PROJECT MANAGEMENT CASE STUDY – DEVELOPMENT OF IRON ORE PROCESSING PLANT

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PROJECT MANAGEMENT CASE STUDY – DEVELOPMENT OF IRON ORE PROCESSING PLANT

ABSTRACT

Project management is an adaptive and practical approach to be implemented for any project conducted by any organization despite the industry, size and sector. It's the project manager's responsibility to identify the project problem statement at hand and adapt the appropriate project management approach to guide the project to success. In this dissertation, as a part of the project team, the author aimed to develop the iron ore processing plant using project management approaches within the allocated budget and time. Apart from setting the project planning framework, the project team were tasked to monitor the project changes that occurred throughout the project execution time frame. In this case study, the author investigated the project management framework and methodology applied in the identified project integration management. The project team analyzed and constructed the project charter, management plan, project scope and cost to outline the project schedule required for project initiation. Project controlling were conducted with the aid of project management software to ensure the project was executed efficiently. Engineering design process were implemented during the project change proposed by the engineering team to increase the efficiency of the iron ore processing plant. As a result, it can be concluded that the ongoing project conducted by the project team is on track for success due to the effective project management approaches implemented.

Keywords: Project Management, Project Schedule Management, Project Cost Management, Project Tracking and Monitoring, Engineering Design Change.

KAJIAN KES PENGURUSAN PROJEK – PEMBANGUNAN LOJI PEMPROSESAN BIJI BESI

ABSTRAK

Pengurusan projek adalah pendekatan yang praktikal dan sesuai untuk dilaksanakan bagi projek-projek yang dijalankan oleh organisasi tidak kira industri, saiz dan sektor. Tanggungjawab pengurus projek untuk mengenal pasti penyataan masalah projek dan menyesuaikan pendekatan pengurusan projek yang sesuai untuk membimbing projek terhadap kejayaan. Dalam disertasi ini, penulis merupakan ahli daripada pasukan projek yang berhasrat untuk merancang dan membangunkan kilang pemprosesan bijih besi menggunakan pendekatan pengurusan projek dalam anggaran dan masa yang diperuntukkan. Selain daripada menetapkan rangka kerja perancangan projek, pasukan projek ditugaskan untuk mengesan, memantau dan mengawal perubahan projek yang berlaku sepanjang tempoh masa pelaksanaan projek. Dalam kajian kes ini, penulis menyiasat rangka kerja pengurusan projek dan metodologi yang digunakan dalam pengurusan integrasi projek yang dikenal pasti. Pasukan projek menganalisis dan membina piagam projek, pelan pengurusan, skop projek dan kos untuk menggariskan jadual projek yang diperlukan untuk permulaan projek. Penjejakan dan kawalan projek telah dijalankan dengan bantuan perisian pengurusan projek untuk memastikan projek dilaksanakan dengan cekap. Proses reka bentuk kejuruteraan telah dilaksanakan semasa perubahan projek yang dicadangkan oleh pasukan kejuruteraan untuk meningkatkan kecekapan loji pemprosesan bijih besi. Hasilnya, dapat disimpulkan bahawa projek yang sedang dijalankan oleh pasukan projek berada di landasan kejayaan kerana pendekatan pengurusan projek yang berkesan dilaksanakan.

Keywords: Projek pengurusan, Projek skop pengurusan, Projek jadual pengurusan, Projek penjejakan dan pemantauan, Kejuteraan rekabentuk.

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1.1 Background Study

A project is an important component in an organization, especially a successful business project which would serve as the bread and butter for the company's business. The Project Management Body of Knowledge (PMBOK) has defined the term project as a temporary endeavour undertaken to create a unique product, service, or results (PMBOK, 2017). Paul Roberts (Roberts, 2013) also suggested that the project definition should be in a wider sense to deliver the outcome, including the benefits that justify it from a business standpoint. It is said that a project is a temporary management environment created to deliver a specified outcome according to a defined business justification. From the definition of both sources, the highlighted words are temporary, unique, and outcome. This brings the meaning that every project is distinct of its own and would not be permanent in the organization.

Since the 1990s, organizations around the globe had begun to realize the importance of project management in company task execution and were seeking ways and methods of adaption into their business planning and management. In today's corporate world, project management has progressed into a vital technique to provide solutions for control and utilisation of company resources efficiently and effectively. According to Kerzner, (Kerzner, Project Management, 2009) project management is the planning, organizing, directing and controlling of the organization resources for a relatively short-term objective that has been established to complete specific goals and objectives. In short, a well-executed project with proper management is the key element in achieving the organization's goal or deliverables to successfully solve the corporate problem or challenges. This is because an organization with a continuous stream of successfully managed projects would guarantee a competitive edge in the commercial market regardless of the industry and sector.

In a typical project management involved in engineering sector, engineering changes were bound to occur throughout the project execution whether to simplify the process or modify the project tasks to produce an output with higher efficiency and effectiveness and ultimately achieve the defined project objective. One of the most common engineering changes that may occur in a project execution is the engineering design changes, be it for a product or a system. George (George Dieter, 2013) has mentioned that it is crucial for product or processes to undergo design change to maintain the product or service quality in order to preserve the competitiveness of the organization in the market. Types of design can be classified for an entirely new and innovative design or initiation, an adaption design from existing design concept or redesigning product or service to correct or address specific issue.

In this dissertation, the implementation of project management approaches for the development of an iron ore processing plant is presented by the author. Due to the confidentiality clause and the non-disclosure agreement approved and signed by the management of Company H and the author, the involved parties or organizations are replaced with anonymity. This is applied to the business names, data, values or figures that may unveil the processes, types of equipment, business operation costs and expenses or any other intellectual properties of Company H. For the similar reason, a scale factor is applied to the parameters of deliverables represented in this dissertation.

1.2 Problem Statement

As mentioned in the background study, project management is crucial to the competitiveness of the organization. Project success is characterised by Kerzner (Kerzner, Project Management, 2009) as the completion of tasks or activities within the constraints of time, cost and performance. From the definition, the project manager has to ensure the project was conducted within the allocated time frame, within the planned expenses and achieve a certain performance or standard level throughout the execution to project completion. The project team were also responsible to manage project design changes based on problem-solving methodology to develop quality assured product with cost competitiveness in the shortest time possible. In this dissertation case study, Company H, an iron ore processing plant company from Country M is planning to develop and build a new operation plant in Country L. In the past years, Company H had cooperated with the government of Country L and had developed its first iron ore processing plant in Site-A in Country L. With the increased global demand for iron ore in the steelmaking industry, an extension project had been explored by Company H and the Government L. They intended to develop an iron ore processing plant in a new designated Site-B while transporting some of the equipment and machinery from their plant in Site-A as well. Due to the complexity of the multiphase project, project management approaches were recommended by the project manager to proceed with the planning, execution, monitoring and control of the project to present with a detailed project output. Project changes that occurred during the project execution such as engineering design changes and project event management are to be resolved with systematic engineering methodology to ensure the efficiency and effectiveness of the newly developed iron ore processing plant.

1.3 Objective

The objectives of this dissertation are as follows:

i. To develop the iron ore processing plant using project management approaches within the allocated budget and time.

ii. To monitor the project changes inclusive of the engineering design changes that occurred throughout the project execution time frame.

1.4 Scope

As indicated in the objective section, the scope of this dissertation includes the project management approaches applied for the development of the iron ore processing plant. The approaches mentioned comprise the adequate application of the project management framework into the proposed project. With the generation of the initial project plan on Week 3 of July 2021 to achieve its purpose, project elements are broken down into phases based on the deliverables or milestones in the project execution. In this case study, a total of four phases of development had been divided which contains the initial agreement phase, the preparation and planning phase, the on-site setup phase and the production phase. Adaptation of project scope management was also done to observe and control the variations that occurred in the period of the project. This is conducted to ensure the project timelines are kept on track and any subject of risk or events that may happen can be effectively controlled to prevent delay in project completion. The record of project management progression will be done till Week 1 of January 2022 due to the submission date limitation of this dissertation.

1.5 Overview of Dissertation

The overview of the dissertation is as follows:

Chapter 1: Introduction: The introductory chapter of the dissertation problem statement, background study, objectives, and scope highlight the development of the iron ore processing plant in a project management aspect.

Chapter 2: Literature review: This section contains the critical and comprehensive review of the literature related to the project management approaches, project management case studies carried out by researchers, project management software or tools, related information or events that may affect the development of the iron ore processing plant.

Chapter 3: Methodology: This chapter provides the skeleton framework of project management related methods, procedures, approaches, and tools adapted to achieve the stated objective in chapter 1.

Chapter 4: Results: The methods, approaches and tools stated in chapter 3 are applied and implemented in this section based on the information from the case study problem statement.

Chapter 5: Discussion: This chapter contains the interpretation of the result from chapter 4. The findings and outcome of the result were discussed based on the result.

Chapter 6: Conclusion: The findings and results from chapters 4 and 5 were concluded to provide a summary of the dissertation and verification of the objectives stated in chapter 1. Recommendations and suggestions were given to present the possible improvement based on the case study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter includes the review of existing literature related to project management and the case studies relevant to project management approaches researched by other researchers. The author conducted relevant literature research to gather data and information identify the necessary sources involved in project management and the method of applying. The author has included a recent publication that is highly relevant to the outcome of the case study.

2.2 Guide to Project Management Body of Knowledge (PMBOK)

Before utilising any methods for project management in the case study, the author had primarily looked into the Guide to Project Management Body of Knowledge (PMBOK) which were developed by the Project Management Institute (PMI) (PMI, Inc, 2022). PMI is a not-for-profit organization that provides insight and knowledge of project management towards individuals or organizations. PMBOK comprises the methodology and framework in the relevance of the project management which was significant for the author's project development and execution. It consists of an assortment of practices, processes and approaches which were proven useful to many industries. PMBOK covers ten major areas related to the project management aspect as shown in Figure 2.1.

Figure 2.1: Project Management Knowledge Area (Westland, 2019)

Aside from the guide in PMBOK, it also contained a sub-section known as the standard for project management. This section provides a foundation for project management understanding and the outcome permitted from the application (PMBOK, 2021). The standard applies to any industry, location, the scale of the project to be managed. Similar to the guide, it is divided into five process groups with a total of 47 project management processes involved (Figure 2.2) which can be categories in the aforementioned project management knowledge areas in project definition and development (Figure 2.3). With the implementation of the processes presented, organizations or individuals can regulate the project management format in a form of standardization for ease of administration. A similar procedure could be applied according to data and information flow (Figure 2.4) regardless of the industry and could be grasped instantly and ultimately preventing unwanted mistakes or failure of the project.

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 Manage Project Knowledge	4.5 Monitor and Control Project Work 4.6 Perform Integrated Change Control	4.7 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 Schedule Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Durations 6.5 Develop Schedule		6.6 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 Manage Quality	8.3 Control Quality	
9. Project Resource Management		9.1 Plan Resource Management 9.2 Estimate Activity Resources	9.3 Acquire Resources 9.4 Develop Team 9.5 Manage Team	9.6 Control Resources	
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Monitor 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 Implement Risk Responses	11.7 Monitor Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Engagement	13.3 Manage Stakeholder Engagement	13.4 Monitor Stakeholder Engagement	

Figure 2.2: Project Management Process Group and Knowledge Area Mapping (PMBOK, 2017)

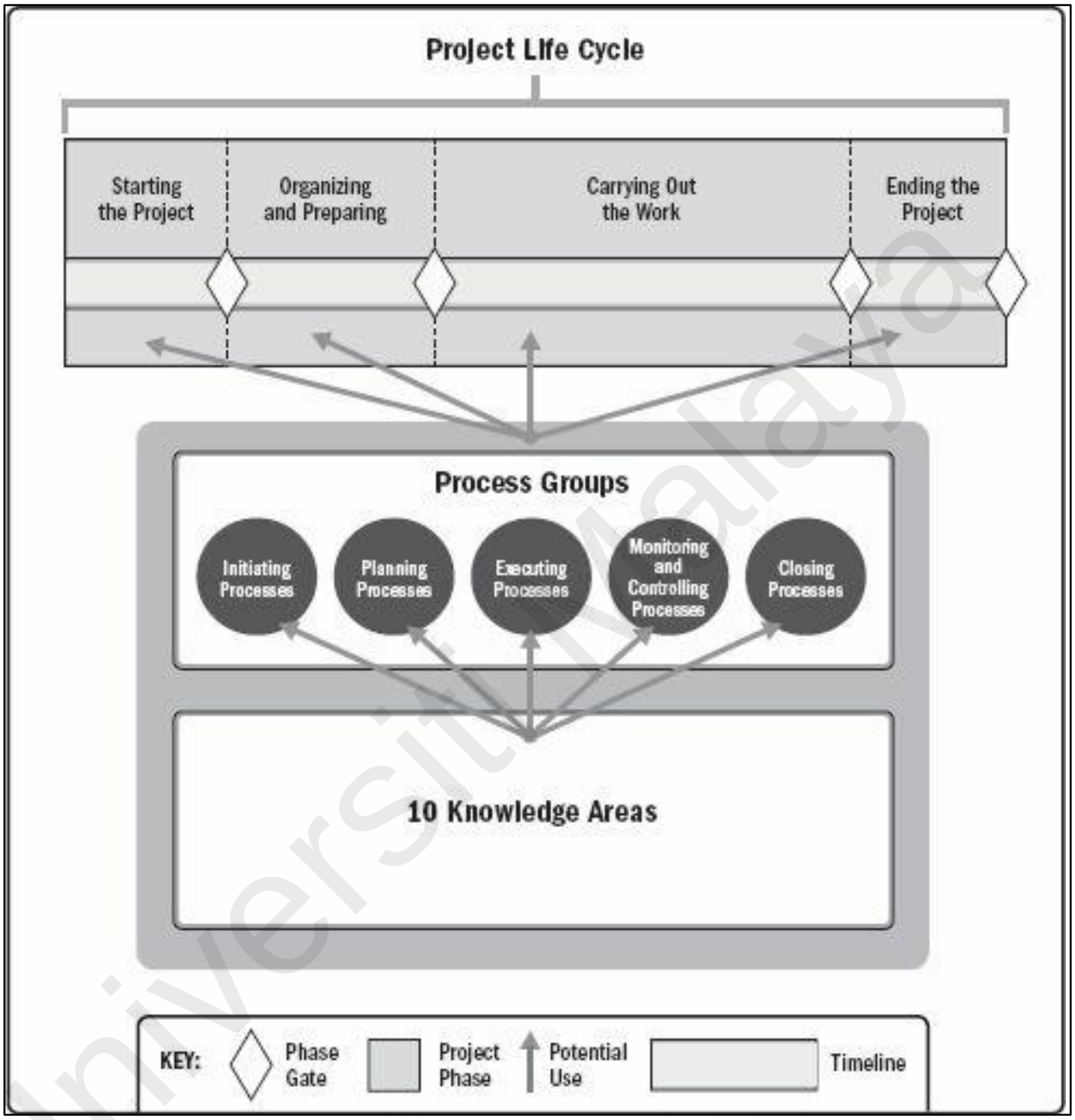


Figure 2.3: Interrelationship of PMBOK Guide Key components in Projects (PMBOK, 2017)

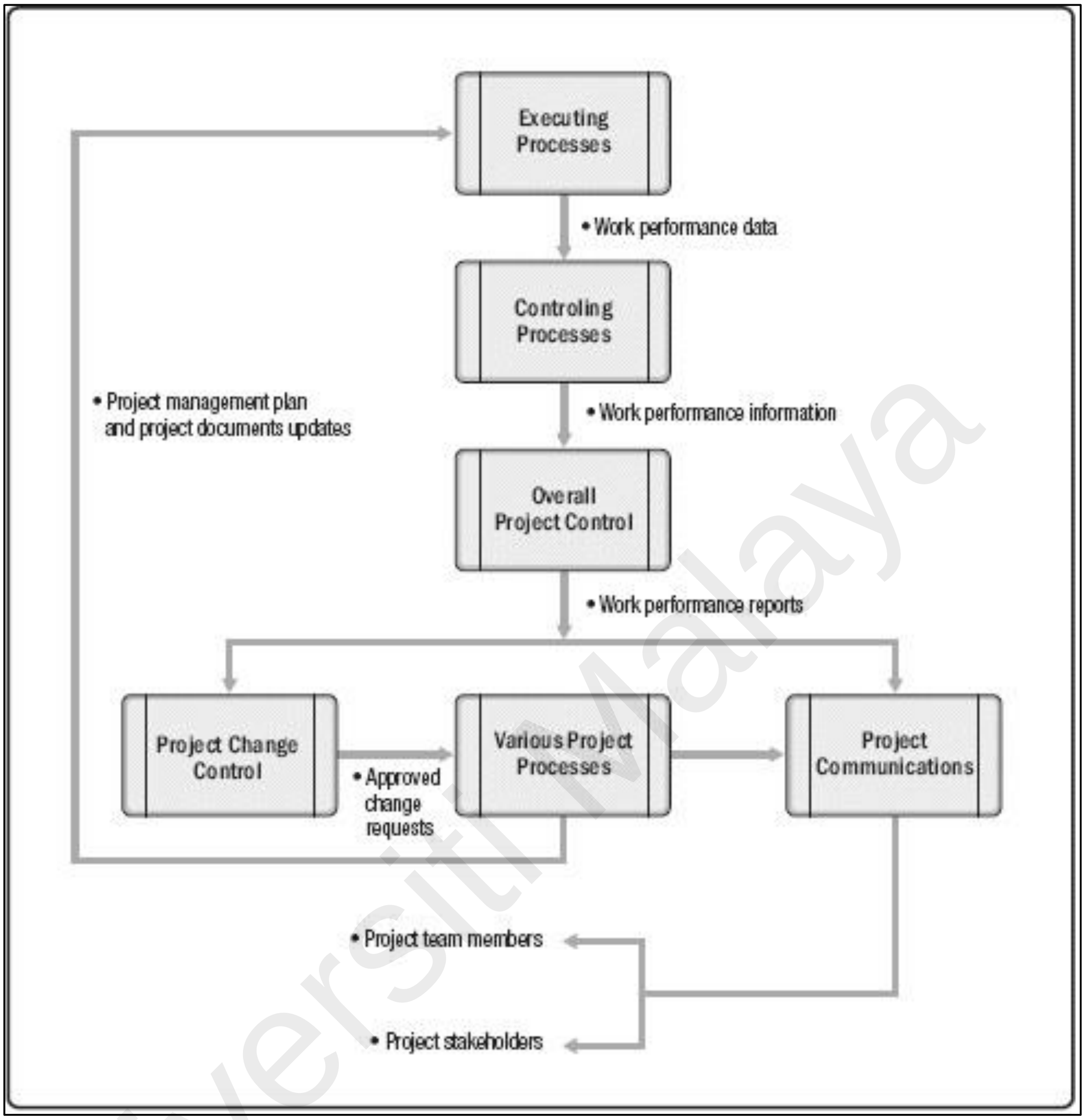


Figure 2.4: Project Data, Information and Report flow (PMBOK, 2017)

2.3 Project Management Case Study

The author has researched and reviewed identical case studies in which the researchers implemented project management approaches or methodology to their projects. Adaptation with multiple aspects of the project management tool is the key aspect the author looked into intending to provide the necessary information required to successfully develop and execute the project in hand. Similar scale and industry of the case studies were studied thoroughly to be compiled for presentation in this section.

