means for a variable, characterized into two classes relying upon the not as much as interval variable. More precisely, a t-test is utilized to look at how the means taken from two free examples vary. T-test follows t-distribution, which is proper when the sample size is small, and the populace standard deviation isn't known. [21] The state of a t-distribution is profoundly impacted by the degree of freedom. The level of freedom suggests the quantity of free perceptions in a given arrangement of observations.

T-Test Formula

$$\text{T-test} = \frac{\bar{x} - \mu}{s/\sqrt{n}} \tag{3}$$

Z-Test:

Z-test touch on to a univariate statistical examination used to test the speculation that extents from two free samples differs. It decides how much a data point is away from its mean of the informational index, in standard deviation. The researcher takes on z-test, when the populace fluctuation is known, fundamentally, [21] when there is an enormous example size; test difference is considered to be roughly equivalent to the populace change.

Z-Test Formula

$$\text{Z-Test} = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} \tag{4}$$

3.6 Methodology Flow Chart

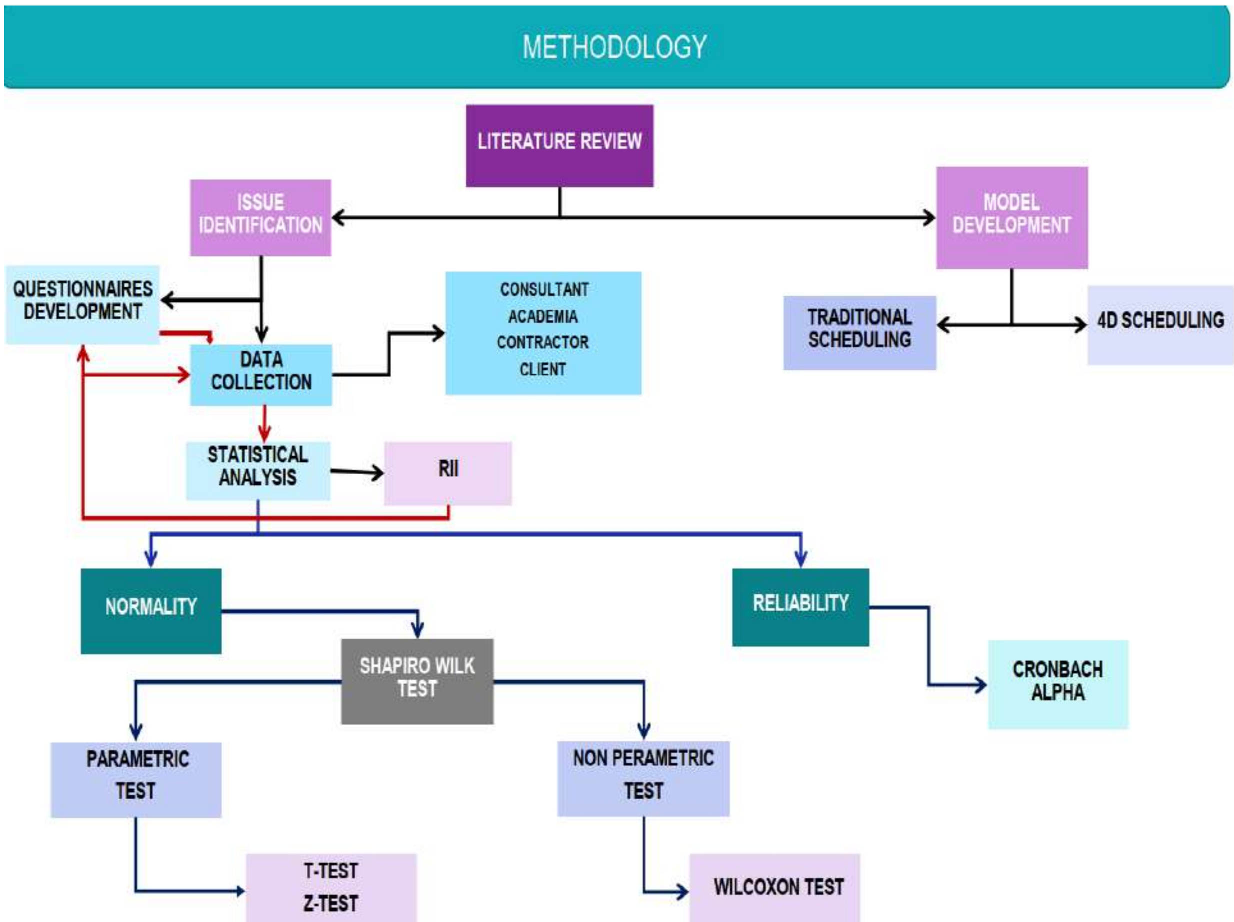


Figure 7 Methodology Flow Chart

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