2.3.1 An International Railway Project

The author has reviewed an infrastructure development project involving an international railway company (Ahuja & Khanna, 2013). The case study implicated a similar scale to the author's project to be planned. It involved a multi-nation economic development and multiple personnel from various countries were put together to develop the project management case study. The aforementioned project was executed by public sector unit organisations incorporated by two different countries' governments. The project was analysed and progressed with project management knowledge areas and processes. Both parties comprise the client and the respective government were responsible for adopting the project management approach contributing to the project success. The case study was initialised with the objective defined for upgrading the current railway infrastructure of two stations. The scope of work was subsequently defined for detailed planning and designing. Relevant stakeholders of the project were identified including the consultant, contractor and sub-contractors. From the project scope and milestones identified, the project was divided into two main phases. This railway project was originally scheduled for 4 years but eventually revised multiple times during the project execution to be extended with granted permission. The delay was caused by modification and unforeseen events occurring throughout the project time frame. Details of project cost were provided but subjected to review and revision due to the currency fluctuation during project execution. The case study was carried out with effective tracking and monitoring which showed the project is on track to a successful outcome. Despite the multiple project revision that took place, the project team managed to maintain the schedule and resources of the project. Effective project management was achieved from the contribution of extensive planning and well-defined project elements in terms of project management approaches.

2.3.2 Project Management in Telecommunication

Implementation of Project Management Standards in the telecommunication sector was researched by the author in this case study (China Telecom Corporation, Ltd, 2012). The case study challenges were focused on maintaining the project on schedule. There are several problems for the case study, one of them was the signing of the contract which determine the launching of the project were delayed causing an effect on the overall schedule. Project changes and modifications were required to make up for the project delay. Besides that, the company comprises multiple networks covering different channels which require proper coordination during the project execution. The complexity in the project scope and the large size of the project presented a great challenge to the project team in this case study. This poses a communication risk among the project team members as well.

To tackle the problems at hand, the project team has set boundaries defined by project management standards by developing a project management committee that formed a project management organizational structure for timely and effective communication. Discussion on project plans and on time-periodic reports was made to track the project progress. A clear and concise documentation process also aided the progress of the project. The team reviewed the scheduling and budget problem and sounded out to the relevant department in charge before it became out of hand. The team also addressed a potential issue that may affect the scheduling by providing the project visibility at a transparent level. This encouraged the team to focus on the task and inspired them the team leader would be supportive of the decision and action were taken. When approaching the ending phase of the project, the project team initiated a countdown report to further track the project progress and a sense of urgency were created to ensure the project to complete in time.

As a result, the project was completed within the designated timeline. The company also execute the project tasks and activities efficiently and effectively. The case study showed the enforcement of project management standards and the process is capable of controlling the impact of project changes. Due to the project success, the project has provided credibility towards the company being the top industry provider. This benefitted the company in the economic and social aspects.

2.3.3 Project Management in Offshore Construction

The author has researched, and reviewed project management challenges encountered by an offshore construction company. The company (Saudi Aramco, 2021) aimed to increase the production capacity of an existing oil field. The main challenges faced by the project team were the complexity of the project in managing and executing the project while maintaining the current production rate. The existing structure design of the plants, pipelines and cable became the main issue due to its complexity in replacement and maintenance. The project team had to devise innovative planning in risk management to ensure the smoothness of project execution. The logistic project department was required to support the operation and maintenance personnel in moving the transportation safely while the engineering department to connect the existing already complex network of pipelines and cable with newly setup facilities. Communication management became a vital aspect in the project execution to ensure faulty installation or miscommunication were avoided. Due to the high amount of specialized logistics and transportation required, these caused the high cost and affected the project budget. The project team foresaw the cost management issue and devised the countermeasure during the project planning stage. Effective risk management approaches implemented aided the project team in executing the project events. With the project challenges identified, the project team proceeded with the solution in reducing the project difficulty and implementing high degree administrating measures to eliminate risk and enhance communication methods as shown in Figure 2.6. The project team also further simplified the construction of the new subsea pipelines and cables to provide fewer crossings to occur. This highly reduces the risk and cost during the project execution. This case study is currently still ongoing and were expected to be completed in the year 2027. However, from the project management strategy adopted by the project team so far, it had to be deduced that the project is on track towards a successful outcome.

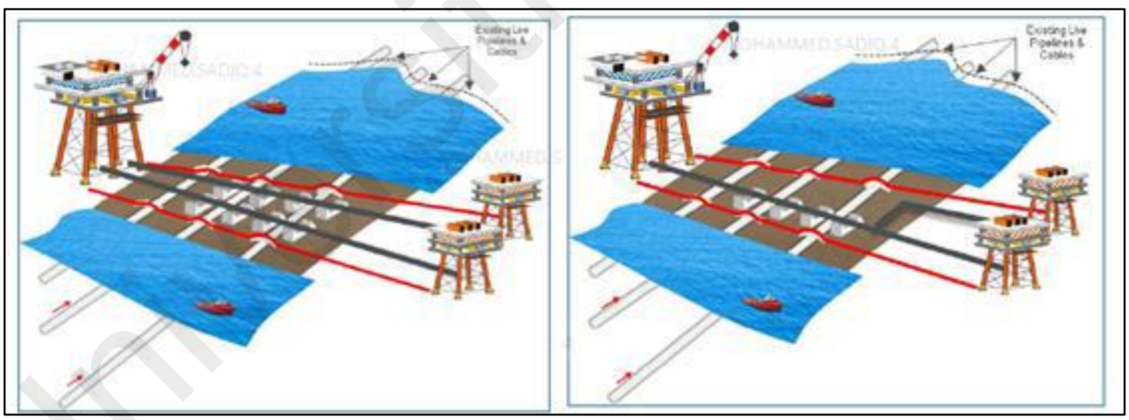


Figure 2.5: Modified subsea arrangement (Saudi Aramco, 2021)

2.3.4 Project Management in Small Engineering Business

The author also researched a case study based on the implementation of a project management approach on a smaller scale engineering business involving cast mining machine designing and manufacturer (Legg, 2011). The case study aimed to apply project management in a rather small scale of operation to ensure the smooth process in designing and manufacturing their equipment. Due to the lack of engineering personnel of project management knowledge, the implementation of project management became the main challenge and the project team had to figure the most efficient and effective project management approach to utilise in this case study. Like any other project management case study, the project manager was elected to develop the initial project plan. The case study also surveyed the engineers and the project team for data collection in contributing to the project management plan development. From the survey results, the exposure and experience of project management of relevant personnel were identified and their role in the subsequent project was determined. Handy tools or software that may aid the implementation of the project were explored by the project team as well. When the overall project management plan was set, the first project management was applied to the project of designing the company equipment. They investigated the project plan and the work breakdown structure to estimate the duration of work required for each identified project task. Then, the department responsible for tracking and monitoring were to input and compare the actual duration of the task required to ensure the project stay on track. A risk management plan was also generated in this case study to highlight and analyse the probability and impact of any events that may occur during the project execution. The case study was concluded that the project management process could be simplified subjected to the size of the project or operation as project management approaches successful improved the time and quality delivered by their project stated in the case study.

2.3.5 Project Case Studies Output

From the project case studies researched and investigated by the author, a guideline is produced to adapt the project management format based on the project case studies in this dissertation. The author has extracted the beneficial project management components from each case studies with modification or expansion and related to the project of iron ore processing plant to be executed with in depth detailing and explanation.

From 2.3.1, the case study on the international railway project, the author has referenced the case study as the benchmark with the project management framework with modification for details. Similarly with the iron ore processing plant development project, the international railway project was categorized as a design and build initiative and the overall project management framework were constructed based on the flow shown in the case study. The outline of the project management elements was adapted by the author as:

- Project Description (Objectives and Scope)
- Project Milestones and Phases
- Project Task and Cost Breakdown
- Project Planning and Scheduling
- Project Tracking and Monitoring

The author adapted the project scheduling with identified milestones based on divided project phases from case study mentioned in 2.3.1 as shown in Figure 2.6

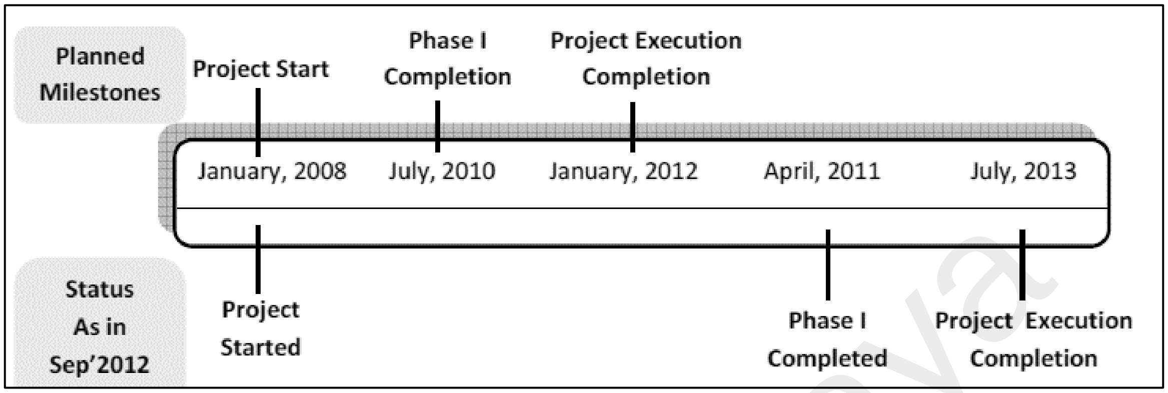


Figure 2.6: Project Milestones dated Sep 2012 (Ahuja & Khanna, 2013)

In addition, the case study also aided the project team in the method applied in documenting the revision conducted during the project execution for the monitoring and tracking process (Figure 2.7). In the international railway project, the revision of each occurred events were recorded merely with sequential numbering from the project initiation with incremental duration. It did not clarify the impact on the project cost and final completion date. The author acknowledged that this would be a vital information required for proper project management monitoring and eventually closing the project in a success in the final phase.

As per the Contract conditions, if it is ascertained that the delay is attributable to the Client, Extension of Time (EOT) becomes applicable. In that scenario, IRCON has to put up its case for EOT with proper documentation, which they are able to do because of detailed records being maintained. At the time of study (March, 2013) Rev. 4 of the Original Baseline was applicable. These revisions were done as follows:

- Rev. 1: Due to the delay by the Client in removing land encroachments, 7 months extension was granted for the project finish date.
- Rev. 2: Due to scope modification by the Client, 2 months extension was granted for Phase I only.
- Rev. 3: Due to flash floods, work on Phase I got delayed and 2 months extension was granted for Phase I only.
- Rev. 4: Due to delay by the Client in providing clear area for work, 11 months extension was granted for remaining work, that was Phase II.

Figure 2.7: Project Revisions in International Railway Project (Ahuja & Khanna, 2013)

From 2.3.2, the case study of project management in telecommunication sector, the author has explored the challenges faced and the solution developed to counteract it by the telecommunication organization team. As mentioned, the team was facing challenge on completing the project within the scheduled time. The author extracted the initiation taken by the telecommunication team. The author has deemed the formation of a separate project management committee feasible in delegating responsibilities and tasks among the project team. The author acknowledged the approach of setting up daily countdown report during the project closing to end phase and creating a sense of urgency among the project team members. The author also adapted the platform of sharing updates used by the telecommunication team through Microsoft Project, a project management tool that provide a cloud-based function which will be introduced further in this chapter. This would provide the iron ore processing plant project with the seamless activities updates throughout the project execution.

As for case study presented in 2.3.3, the offshore construction project, the author recognized the similarity of the need to continue current operation while developing the iron ore processing plant in Site-B. The multiple contractors, consultants and suppliers from the iron ore processing plant project will have to work simultaneously to ensure the project to progress smoothly. The author has adapted the three-pronged approach from the offshore project adapted in project planning and measure identification to address the technical solution, simplification of processes and measure of administrating due identical problem faced by the iron ore processing plant development project.

Lastly, in 2.3.4, the case study of project management in small engineering business, the author has extracted the importance of implementing the project management based on the scale of the project operation. The project in small engineering business were involved in mining industry which are the same as the iron ore processing plant conducted by the project team. Hence, this provided insight in term of equipment management and allocation for the project progress.

From the case studies investigated by the author, the project team collaborated with the author in extracting the essential project management approaches based on the framework in PMBOK. The methodology for the mentioned approaches were further clarified in chapter 3.

2.4 Project Engineering Design Change

The author has researched the journal regarding engineering changes which typically carried out by companies or organizations which were required to improve the product or process design and adapting the said product or process in enhancing the overall product or process manufacturability. Natalia and the team (Natalia Iakymenko, 2020) has highlighted the engineering change strategies, practices and tool that were practical in implementation of project management procedure. These implemented engineering changes regardless the scale, it may affect the planning, cost, and scheduling for the project to be executed. The related engineering change practices and strategies and engineering process framework which are applied in this case study are further elaborated in the sub section below.

2.4.1 Engineering Change Practices & Strategies

Natalia's team has highlighted five main engineering change strategies scaling from less efficient (S1) to most efficient (S5) based on the practices that could be applied in various engineering changes designing tools. The theoretical framework of mentioned strategies and practices are shown in the figure below. From the figure shown, the tools that were applicable to the development of iron ore development plant are P7: involvement of suppliers and contractors in company H for assessment and implementation process which provides efficiency from S2-S4 and P8: Assessment of engineering change on project based on the impact of time and cost which were considered to be an effective strategy (S3). On the other hand, the applicable tools to achieve the project objectives would be T5: Failure mode and effect analysis (FMEA) which the project team has the experience in implementation and T6: Design for manufacturing and assembly which involves the consultant and engineering team to devise plan for plant operation efficiency and effectiveness in long run.

		ECM strategies				
	ECM practices and tools	Less S1	Earlier S2	Effective S3	Efficient S4	Better S5
ECM practices	*P1* – Establishment of a clear ECM process			✓	✓	✓
	P2 – Appointment of a coordinator of EC activities			✓	✓	
	P3 – Establishment of a cross-functional team to work on ECs		✓	✓	✓	
	P4 – Separate meetings to work on ECs			✓	✓	
	P5 – Development of several solutions to ECs			✓	✓	
	P6 – Involvement of production early in the design and engineering process	✓	✓			
	P7 – Involvement of the suppliers early in the EC assessment and implementation process and cross-enterprise ECM process		✓	✓	✓	
	P8 – Assessment of EC impacts on time and cost			✓		
	P9 – Documentation and centralised access to EC status and history			✓	✓	✓
	P10 – Formal post-implementation review of ECs					✓
	P11 – Making decisions regarding ECs at the lowest possible level				✓	
	P12 – EC implementation by urgency				✓	
	P13 – Batch implementation of ECs				✓	
Computer-based tools to support ECM	*T1* – Dedicated IT systems for ECM			✓	✓	✓
	T2 – Configuration Management Systems		✓	✓	✓	✓
	T3 – PDM/PLM systems			✓	✓	✓
Change reduction and front-loading tools	*T4* – Quality Function Deployment (QFD)	✓	✓			
	T5 – Failure Mode and Effect Analysis (FMEA)	✓	✓			
Design tools	*T6* – Design for Manufacturing and Assembly (DfMA)	✓	✓			
	T7 – Design for Changeability (DfC)	✓			✓	
	T8 – Design freeze	✓				
Change propagation and impact assessment tools	*T9* – Change Prediction Methods (CPMs) and Design Structure Matrices (DSMs)		✓	✓		

Figure 2.8: Theoretical framework for EC (Natalia Iakymenko, 2020)

2.4.2 Engineering Design Process

With the engineering change process strategies and practices set in place, the engineering design process to be implemented during the project changes were investigated further by the author. The project engineering team were to collaborate with the consultants and suppliers to identify the main problem statement for the engineering design objectives. In this case study, the main concern would be to reduce the time and interval of plant downtime maintenance and increasing the equipment or machines efficiency. As mentioned by Dieter (George Dieter, 2013), the mechanical engineering design phases of the engineering change were conducted in accordance with the design process flow shown in Figure 2.9. With the defined problem, the consultant and project design engineers plan and develop the conceptual design to address the product design specification. Construction of the design parameters was conducted to review the design selection based on acceptance criteria. Detail design were generated after the screening and ranking process. Simulation and reiteration were conducted based on the defining value such as the intended design load, allowable stress, buckling analysis etc. Finally, the production ramp-up would be done to implement the design and assemble the final product. In this project case study, the targeted design modification would be performed on specific machineries based on the changes intended. Relevant factor such as the structural design of the plant layout would be altered accordingly depending on the final design output.

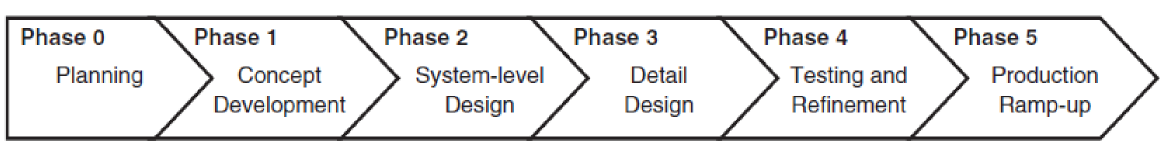


Figure 2.9: Product development process (George Dieter, 2013)

2.5 Project Management Software

In this dissertation, the author has explored the project management software tools available to help with the generation of project management plans and scheduling. Project management software can assist proj ect managers and the team to organize and manage tasks with ease (Smetana, 2020). Review on the software functions and cost were taken into consideration before deciding which project management tool to be adapted for the case study. In this section, the valuable overview function and features of the software were presented.

2.5.1 Microsoft Project

Microsoft Project is a project management software developed by Microsoft Corporation (Microsoft Corporation, 2022). It is well known for its adaptability of application to guarantee effective project planning and project execution. Smetana (Smetana, 2020) has mentioned that some of its features include the built-in project template, ease of applying input on planning and scheduling, customisable dashboard for project graphs, tasks and progress, restructuring of reports required for presentation, resourcing managing capability with high flexibility and provides remote access to allow collaboration in anywhere by the project team. From the project management aspect, Coutinho (Coutinho, 2018) stated that Microsoft Project is applicable in various stages of project management comprises the function of resource management, budget evaluation, schedule management, performance measurement and risk assessment. The project team will have full control over the project if Microsoft Project is utilized at maximum. Figures 2.6 and 2.7 showed the overview of the Microsoft project capability and its features.

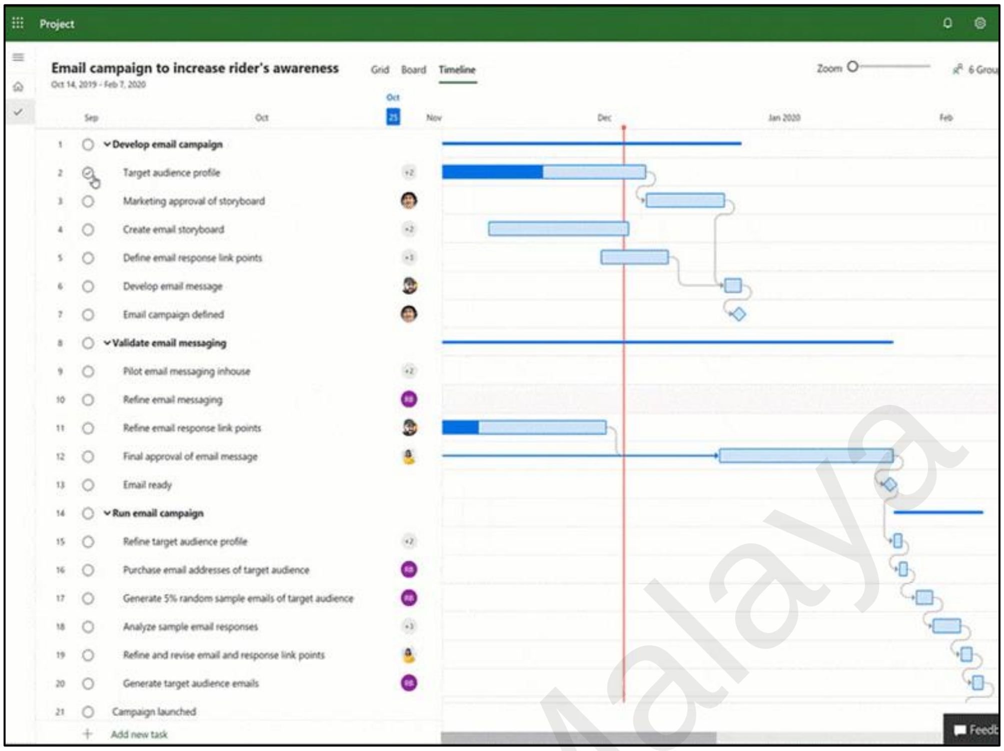


Figure 2.10: Microsoft Project Schedule Overview (Microsoft Corporation, 2022)

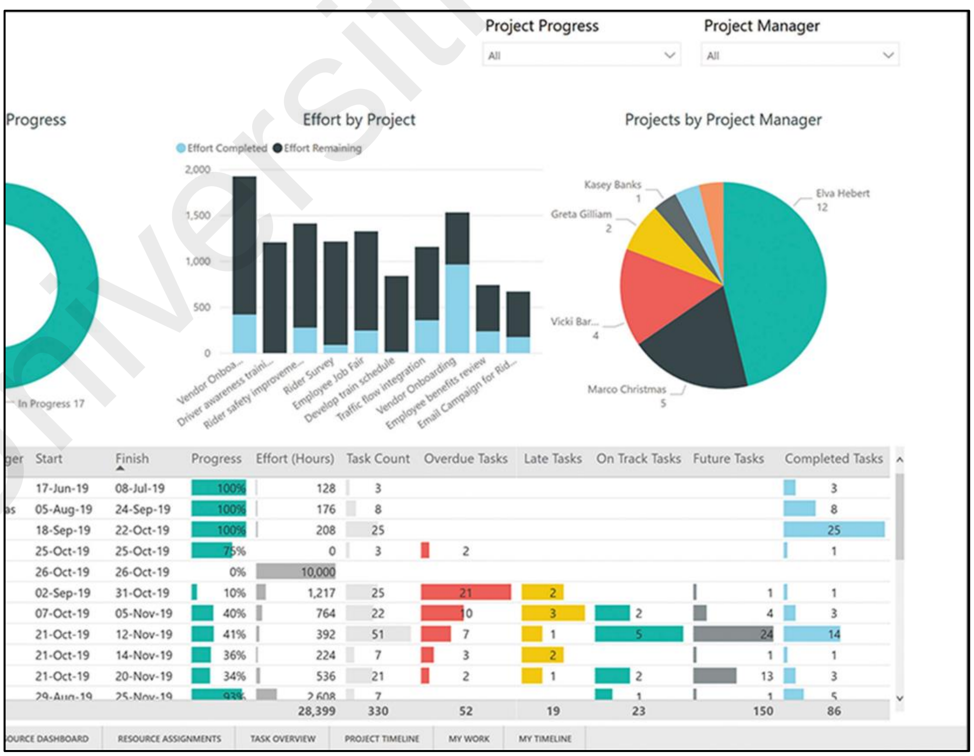


Figure 2.11: Microsoft Project Report Overview (Microsoft Corporation, 2022)

2.5.2 ProjectLibre

Aside from the widely used Microsoft Project aforementioned, the author also looked into Project Libre. Similarly, Project libre is an open-source project management software developed to serve as an alternative to Microsoft Project (Stroud, 2013). It offers a comprehensive set of productivity tools to the project manager and team. ProjectLibre (ProjectLibre, 2020) was created to offer free of charge and included the key features such as Microsoft Project compatibility, Gantt chart generation, network diagram creation, work and resource breakdown resource, earned value costing and resource histograms representation to visually present the project data and elements. The overview of ProjectLibre and graphical representation were shown in Figures 2.8 to 2.10.

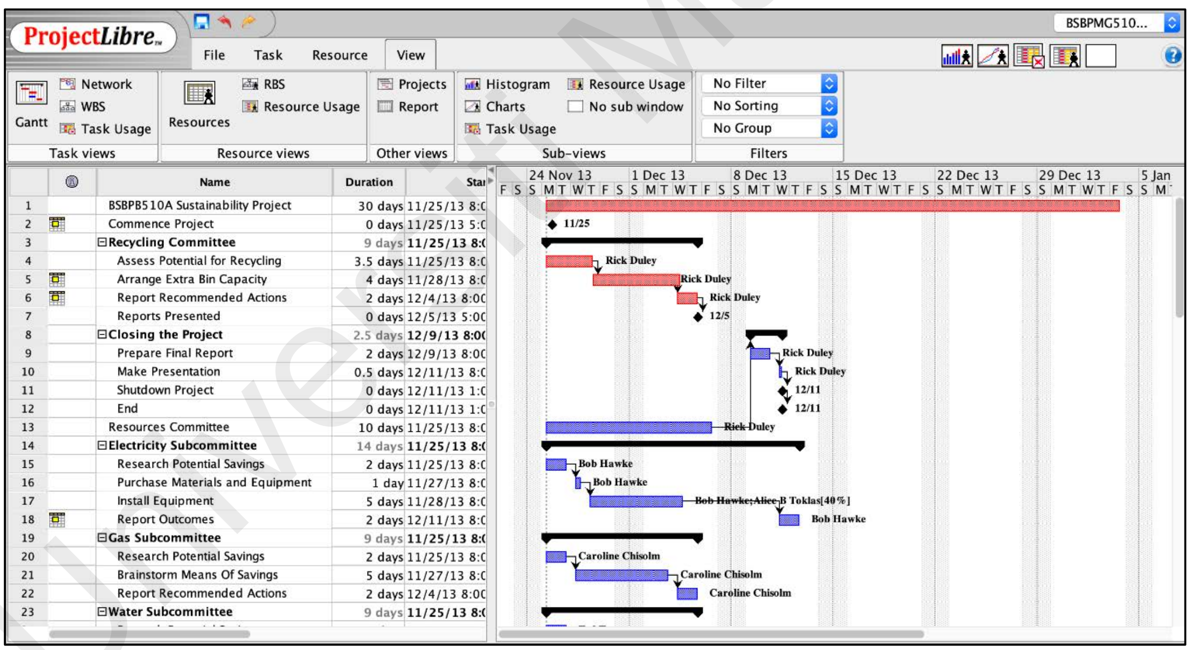


Figure 2.12: ProjectLibre Schedule Overview (ProjectLibre, 2020)

Figure 2.13: ProjectLibre Report Overview (ProjectLibre, 2020)

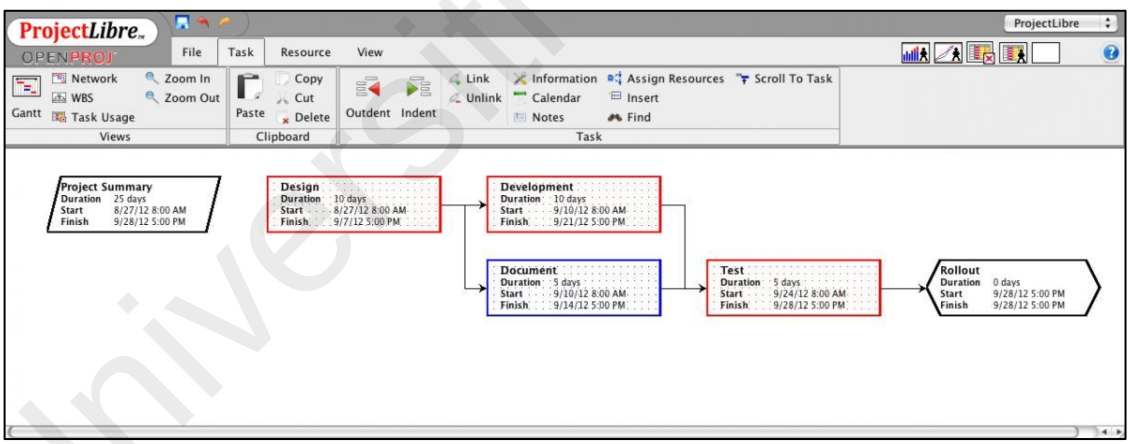


Figure 2.14: ProjectLibre Network Diagram Overview (ProjectLibre, 2020)

CHAPTER 3: METHODOLOGY

3.1 Introduction

The methodology of the dissertation is presented in this chapter. Similar to most project management case studies, the author is involved in the project management team in the project of iron ore processing plant development from the initial stage. Therefore, a general framework of the project management methodology is presented and the step-by-step implementation of the selected project management approaches were presented in the sub-chapters of this section.

3.2 Project Integration Management

In most cases of project management implementation, project integration management was the first aspect to be looked into. This is mainly because it includes the processes and activities to identify, define, combine, unify and coordinate the various process and project management activities required for the project (PMBOK, 2017). According to the PMBOK guide on this topic, Project Integration Management involves the decision making of resource distribution, the project needs assessment, analysing feasible options and ultimately adapting to the objectives of the project.

3.2.1 Project Charter and Management Plan

In PMBOK Guide (PMBOK, 2017), the project charter is defined as a document that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities. This document is crucial for the subsequent management approach to take place. As the author is part of the project team member under the project manager, the project charter is developed according to the data flow as shown in Figure 3.1 and Figure 3.2 with approval from the project manager.

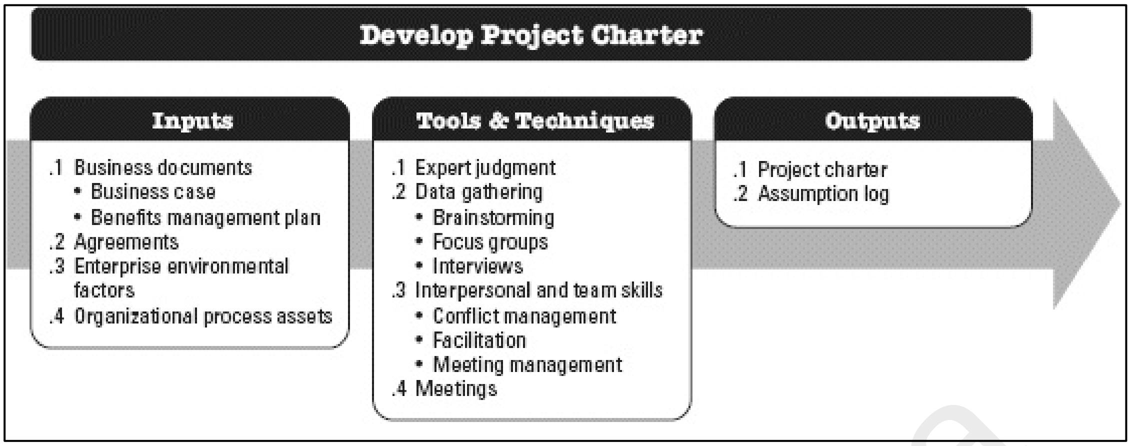


Figure 3.1: Develop Project Charter (PMBOK, 2017)

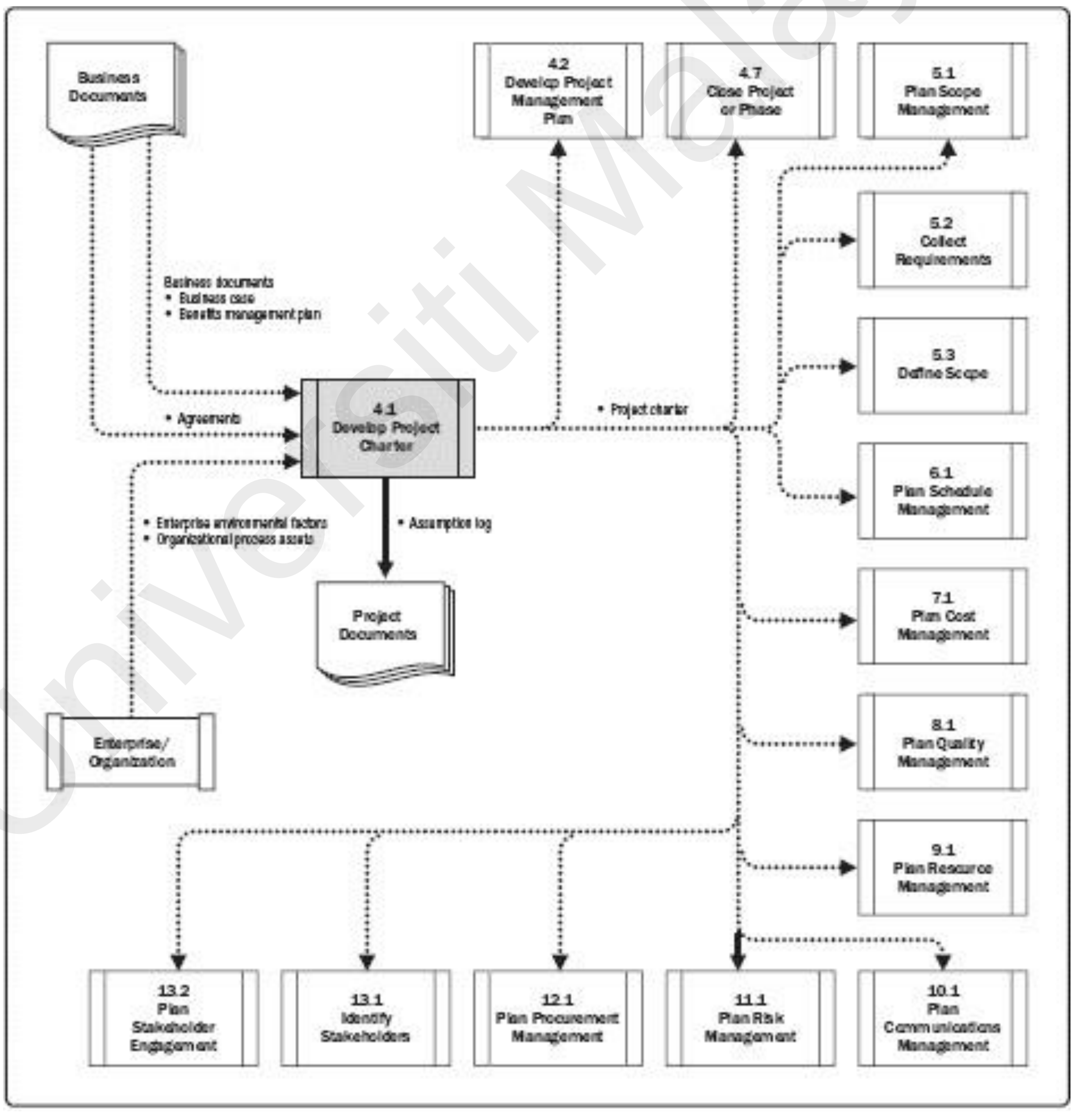


Figure 3.2: Develop Project Charter: Data Flow Diagram (PMBOK, 2017)

With a clear understanding of the project charter development flow, the project manager progresses the planning with the project management plan that requires the project charter as the key input. Similar to the creation of the project charter, the project team obeyed the data flow for the project management plan as shown in Figures 3.3 and 3.4 below.

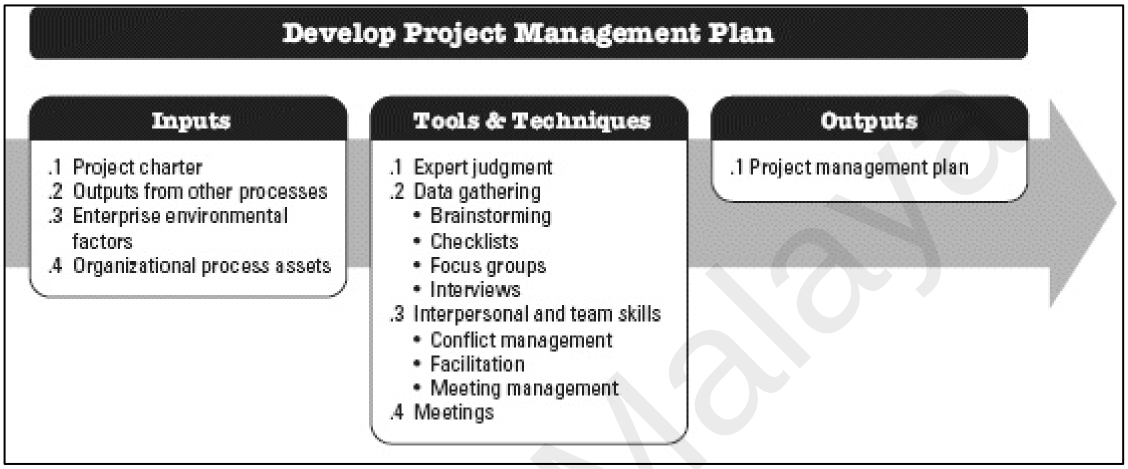


Figure 3.3: Develop Project Management Plan (PMBOK, 2017)

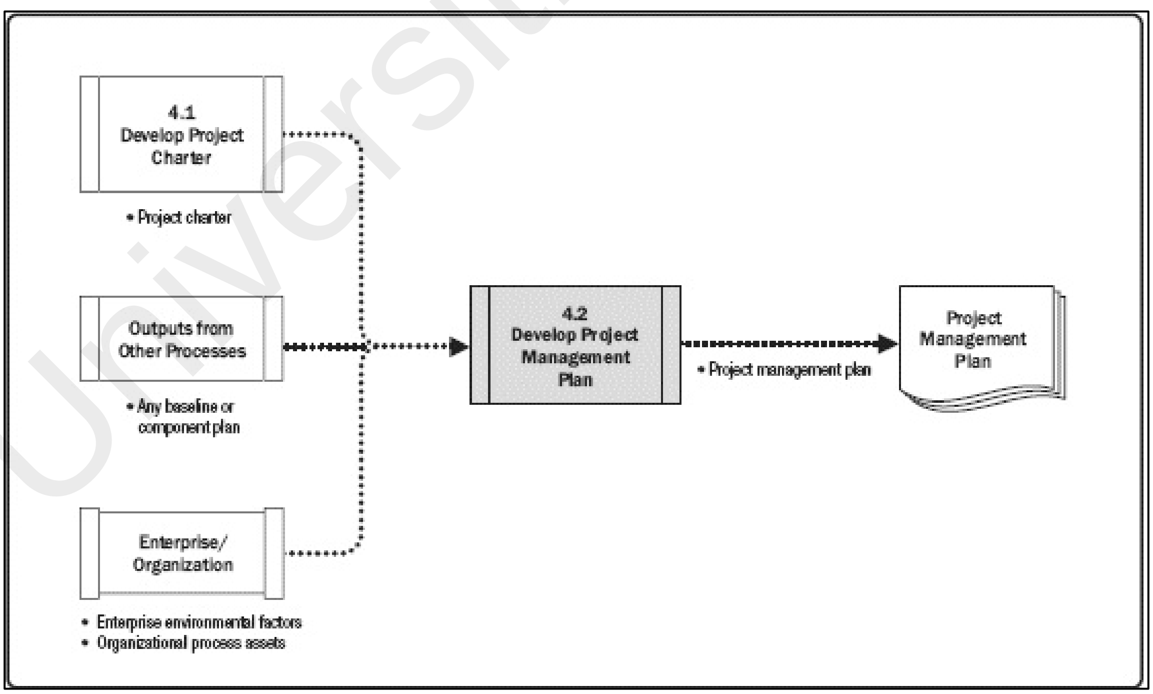


Figure 3.4: Develop Project Management Plan: Data Flow Diagram (PMBOK, 2017)

The project manager has referred to and modified the overall framework shown in Figure 3.5 to generate the project charter that fits the case study discussed in this dissertation.

PROJECT MANAGER'S CHARTER

1. **Project Manager:**

   Name: ____________________
   Appointment/Position: ____________________
   Date of Appointment: ____________________

2. **Project Title:** ____________________

3. **Responsibility and Authority given to the Project Manager:**

   The above named Project Manager has been given the authority, responsibility and accountability for ____________________

4. **Project Goals and Deliverables are:**

   a: ____________________
   b: ____________________
   c: ____________________

5. **The Project will be reviewed.**

   ____

6. **Financial Authority:**

   The Project Manager's delegated financial powers are: ____________________
   ____

7. **Intramural Resources:**

   The following resources have been/are to be made available:

8. **Trade-offs:**

   a: Cost: ________ %
   b: Time: ________ days/weeks.
   c: Performance: ____________________

9. **Charter Review: No charter review is expected to take place for the duration of this project unless it becomes clear that the PM cannot fulfil his/her duties or a reassessment of the trade-offs is required.**

10. **Approved:**

    Sponsor/Client/Customer/Programme Manager: ____________________
    Project Manager: ____________________
    Line Manager: ____________________

11. **Distribution:**

    a: Sponsor; b: Programme Manager; c: Line Manager

Figure 3.5: Project Manager's Charter (Lester, 2014)

The project management team has identified and applied additional inputs which comprise of project description, project team, objectives, scope, deliverables, key stakeholders and other project elements required in a similar format as shown in Figure 3.5 to obtain project authorization. Kerzner mentioned that when the project charter contains a scope baseline and management plan, it may function as the project plan (Kerzner, Project Management, 2009). Therefore, the project team of Company H has integrated the project management plan into the project charter generated to be presented in Chapter 4.

3.3 Project Scope Management

With the completion of the project charter and management plan for the development of the iron ore processing plant, the project scope outlined were analysed by the project team subjected for scope management. Burke (Burke, 1999) has mentioned that scope management defines what the project includes and what is not included to meet the stated project objectives. The project team were tasked to define scope by conducting an in-depth analysis with expert judgement, data gathering, data analysis and decision making to determine output which comprises the scope statement, acceptance criteria, constraint and assumptions of the project as shown in Figure 3.6 and Figure 3.7 below.

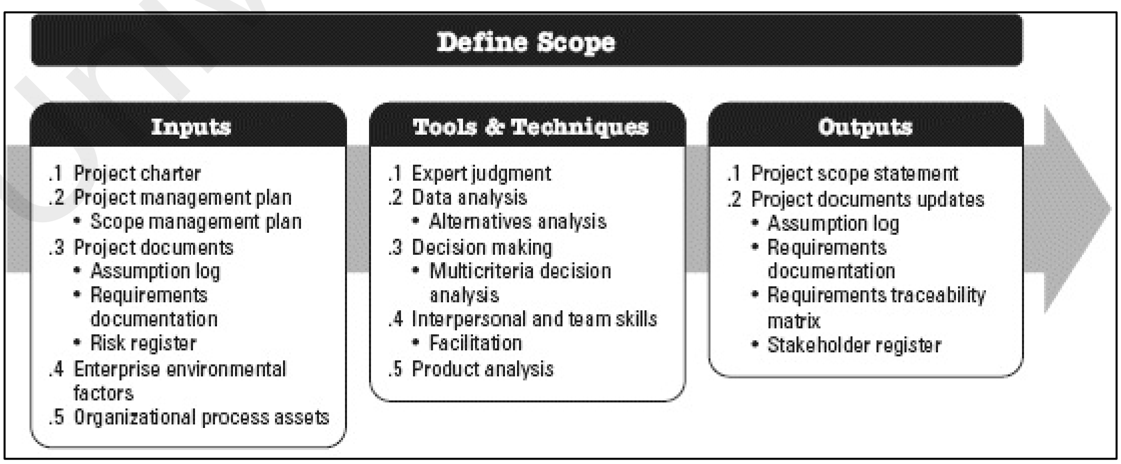


Figure 3.6: Define Scope (PMBOK, 2017)

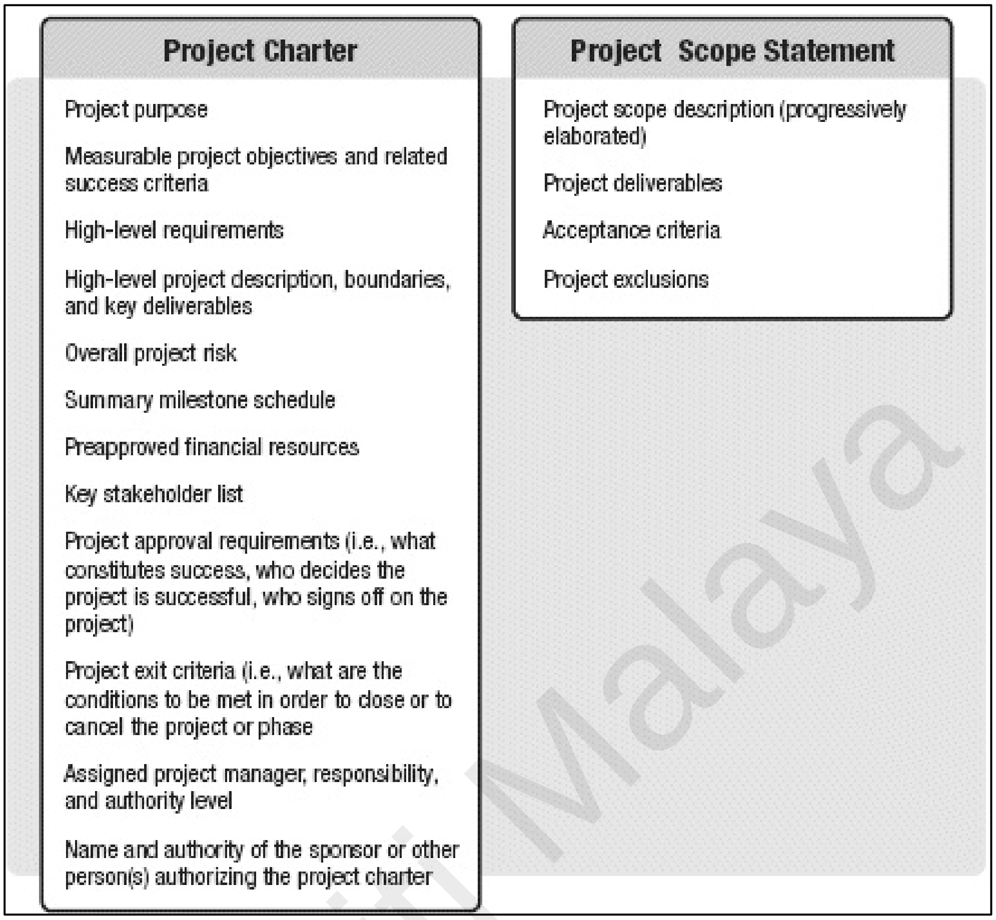


Figure 3.7: Elements of the Project Charter and Project Scope Statement (PMBOK, 2017)

3.3.1 Work Breakdown Structure (WBS)

As identified by Lester (Lester, 2014), WBS is a process of controlling a project by breaking down the project phases into main stages or tasks. Subsequently, it can be broken down further into subtasks or work packages until it satisfied the project control structure. In this case study, with inputs from the project management plan and documents (Figure 3.8), a WBS organized by project phases is implemented as shown in Figure 3.9. The WBS for the iron ore processing plant was integrated into the project schedule in Microsoft Project are presented in Chapter 4.

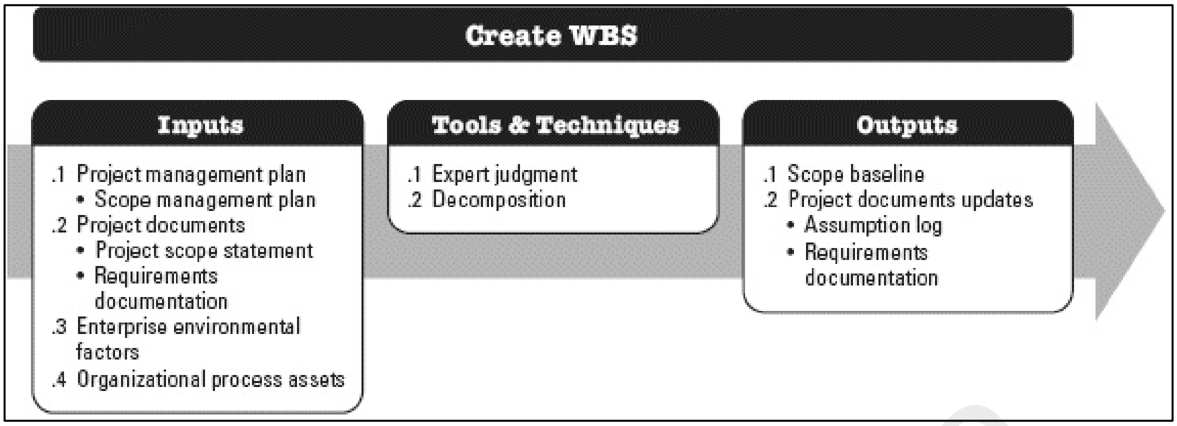


Figure 3.8: Create WBS (PMBOK, 2017)

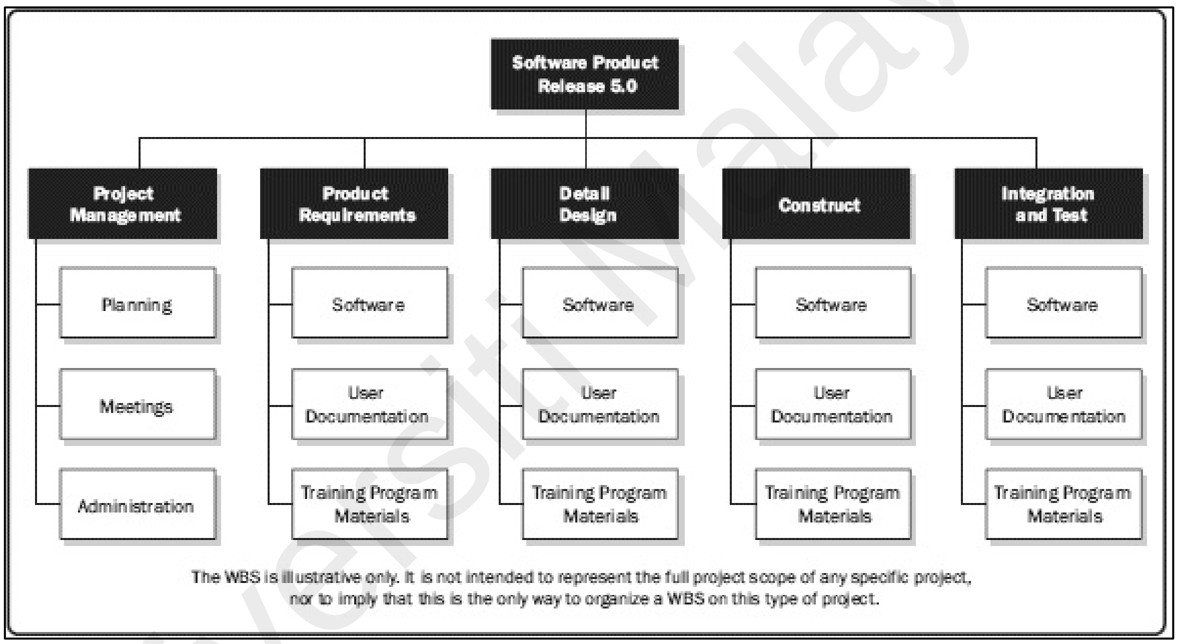


Figure 3.9: Sample WBS Organized by Phase (PMBOK, 2017)

3.4 Project Schedule Management

In a project execution, the project team has to ensure the project tasks are completed within the time limit. To achieve this, the project team analysed the subtasks from WBS to develop the project schedule. Each major project phase that was identified in the earlier stages were documented based on its deliverables. All linkage of sequenced tasks were investigated and analysed logically. Based on the complexity of the tasks or subtasks, the project team estimated the duration of completion. With all necessary inputs in line, the detailed schedule was generated with the aid of Microsoft Project in Gantt Chart format with as shown in Figure 3.10.

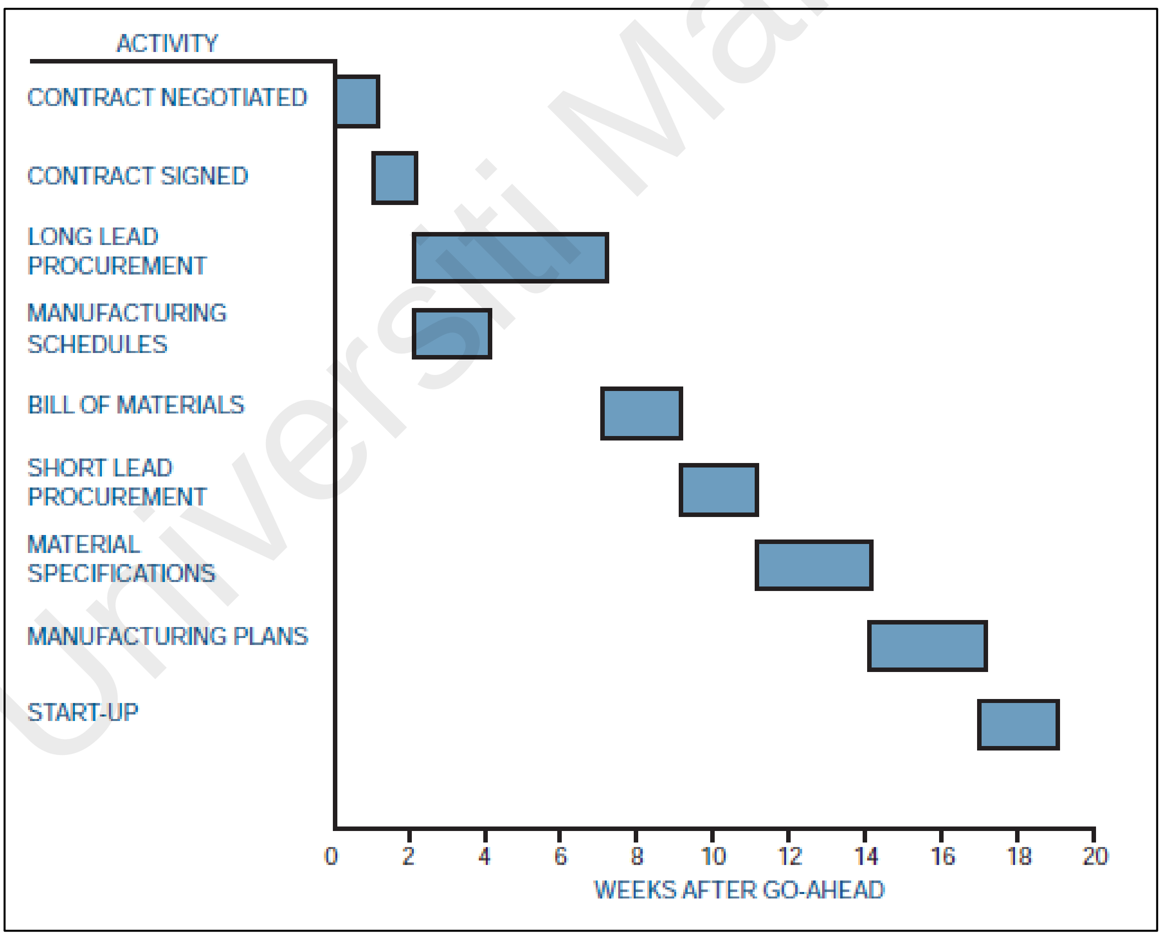


Figure 3.10: Single Activity Gantt Chart (Kerzner, Project Management, 2009)

3.5 Project Cost Management

As the major outline of the project elements had been identified with the project charter and management plan, this would provide the approved financial resources for the project budget. The project team with specialized knowledge and expertise were to provide judgement and analysis based on previous similar project data, financial database, equipment and services charges that would aid the assignment. cost estimation and budgeting as shown in Figure 3.11 that was conducted by consultants and contractors of the project to offer the elements required for project budgeting purposes. The cost of the overall resources needed to complete the project was consequently focused to ensure it did not exceed the approved project budget. A budget breakdown was presented as a result of this approach in Chapter 4. In figure 3.12, as derived from PMBOK (PMBOK, 2017) the cost estimation was done based on the project tasks throughout the project period. The figure would be adjusted as project time progressed if additional alterations on the project budget, cost or expenditure were required.

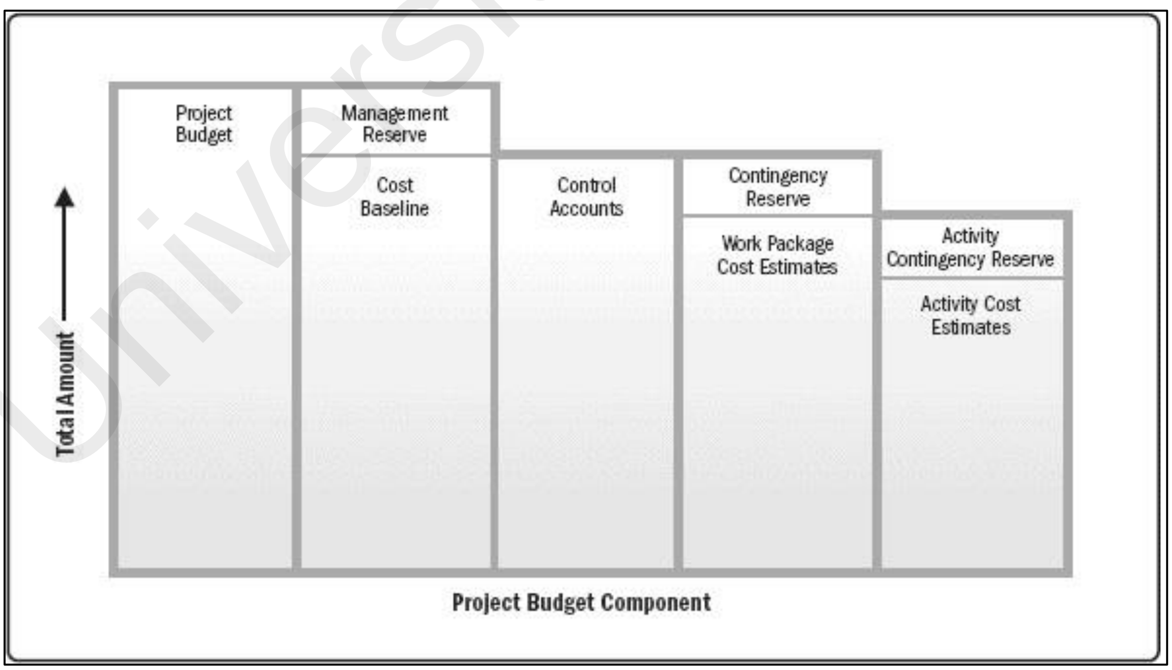


Figure 3.11: Project Budget Components (PMBOK, 2017)

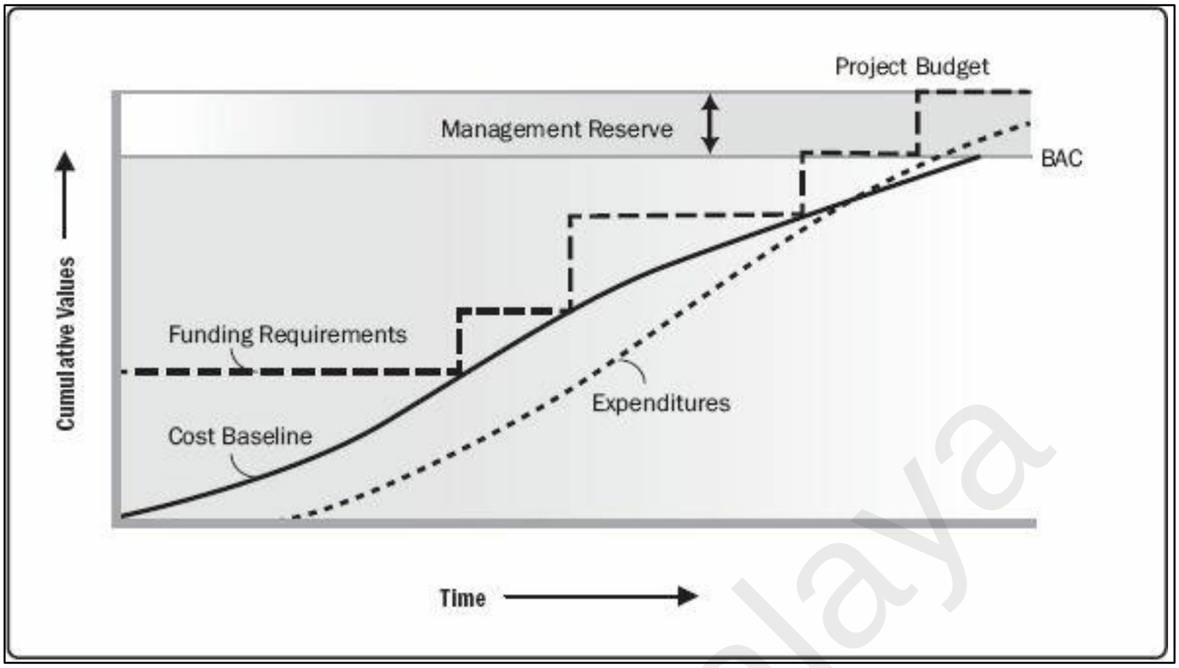


Figure 3.12: Cost Baseline, Expenditures and Funding Requirements (PMBOK, 2017)

3.6 Project Monitor, Control and Changes

3.6.1 Monitor and Control Project Work

When the project baseline was in place, PMBOK (PMBOK, 2017) mentioned monitoring became the key aspect of project management to be performed throughout the project. Continuous monitoring provides the project management team better insight into the status of the project tasks carried out and identifies the areas that may require extra attention. Next, change came into play to determine any corrective or preventive actions or replanning were required to be taken to resolve the matter. As shown in Figure 3.13, the data flow process would allow the stakeholders to grasp the status of the project and recognise any performance issues to be addressed. After the comparison of planned results and actual results, a change request may be issued to modify, adjust or expand the project scope, schedule or cost.

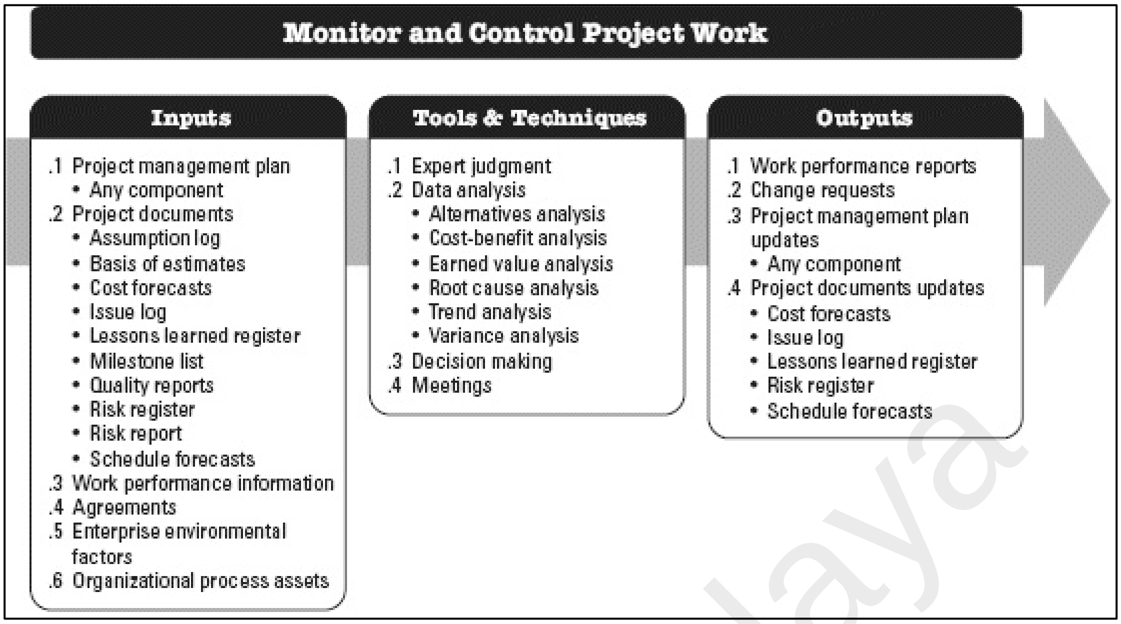


Figure 3.13: Monitor and Control Project Work (PMBOK, 2017)

3.6.2 Integrated Change Control

Throughout a project period, a project change is always inevitable. It is crucial to monitor and control the change implemented and the impact should be assessed whether it would after the project objectives, scope, or outcome. In this case study, the project team has implemented a change control system to accommodate the changes that may unvaryingly happen. According to Burke (Burke, 1999), it was essential to ensure that all changes that may occur during the project period were captured and approved by the designated people before being incorporated in the project management plan. Besides, any other changes should be beneficial to the project. In many cases when a change request was to be issued (Figure 3.15), it would be assessed according to the data flow diagram as shown in Figure 3.14. The impact statement form shown in Figure 3.16 were to be submitted to the project management, stakeholders, or project sponsor for approval of the changes and impact on the project. With the impact identified, the project management plan was to be updated into new revision and monitoring of project task were continually executed.

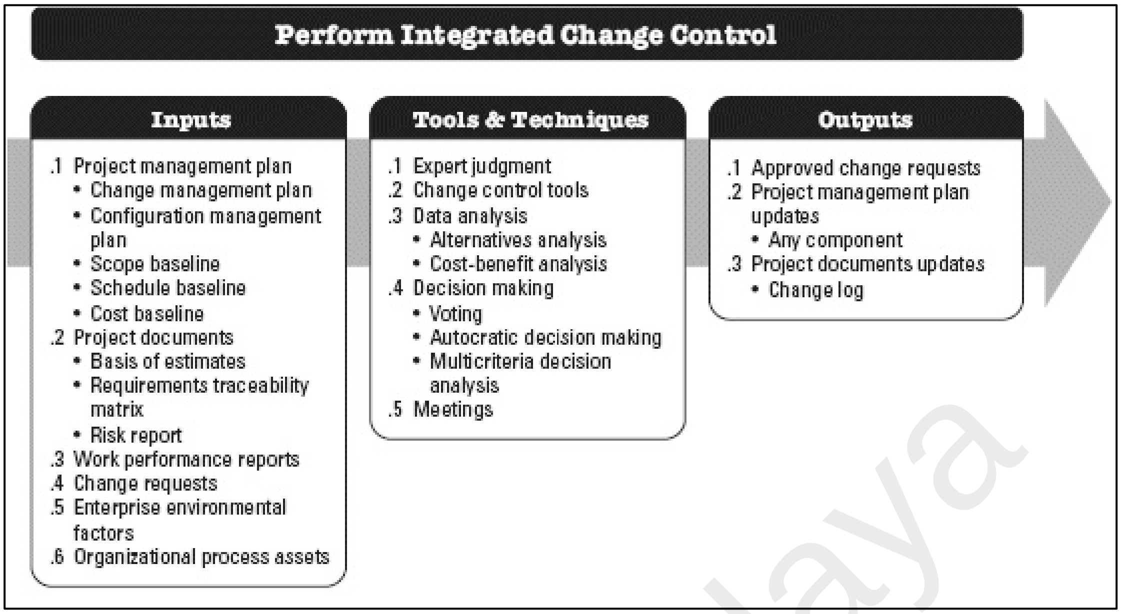
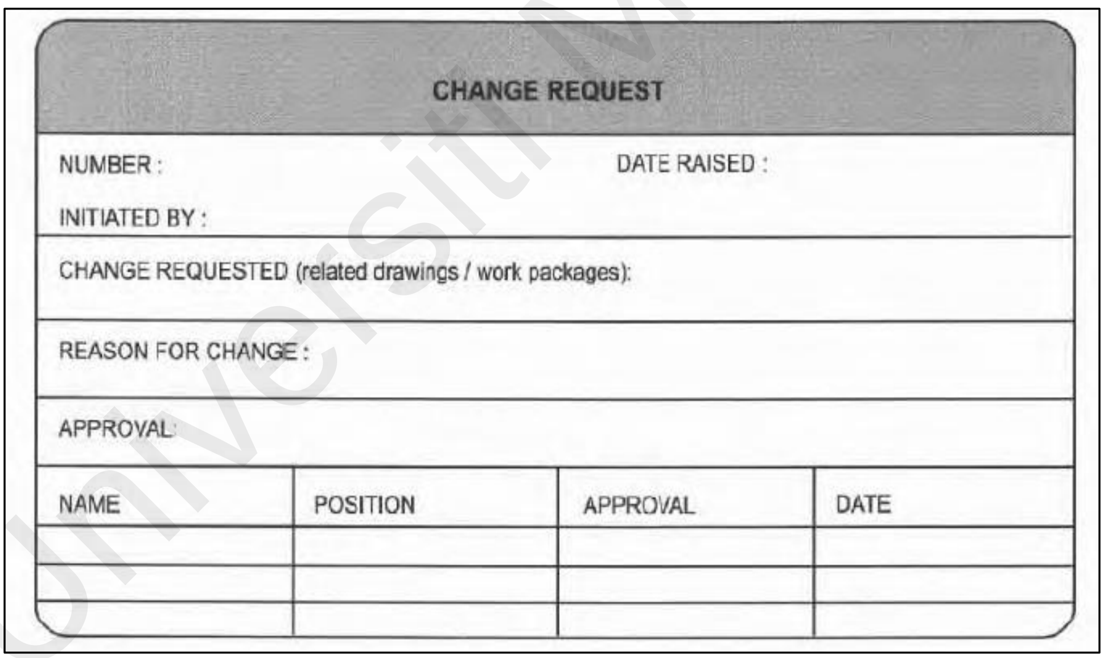


Figure 3.14: Perform Integrated Change Control (PMBOK, 2017)



CHANGE REQUEST

NUMBER : DATE RAISED :

INITIATED BY :

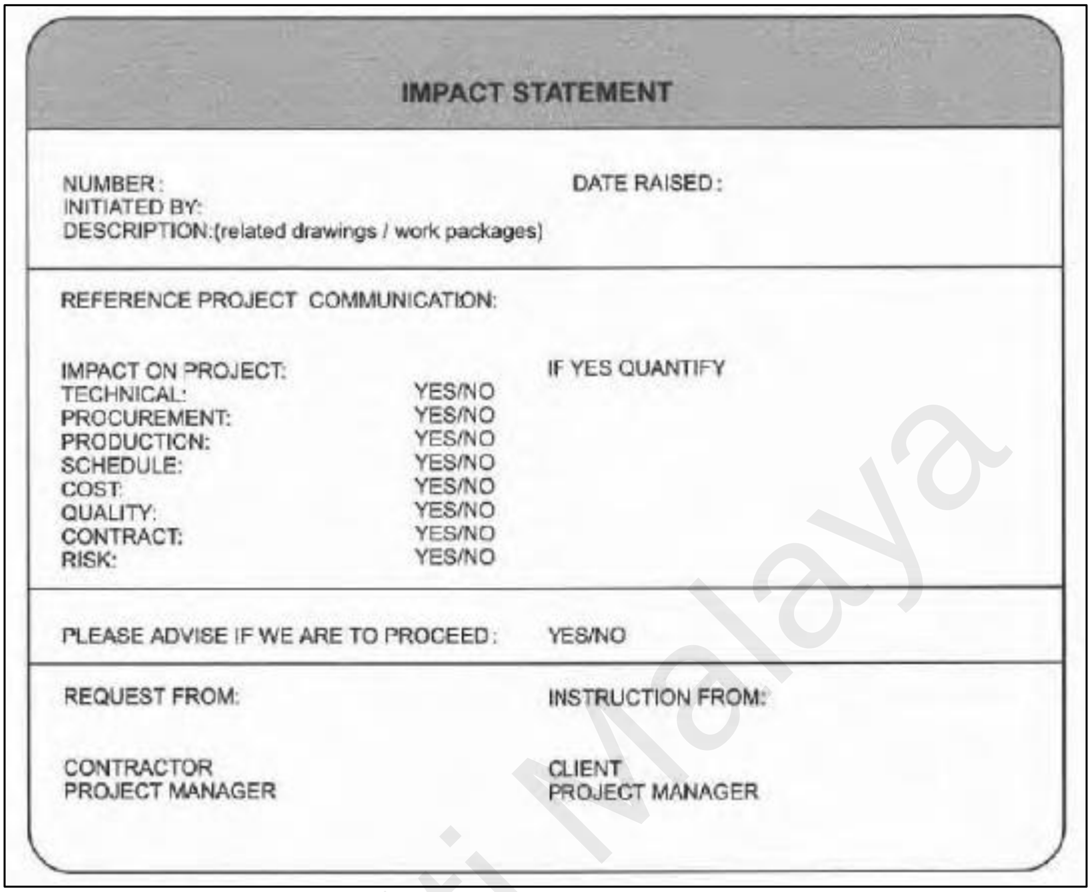
CHANGE REQUESTED (related drawings / work packages):

REASON FOR CHANGE :

APPROVAL:

NAME	POSITION	APPROVAL	DATE

Figure 3.15: Change Request Form (Burke, 1999)



IMPACT STATEMENT

NUMBER: DATE RAISED:
INITIATED BY:
DESCRIPTION:(related drawings / work packages)

REFERENCE PROJECT COMMUNICATION:

IMPACT ON PROJECT: IF YES QUANTIFY

TECHNICAL:	YES/NO
PROCUREMENT:	YES/NO
PRODUCTION:	YES/NO
SCHEDULE:	YES/NO
COST:	YES/NO
QUALITY:	YES/NO
CONTRACT:	YES/NO
RISK:	YES/NO

PLEASE ADVISE IF WE ARE TO PROCEED: YES/NO

REQUEST FROM: INSTRUCTION FROM:

CONTRACTOR CLIENT
PROJECT MANAGER PROJECT MANAGER

Figure 3.16: Impact Statement Form (Burke, 1999)

3.6.3 Project Engineering Design Changes

From the change request initiated by the relevant project team member, the project changes which involves engineering design changes were subjected to follow the engineering design flowchart indicated in the sub chapter 2.4.2. A detailed design process was implemented by the project mechanical design team with the collaboration with the consultant and supplier of the project. Firstly, the project mechanical design team identified the project needs and objectives which typically involves implementation of design changes with improvement from the initially proposed design. The project team proceeded to gather information required to fulfil the project design changes and conceptualized the possible design solution. Concept selection was then conducted to decide based on the feasibility of the design choices. Upon the determination of conceptual design, design review conducted by the project team to develop the resources required to complete the project design changes. Then, the relevant project team would be tasked to prepare and compile the project design changes required configuration which includes the parts and components listed under the product architecture. The parameter was suggested based on the requirement of strength and flexibility in this case study. Subsequently, detailed engineering design documents subjected to the design changes were generated. This included the 3D CAD model, design prototypes, simulation reports, engineering parts drawings, assembly drawings and the overall cost information affecting the project outcome. With all aspect of project design changes reviewed and approved, the purchase of parts and implementation of design changes will be initiated. The detailed design process implemented for the development of iron ore plant were illustrated as shown in Figure 3.17.

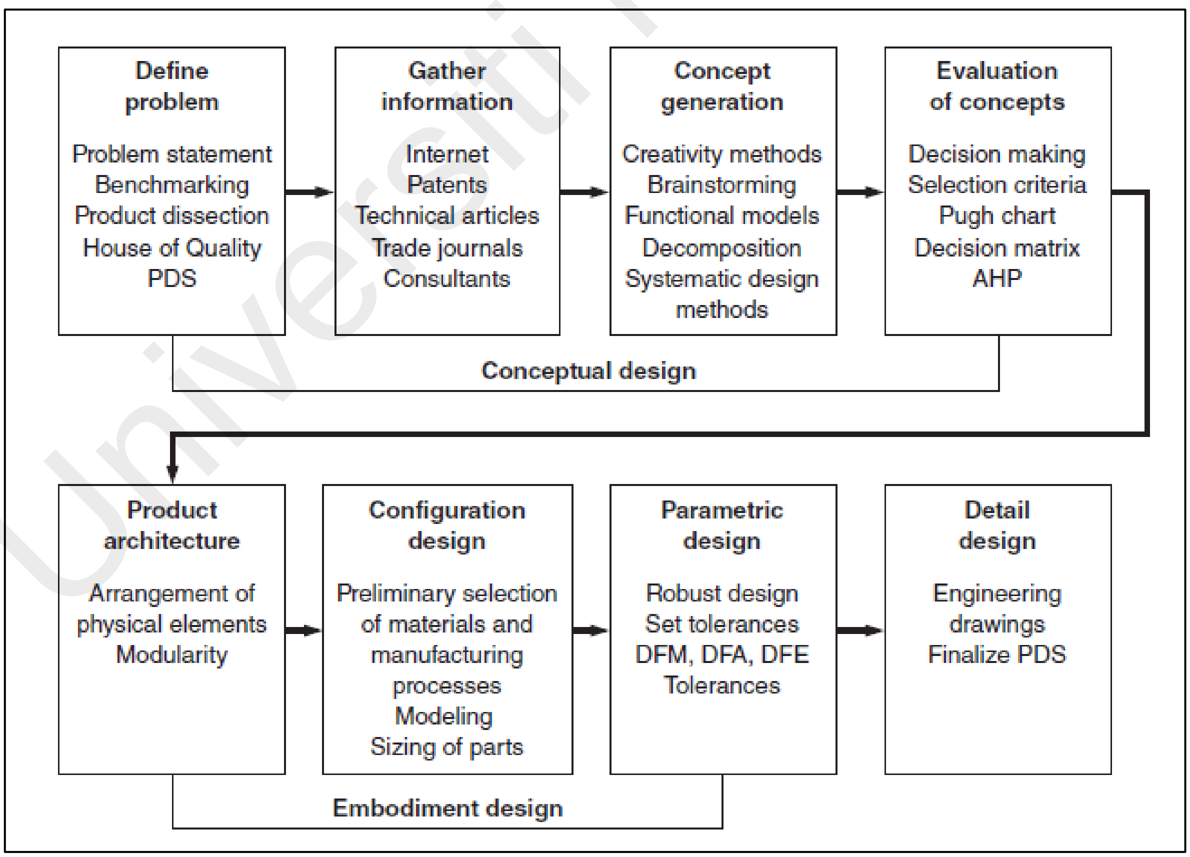


Figure 3.17: Engineering Design Process (George Dieter, 2013)

CHAPTER 4: RESULTS

4.1 Introduction

From the methodology described in chapter 3, the project management approaches mentioned were implemented into the project of iron ore processing plant development in this section. The results were to be presented, tabulated and displayed accordingly with the data gathering, analyse, and computation from the project management team with the author's involvement (Appendix A and B).

4.2 Project Charter and Management Plan

Table 4.1: Project Charter and Management Plan

PROJECT CHARTER & MANAGEMENT PLAN	
Project Plan Summary	
Project Name	IOPP-2
Project Sponsor	Company H
Project Manager	Mr Ho
Project Dates	Week 3 July 2021 to Week 2 May 2021
Project Summary	To develop and build an iron ore processing plant at Site-B for iron ore production
Budget / Resources	USD 1,500,000
Approved Date	15th July 2021
Approving Body	Company H Management - CEO

Project Objective
To develop and build an iron ore processing plant at Site-B within the allocated time frame and budget.

Project Scope
Phase 1: - To arrange and obtain exploration and feasibility report and mining license for iron ore processing at Site-B

Phase 2: - To confirm civil, structural, and M&E consultant - To obtain a geomagnetic survey, trenching and hole drilling report - To obtain and confirm site layout - To conclude Site-B processing plant design process flow and equipment Phase 3: - To conclude consultant proposal - To conduct transition of equipment and employee from Site-A to Site-B - To initiate pre-extraction operation with trommel equipment at Site-B - To conduct and conclude site setup (infrastructure, earthworks, plant construction & factory installation) - To confirm mining plan Phase 4: - To sign off the processing plant and begin production

Project Deliverables / Milestones (Date)
Phase 1: o Mining License (26/1/22) Phase 2: o Consultant Confirmation (26/8/22) o Geomagnetic Survey Report (7/10/21) o Trenching Report (30/9/21) o Hole Drilling Report (23/12/21) o Site Layout Drawing (5/10/21) o Process flow and Equipment Document (15/10/21)

Phase 3: o Consultant Proposal (5/11/21) o Extraction Report (4/11/21) o Earthwork Construction Sign-off Document (19/1/22) o Plant Construction Sign-off Document (23/2/22) o Mining Plan (3/10/22) Phase 4: o Processing Plant and Production Sign-off Document (12/5/22)

Stakeholders
Project Sponsor: Company H CEO: Mr Tan Project Manager: Mr Ho Project Team: Company H Governing Body: Mining Department, Health and Safety Department (Government L) Consultants: Outsourced (to be determined) Suppliers: Company S, Company T and Company K

Project Team	
Role	*Name / Team Leader*
CEO	Mr Tan
Project Manager	Mr Ho
Assistant Project Manager	Author
Plant Manager	Mr Chanh
Logistics Team	Mr Keo
Procurement Team	Mr Van
Engineering Team	Mr Yap
Finance Team	Mr Seow

Project Budget / Resources
This project has a total budget of USD 1,500,000: • USD 1,000,000 allocated for four project phases as stated in the scope • USD 500,000 allocated for miscellaneous expenses and contingency fund

Constraints
Time Constraint: Project to be completed in 9 months Budget Constraint: Project expenses to be controlled within USD 1,500,000

Authorization	
Prepared by Project Manager	Mr Ho (1/7/21)
Approved by Project Sponsor	CEO, Mr Tan (12/7/21)
Approved by Governing Body	Department of Mining – Government L (14/7/21)

4.3 Project Schedule - Gantt Chart

As mentioned, the project status cutoff date was set at 10th January 2022 to be presented in this dissertation as shown in Figures 4.1, 4.2, 4.3 and 4.4:

WBS Coding is categorized by phase and subtasks is applied and shown as shown in Figure 4.1, 4.2, 4.3, 4.4 and 4.5.

Project Cost Breakdown categorized by phase and subtasks is plugged in Figure 4.1, 4.2, 4.3, 4.4.

ID	Task Name	Duration	Start	Finish	Pred	WBS	Cost
1	NEW IRON ORE PROCESSING PLANT SETUP	226 days	19/7/21	30/5/22		1	$100,000.00
2	PHASE 1: AGREEMENTS	138 days	19/7/21	26/1/22		1.1	$100,000.00
3	Agreement Arrangement	138 days	19/7/21	26/1/22		1.1.1	$100,000.00
4	Agreement Signed	0 days	19/7/21	19/7/21		1.1.1.1	$0.00
5	Tranche Payments	8 days	19/7/21	28/7/21	4	1.1.1.2	$10,000.00
6	Exploration Phase	90 days	29/7/21	1/12/21	5	1.1.1.3	$20,000.00
7	Feasibility Report Phase	30 days	2/12/21	12/1/22	6	1.1.1.4	$10,000.00
8	MPI & Dept Reviews & Approval Process	10 days	13/1/22	26/1/22	7	1.1.1.5	$10,000.00
9	Mining License	0 days	26/1/22	26/1/22	8	1.1.1.6	$50,000.00

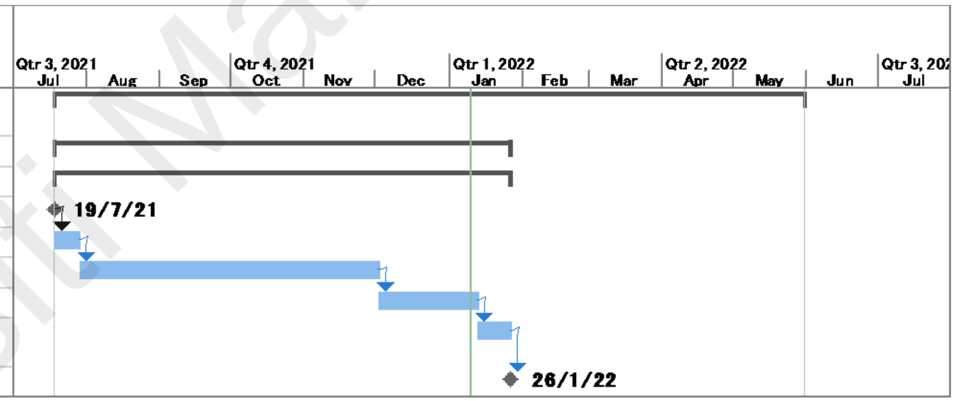


Figure 4.1: Project Phase 1 Schedule

ID	Task Name	Duration	Start	Finish	Pred	WBS	Cost
12	**PHASE 2: PREPARATION - Site Surveys & Plan**	**114 days**	**19/7/21**	**23/12/21**		**1.2**	**$400,000.00**
13	**Consultant**	**19 days**	**2/8/21**	**26/8/21**		**1.2.1**	**$5,000.00**
14	**Electrical & Civil Consulting Searching**	**19 days**	**2/8/21**	**26/8/21**		**1.2.1.1**	**$5,000.00**
15	Settling Pond	14 days	2/8/21	19/8/21		1.2.1.1.1	$1,000.00
16	Civil & Structural	14 days	2/8/21	19/8/21		1.2.1.1.2	$3,000.00
17	M&E	14 days	9/8/21	26/8/21		1.2.1.1.3	$1,000.00
18	Consultant Confirmation	0 days	26/8/21	26/8/21	14	1.2.1.2	$0.00
19							
20	**Geomagnetic Survey with Drone**	**50 days**	**30/7/21**	**7/10/21**		**1.2.2**	**$50,000.00**
21	Final Quotation	12 days	30/7/21	16/8/21		1.2.2.1	$0.00
22	Issue PR	1 day	17/8/21	17/8/21	21	1.2.2.2	$0.00
23	Drone Team at Site	3 days	18/8/21	20/8/21	22	1.2.2.3	$10,000.00
24	Geomagnetic Team at Site	3 days	23/8/21	25/8/21	23	1.2.2.4	$10,000.00
25	Geomagnetic Drone Survey	21 days	26/8/21	23/9/21	24	1.2.2.5	$25,000.00
26	Geomagnetic Survey Report Preparation	10 days	24/9/21	7/10/21	25	1.2.2.6	$5,000.00
27							
28	**Trenching Survey**	**44 days**	**2/8/21**	**30/9/21**		**1.2.3**	**$50,000.00**
29	Approval Granted	1 day	2/8/21	2/8/21	5	1.2.3.1	$0.00
30	Excavators at Site	3 days	3/8/21	5/8/21	29	1.2.3.2	$10,000.00
31	Trenching Process	30 days	6/8/21	16/9/21	30	1.2.3.3	$25,000.00
32	Channeling Testing	40 days	6/8/21	30/9/21	30	1.2.3.4	$10,000.00
33	Trenching Report	0 days	30/9/21	30/9/21	31,3	1.2.3.5	$5,000.00
34							
35	**Hole Drilling**	**55 days**	**8/10/21**	**23/12/21**		**1.2.4**	**$50,000.00**
36	Drill Hole Plan	5 days	8/10/21	14/10/21	26,3	1.2.4.1	$15,000.00
37	Drill Hole Activities	30 days	15/10/21	25/11/21	36	1.2.4.2	$30,000.00
38	Drill Hole Report	20 days	26/11/21	23/12/21	37	1.2.4.3	$5,000.00

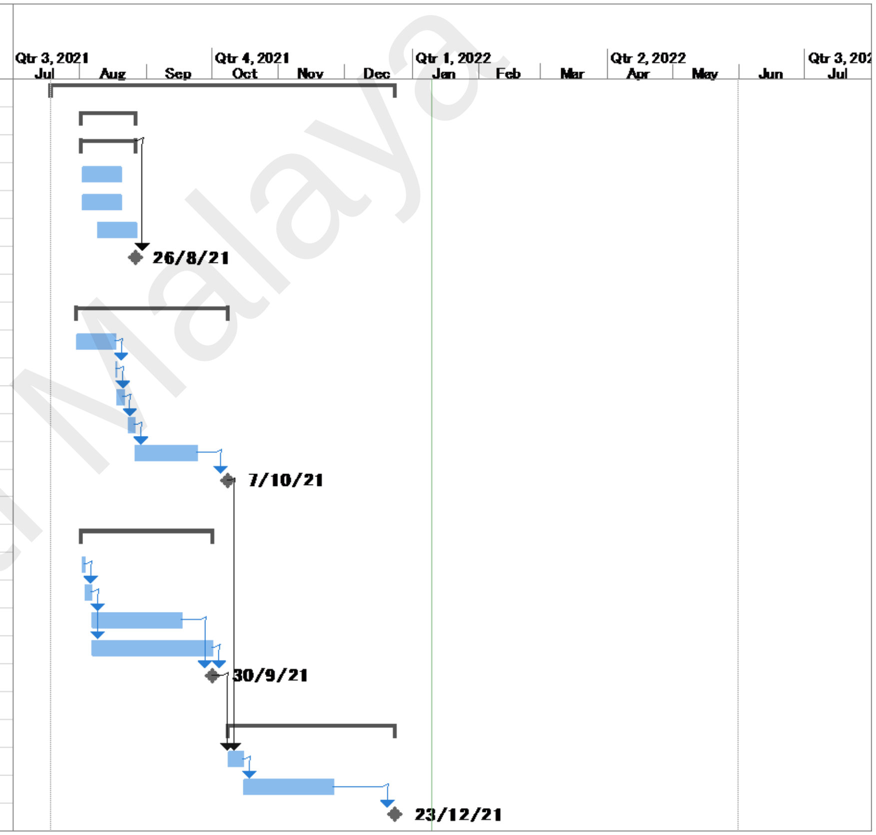


Figure 4.2: Phase 2 Schedule

ID	Task Name	Duration	Start	Finish	Pred	WBS	Cost
40	**Site Preparation Survey**	**25 days**	**1/9/21**	**5/10/21**		**1.2.5**	**$100,000.00**
41	Factory Actual Site Survey	5 days	1/9/21	7/9/21		1.2.5.1	$10,000.00
42	Access Road	5 days	1/9/21	7/9/21		1.2.5.2	$10,000.00
43	Electricity Supply	5 days	1/9/21	7/9/21		1.2.5.3	$10,000.00
44	Water Source	5 days	1/9/21	7/9/21		1.2.5.4	$10,000.00
45	Tailing Dam & Settling Ponds	5 days	1/9/21	7/9/21		1.2.5.5	$10,000.00
46	Processing Site Confirmation	0 days	7/9/21	7/9/21	41,4	1.2.5.6	$0.00
47	**Site Layout Drawing**	**20 days**	**8/9/21**	**5/10/21**		**1.2.5.7**	**$50,000.00**
48	Site Layout & Setup Discussion	20 days	8/9/21	5/10/21	46	1.2.5.7.1	$50,000.00
49	Site Layout Confirmed	0 days	5/10/21	5/10/21	48	1.2.5.7.2	$0.00
50							
51	**Processing Plant Design & Equipment Specs**	**65 days**	**19/7/21**	**15/10/21**		**1.2.6**	**$145,000.00**
52	**Process Flow**	**30 days**	**19/7/21**	**27/8/21**		**1.2.6.1**	**$35,000.00**
53	Raw Materials	10 days	19/7/21	30/7/21		1.2.6.1.1	$5,000.00
54	Process Flow and Setup Discussion with Supp	30 days	19/7/21	27/8/21		1.2.6.1.2	$10,000.00
55	Conclude Process Flow	0 days	27/8/21	27/8/21	54	1.2.6.1.3	$20,000.00
56	**Extraction Equipment**	**55 days**	**2/8/21**	**15/10/21**		**1.2.6.2**	**$105,000.00**
57	Trommel Specs Searching	14 days	2/8/21	19/8/21		1.2.6.2.1	$5,000.00
58	Issue PR	1 day	20/8/21	20/8/21	57	1.2.6.2.2	$0.00
59	Trommel Lead Time	30 days	23/8/21	1/10/21	58	1.2.6.2.3	$0.00
60	Trommel Transportation	10 days	4/10/21	15/10/21	59	1.2.6.2.4	$100,000.00
61	**Current Equipment & Specs (Inspection)**	**10 days**	**2/8/21**	**13/8/21**		**1.2.6.3**	**$0.00**
62	Transformer	10 days	2/8/21	13/8/21		1.2.6.3.1	$0.00
63	Weightbridge	10 days	2/8/21	13/8/21		1.2.6.3.2	$0.00
64	Quality-XRF	10 days	2/8/21	13/8/21		1.2.6.3.3	$0.00
65	Heavy Machineries (Wheelloader & Crane)	10 days	2/8/21	13/8/21		1.2.6.3.4	$0.00
66	In-line Load Cells	10 days	2/8/21	13/8/21		1.2.6.3.5	$0.00
67	Pumps	10 days	2/8/21	13/8/21		1.2.6.3.6	$0.00
68	Intake	10 days	2/8/21	13/8/21		1.2.6.3.6.1	$0.00
69	Slurry	10 days	2/8/21	13/8/21		1.2.6.3.6.2	$0.00
70	Conclude Equipment	0 days	15/10/21	15/10/21	61,5	1.2.6.4	$5,000.00

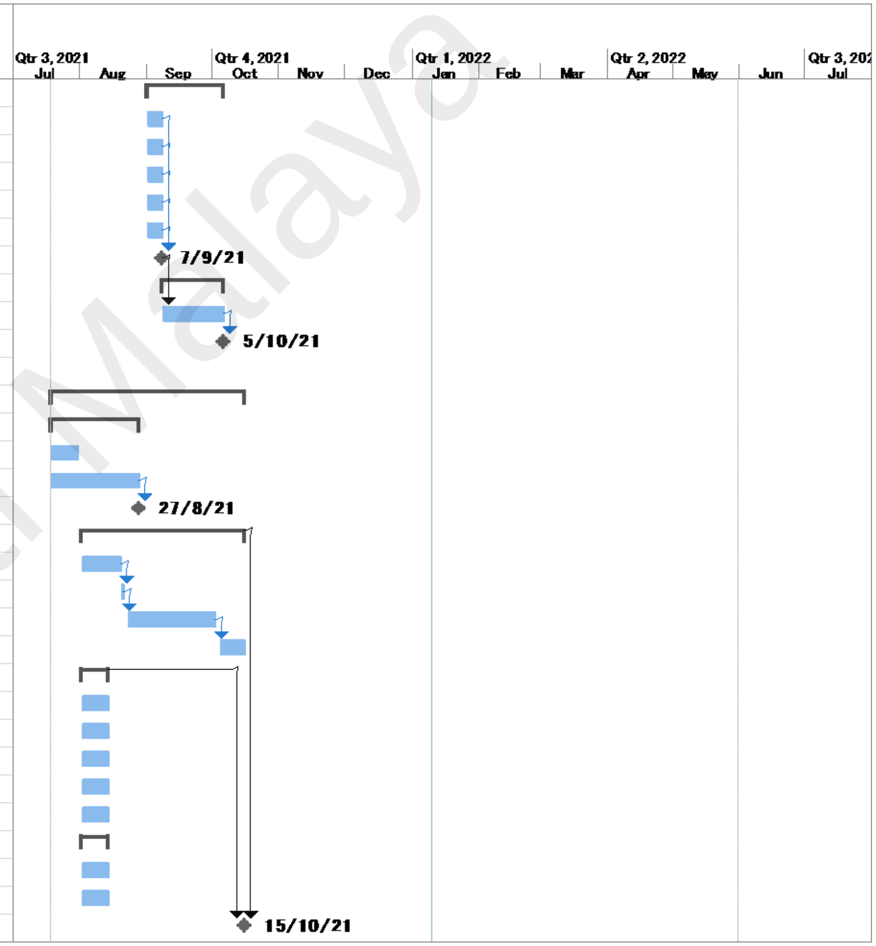


Figure 4.2, continued

ID	Task Name	Duration	Start	Finish	Predeces:	WBS
73	**PHASE 3: SETUP**	**183 days**	**27/8/21**	**10/5/22**		**1.3**
74	**Consultant**	**76 days**	**27/8/21**	**10/12/21**		**1.3.1**
75	Consultant Proposal Discussion	50 days	30/8/21	5/11/21	18,55	1.3.1.1
76	Drawing	30 days	30/8/21	8/10/21	55	1.3.1.2
77	**Contractor**	**76 days**	**27/8/21**	**10/12/21**		**1.3.1.3**
78	Earthwork	60 days	27/8/21	18/11/21	18	1.3.1.3.1
79	Civil	60 days	27/8/21	18/11/21	18	1.3.1.3.2
80	Electrical	60 days	27/8/21	18/11/21	18	1.3.1.3.3
81	Transportation	60 days	27/8/21	18/11/21	18	1.3.1.3.4
82	**Government Application**	**76 days**	**27/8/21**	**10/12/21**		**1.3.1.3.5**
83	Electric Supply	45 days	11/10/21	10/12/21	76	1.3.1.3.5.1
84	Transportation Permit	10 days	27/8/21	9/9/21	18	1.3.1.3.5.2
85	Conclude Proposal	0 days	5/11/21	5/11/21	75	1.3.1.4
86						
87	**Transition from Old Plant**	**124 days**	**1/11/21**	**21/4/22**		**1.3.2**
88	**Transfer Equipment from Old Plant**	**35 days**	**24/2/22**	**13/4/22**		**1.3.2.1**
89	Last Day of Production	1 day	24/2/22	24/2/22	132	1.3.2.1.1
90	Disassembly	20 days	25/2/22	24/3/22	89	1.3.2.1.2
91	Packing	7 days	25/3/22	4/4/22	90	1.3.2.1.3
92	Transportation to New Site	7 days	5/4/22	13/4/22	91	1.3.2.1.4
93	**Employee Transfer**	**124 days**	**1/11/21**	**21/4/22**		**1.3.2.2**
94	1st Batch	3 days	1/11/21	3/11/21	100	1.3.2.2.1
95	2nd Batch	3 days	14/4/22	18/4/22	92	1.3.2.2.2
96	3rd Batch	3 days	19/4/22	21/4/22	95	1.3.2.2.3
97						
98	**Pre-extraction**	**14 days**	**18/10/21**	**4/11/21**		**1.3.3**
99	**Trommel Unit Operation**	**13 days**	**18/10/21**	**3/11/21**		**1.3.3.1**
100	Trommel Installation & Platform Prep	10 days	18/10/21	29/10/21	60	1.3.3.1.1
101	Extraction Team on Site	3 days	1/11/21	3/11/21	100	1.3.3.1.2
102	Trommel Operation Start	0 days	3/11/21	3/11/21	101	1.3.3.1.3
103	**Excavation Team**	**1 day**	**4/11/21**	**4/11/21**		**1.3.3.2**
104	Excavator on Site	1 day	4/11/21	4/11/21	101	1.3.3.2.1
105	Extraction Start	0 days	4/11/21	4/11/21	104	1.3.3.3

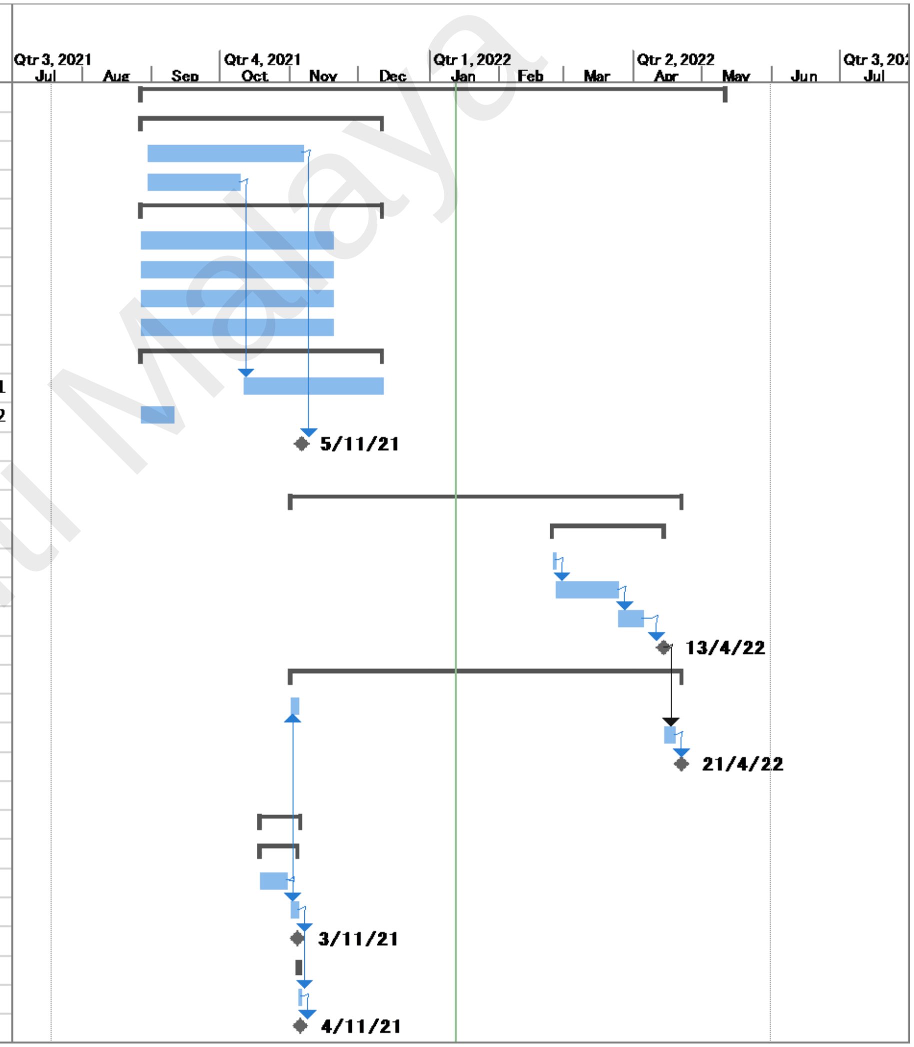


Figure 4.3: Phase 3 Schedule

ID	Task Name	Duration	Start	Finish	Predeces:	WBS
115	**Site Setup**	**132 days**	**8/11/21**	**10/5/22**		**1.3.5**
116	**Infrastructure**	**10 days**	**20/1/22**	**2/2/22**		**1.3.5.1**
117	Office	10 days	20/1/22	2/2/22	125	1.3.5.1.1
118	Living Quarters	10 days	20/1/22	2/2/22	125	1.3.5.1.2
119	**Earthworks**	**53 days**	**8/11/21**	**19/1/22**		**1.3.5.2**
120	Final Quotation	1 day	8/11/21	8/11/21	85	1.3.5.2.1
121	Issue PR	1 day	9/11/21	9/11/21	120	1.3.5.2.2
122	Conclude Earthworks Contract	1 day	10/11/21	10/11/21	121	1.3.5.2.3
123	Processing Plant Earthworks Lead Time	30 days	11/11/21	22/12/21	122	1.3.5.2.4
124	Stockpile Earthworks Lead Time	20 days	23/12/21	19/1/22	123	1.3.5.2.5
125	Conclude Earthworks Construction	0 days	19/1/22	19/1/22	124	1.3.5.2.6
126	**Plant Construction**	**78 days**	**8/11/21**	**23/2/22**		**1.3.5.3**
127	Final Quotation	1 day	8/11/21	8/11/21	85	1.3.5.3.1
128	Issue PR	1 day	9/11/21	9/11/21	127	1.3.5.3.2
129	Conclude Construction Contract	1 day	10/11/21	10/11/21	128	1.3.5.3.3
130	Processing Plant Construction Lead Time	30 days	23/12/21	2/2/22	129,113	1.3.5.3.4
131	Stockpile Construction Lead Time	15 days	3/2/22	23/2/22	130	1.3.5.3.5
132	Conclude Plant Construction	0 days	23/2/22	23/2/22	131	1.3.5.3.6
133	**Factory Installation**	**54 days**	**24/2/22**	**10/5/22**		**1.3.5.4**
134	**Electrical Equipment**	**10 days**	**24/2/22**	**9/3/22**		**1.3.5.4.1**
135	Setup	10 days	24/2/22	9/3/22	132	1.3.5.4.1.1
136	**Processing Equipment**	**44 days**	**10/3/22**	**10/5/22**		**1.3.5.4.2**
137	Setup & Connection	30 days	10/3/22	20/4/22	135	1.3.5.4.2.1
138	Test & Commisioning	14 days	21/4/22	10/5/22	137	1.3.5.4.2.2
139						
140	**Mining Plan**	**31 days**	**27/1/22**	**10/3/22**		**1.3.6**
141	Mining Engineer Arrival on Site	1 day	27/1/22	27/1/22	9	1.3.6.1
142	Review & Revise of Mining Plan	30 days	28/1/22	10/3/22	141	1.3.6.2
143	Mining Plan Confirmation	0 days	10/3/22	10/3/22	9,142	1.3.6.3

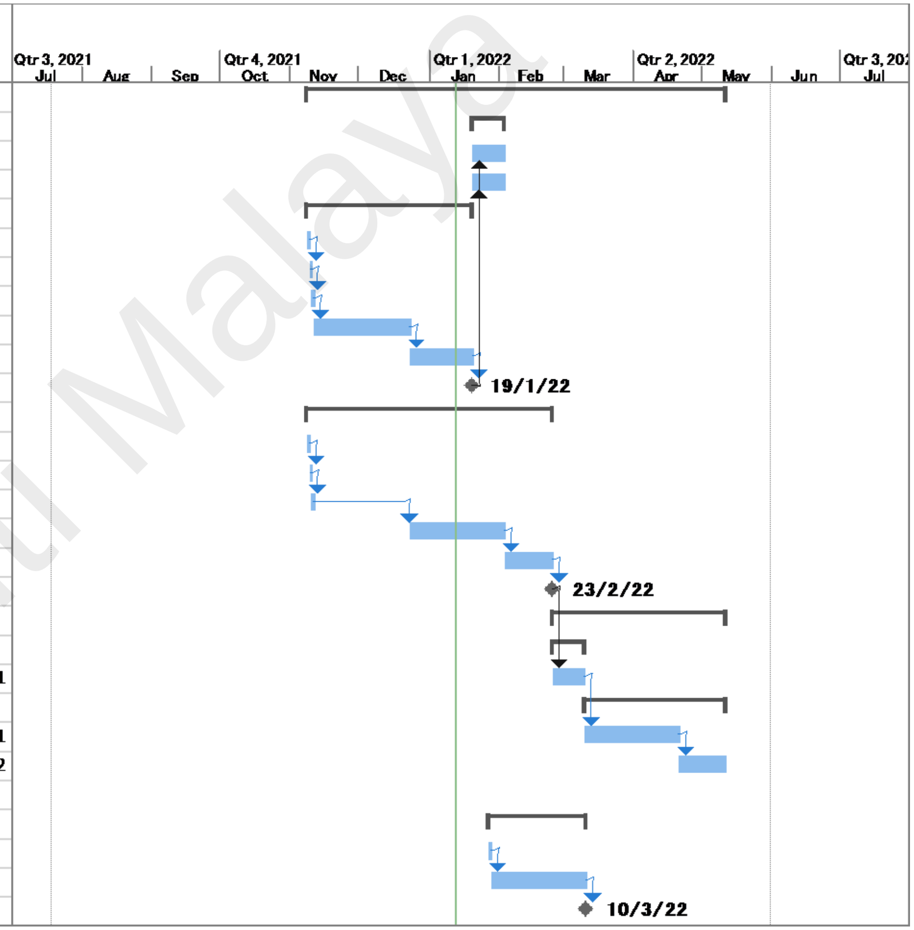


Figure 4.3, continued

ID	Task Name	Duration	Start	Finish	Pred	WBS	Cost
146	PHASE 4: PRODUCTION	147 days	5/11/21	30/5/22		1.4	$0.00
147	Extraction Operation	1 day	5/11/21	5/11/21		1.4.1	$0.00
148	Extraction (Hackers), Wheelloaders & Trucks on	1 day	5/11/21	5/11/21	105	1.4.1.1	$0.00
149							
150	Processing Plant Operation	14 days	11/5/22	30/5/22		1.4.2	$0.00
151	Processing Plant Sign-off	1 day	11/5/22	11/5/22	138,	1.4.2.1	$0.00
152	SOP Setup	14 days	11/5/22	30/5/22	138	1.4.2.2	$0.00
153	Production Sign-off	1 day	12/5/22	12/5/22	151	1.4.2.3	$0.00

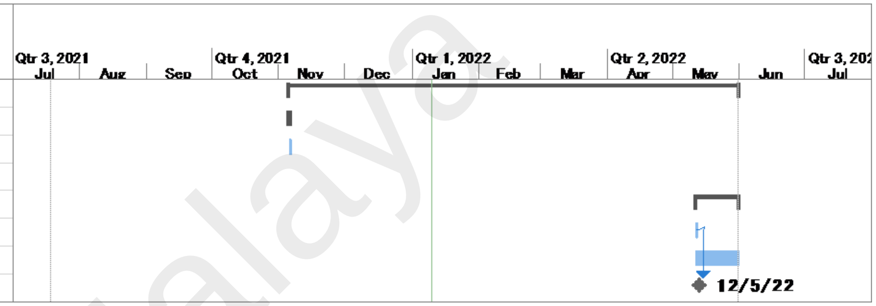


Figure 4.4: Phase 4 Schedule

4.4 Work Breakdown Structure

From the project charter and management plan, the project phases and their subtasks are defined by WBS coding as displayed in Figure 4.5. The WBS chart was converted to level 3 coding to display the overall structure. The description of tasks was presented by WBS coding due to the complexity and ease of presentation.

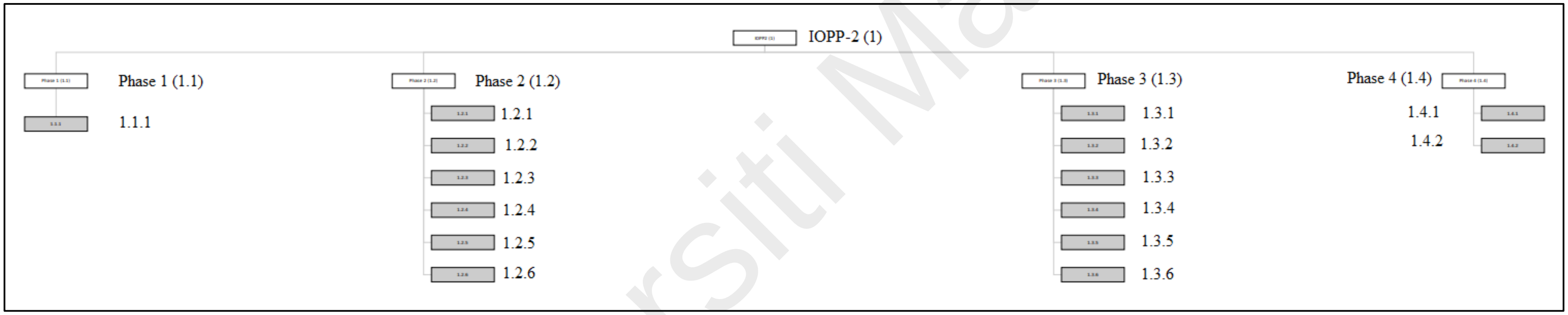


Figure 4.5: Overall WBS Structure for IOPP-2

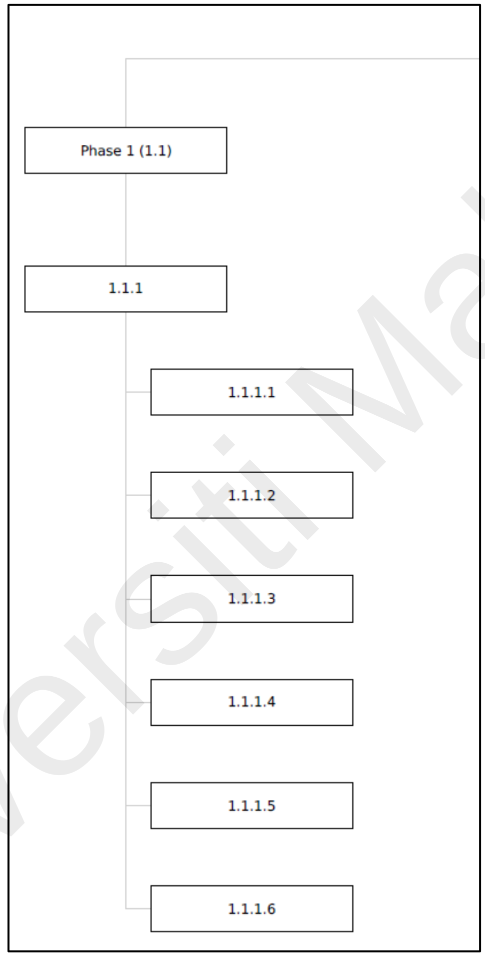


Figure 4.6: Project Phase 1 WBS

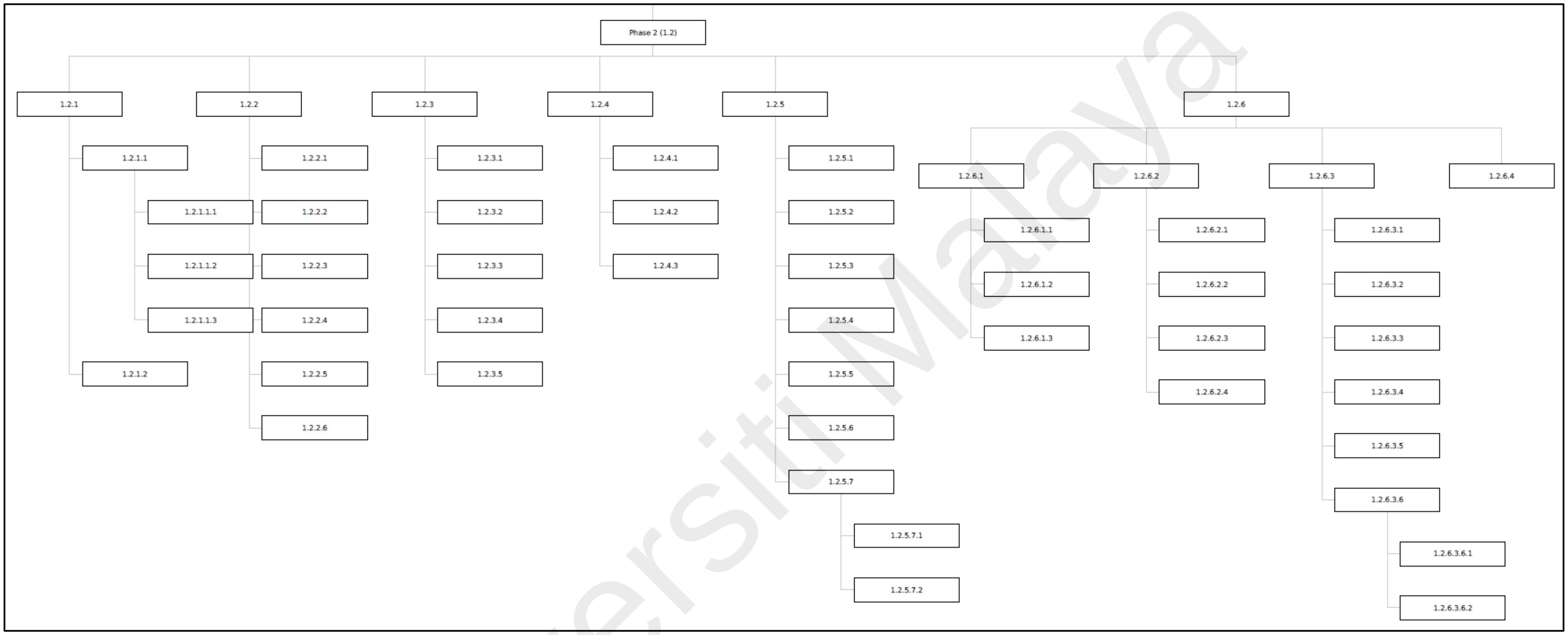


Figure 4.7: Project Phase 2 WBS

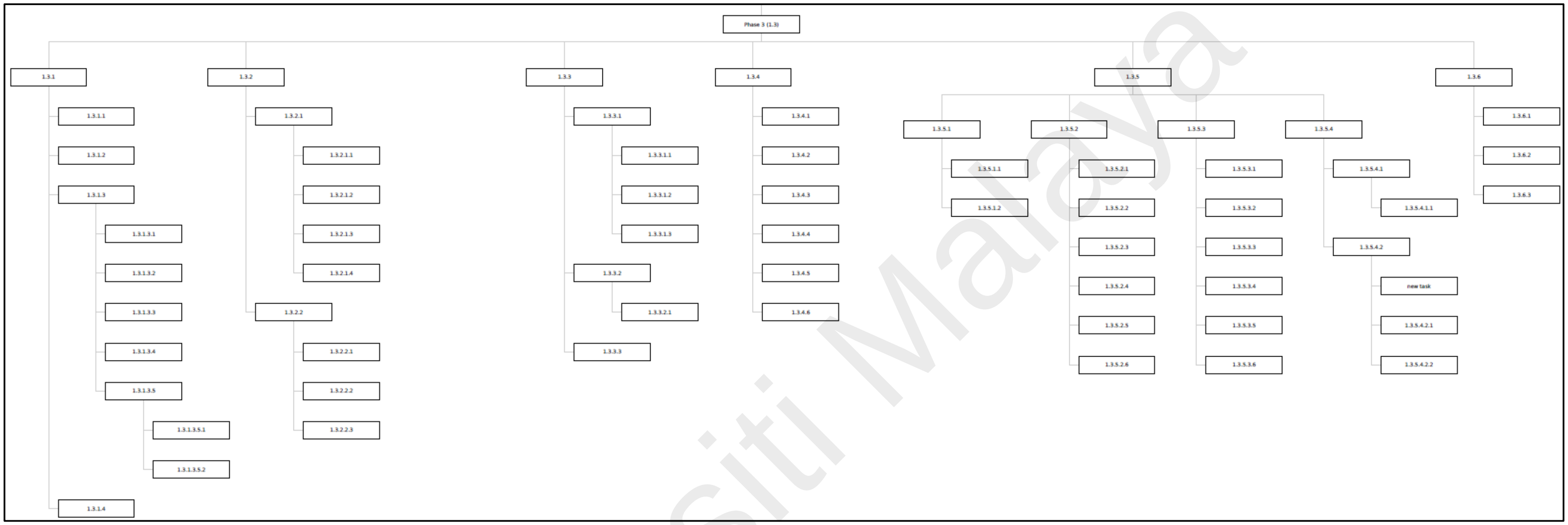


Figure 4.8: Project Phase 3 WBS

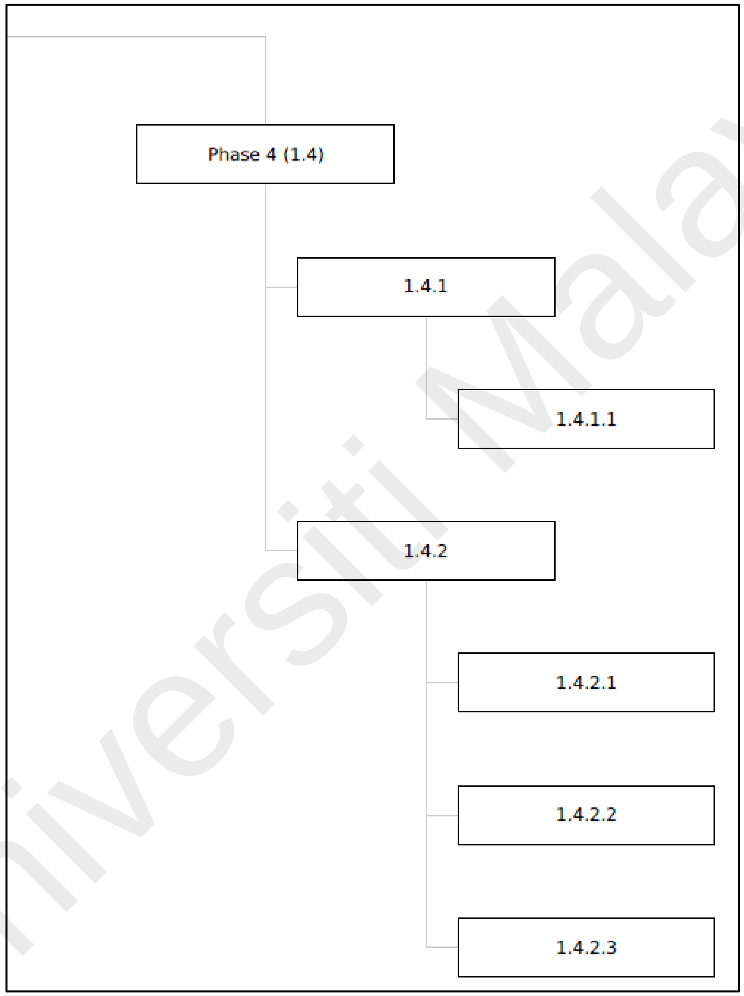


Figure 4.9: Project Phase 4 WBS

4.5 Project Scope Management

The generated project scope plan based on the project charter and management plan was tabulated and shown in Table 4.2 below. Similar information and data presented in the charter and management plan were not repeated.

Table 4.2: Project Scope Management Plan

IOPP-2 PROJECT SCOPE PLAN
Project Scope Statement
Project Scope for this project from phase 1 to phase 4 had been identified in the project charter and management plan in Table 4.1

Acceptance Criteria
• CEO to approve and sign off on the deliverables mentioned in Project Charter • Existing equipment to be transported and delivered to Site-B within the allocated time frame (Before plant construction concluded) • Obtain Mining License before the arrival of Mining Engineer. • Any project changes subject to the approval of the authorization party.

Constraints
Project Constraints for this project from phase 1 to phase 4 had been identified in the project charter and management plan in Table 4.1

Assumption
• There will be no legislative, business strategy or policy changes during this project unless due to major modification that would affect the project scope. • Cost of materials, equipment and tools will not change upon agreement during the project unless due to major modification that would affect the project scope. • Resources including materials, equipment and tools will be in good condition to be used throughout the project. • SOP setup finish date to be neglected from project completion time frame as the task is conducted concurrently with the processing plant sign-off for plant operation revision purposes.

4.6 Project Cost Breakdown

From the WBS created in Figures 4.1 to 4.4, the cost required for each phase and subtasks were tabulated as shown in Table 4.3 (Appendix D). Only level 3 subtasks were shown and the tasks that did not require any cost would not be displayed.

Table 4.3: Project Cost Breakdown

IOPP-2 PROJECT COST BREAKDOWN	
Phase / Tasks	*Cost*
Phase 1	**$100,000**
Tranche Payment	$10,000
Exploration Phase	$20,000
Feasibility Report Phase	$10,000
MPI & Dept Reviews & Approval Process	$10,000
Mining License	$50,000
Phase 2	**$400,000**
Consultant Confirmation	$5,000
Geomagnetic Survey	$50,000
Trenching Survey	$50,000
Hole Drilling	$50,000
Site Preparation Survey	$100,000
Processing Plant Design & Equipment	$145,000
Phase 3	**$500,000**
Consultant Proposal	$60,000
The transition from Old Plant (Site-A)	$50,000
Pre-extraction	$40,000
Purchase of Processing Equipment	$150,000
Site Setup	$175,000
Mining Plan	$25,000
Phase 4	**$0**
Misc. Expenses	**$100,000**
Contingency Fund	**$400,000**
TOTAL	**$1,500,000**

4.7 Project Monitor and Change Control

Throughout the project execution up to 10th Jan 2022, tracking and monitoring have been conducted by the project team. Several revisions were proposed or initiated and submitted for approval based on the scenario stated in table 4.4 shown. The impact on the overall project schedule was recorded as well.

Table 4.4: Project Change & Impact Form

IOPP-2 PROJECT CHANGE & IMPACT FORM
Revision 1 – Task Delay (Date: 2/10/21)
Scenario: • Due to the outbreak of pandemic Covid-19 in Country L, the government has strengthened border control for personnel and equipment entering the country to prevent imported cases. • Additional screening is required for official border crossing, more time was required to obtain permission and border crossing documents. • The trommel equipment and the assigned technician from Supplier K which were purchased and imported from another country will have to undergo a quarantine period of a total of 28 days upon arrival at the border (Involvement of country and district border crossing)
Impact: • Project Task #60 increased by 30 days (Totaling 40 days)
Approved by: CEO

Revision 2 – Engineering Change (Date: 17/11/21)
Scenario: • Engineering Team has proposed a new design of modular conveyor belt system to replace the suggested design by the consultant • Discussion with consultant and contractor is conducted to ensure the feasibility and affordability of the proposed design • The changes were deemed beneficial to the project which would further reduce the maintenance downtime and efficiency of the production.
Impact: • Project Task #110 cost increased by $80,000 (Totaling to $180,000)
Approved by: CEO

Revision 3 – Engineering Change (Date: 22/12/21)

Scenario:

- Engineering Team has proposed a new design of telescopic conveyor (Appendix C) to enhance the initial design by the consultant
- Discussion with consultant and contractor is conducted to ensure the feasibility and affordability of the proposed design
- The changes were deemed beneficial to the project which would further improve the stockpiling and sorting ability of the iron ore at end of the production line. The effectiveness and efficiency of production uptime can be enhanced further with this recommended equipment.

Impact:

- Project Task #110 cost increased by $120,000 (Totaling to $300,000)

Approved by: CEO

Revision 4 – Task Delay (Date: 28/12/21)

Scenario:

- Due to the occurrence of flood in Site-B, the health and safety authority has prevented earthworks to be done on the designated location
- Additional time is required to clear the site to ensure no damage is done to existing earthworks. (Reparation to be done if damages exist)
- Health and safety authority to approve prior earthworks commencement.

Impact:

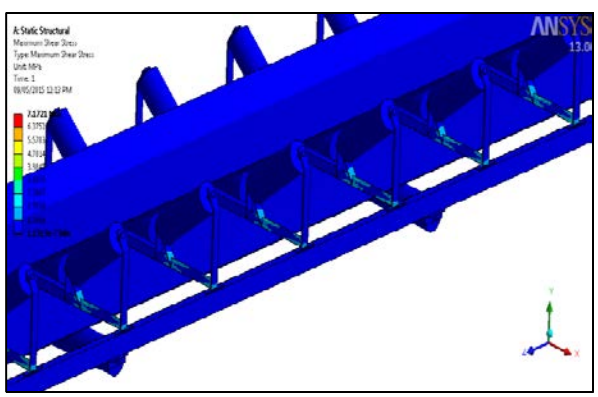
- Project Task #123 increased by 10 days (Totaling 40 days)

Approved by: CEO

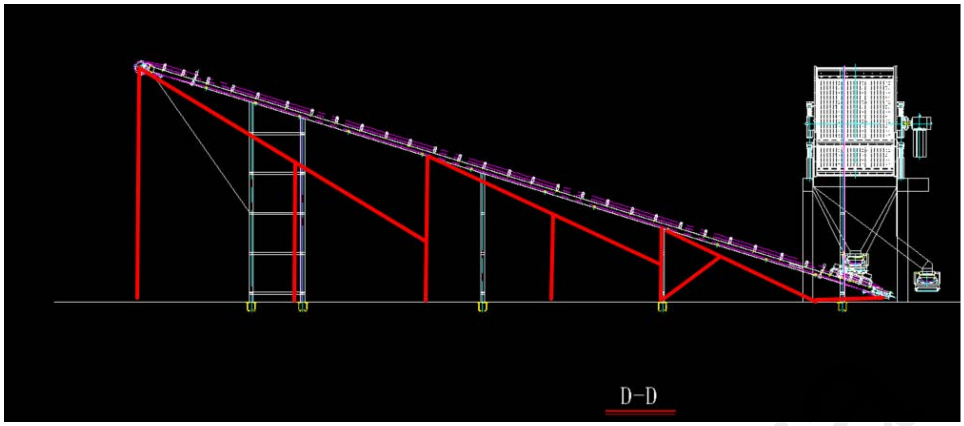
4.8 Project Engineering Design Changes

As mentioned in Chapter 4.7, the project team underwent project changes, the engineering design changes that occurred were highlighted in this case study to showcase the mechanical aspect of the project. The design process workflow was in accordance to the method presented in Chapter 3.6.3.

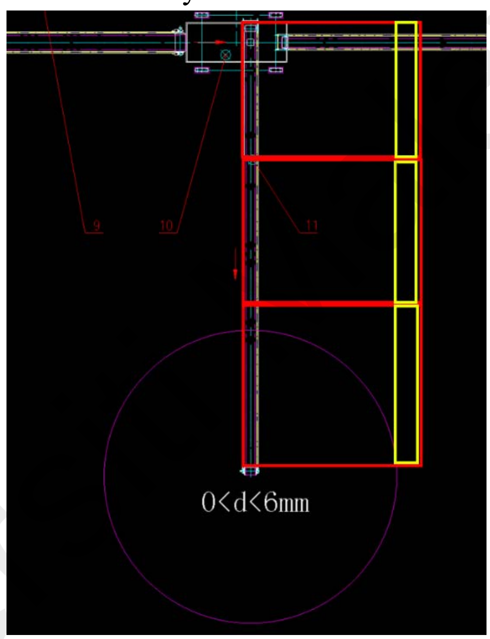
Table 4.5: Project Engineering Design Change Report

Revision 2 – Engineering Change: Modular Conveyor Belt
1. Problem Statement: • Long downtime maintenance required to repair faulty 30m length conveyor belt. • Iron ore processing is stopped until conveyor belt is repaired affecting the production rate.
2. Design Change Objective: • Reduce the downtime maintenance time for conveyor belt system. (Less than 30min) • Increase the production uptime for iron ore processing plant.
3. Proposed Solution: • Replace the 30m long conveyor belt with 3 smaller 10m mobile conveyor belt. • Modular conveyor belt system to replace the faulty conveyor with a track device.
4. Design Validation: • Design of track system to allocate back up conveyor belts, in case of downtime, disconnect the faulty conveyor and reconnect to resume production • Simulation conducted by consultant using ANSYS software for design load (30 metric tons considering conveyor belt with full load of iron ores) validation as shown below 

5. Design Detail (CAD and Product image provided by Supplier)



Side view of 3 mobile conveyor belt to be installed on track system



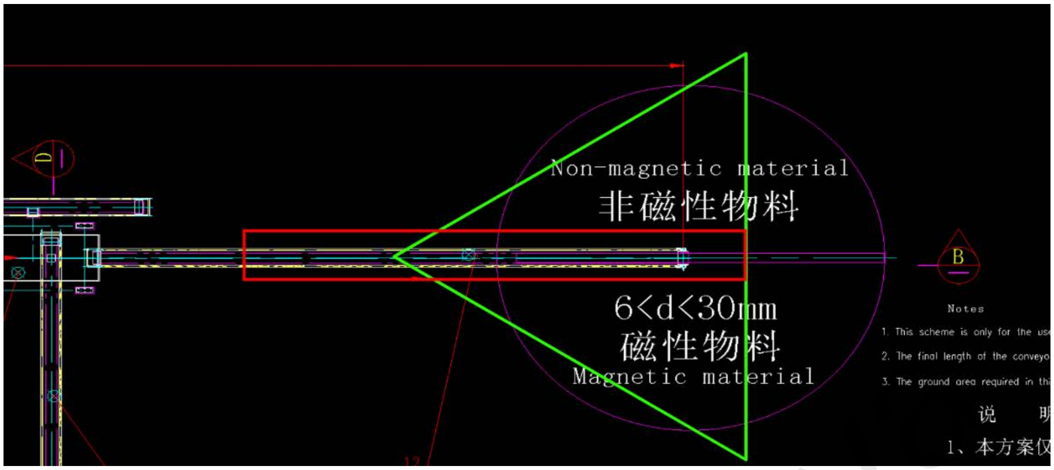
Top view of the back-up conveyor belt and the track system

Mobile Conveyor Belt to be installed on the track system

6. Design Outcome: • The downtime maintenance time are expected to cut short to 30min. Production were expected to resume after conveyor belt connection locking on track system. • Maintenance can then be executed on the faulty conveyor without disrupting the iron ore processing operation. • Actual downtime maintenance improvement is to be evaluated upon commencement of production in IOPP-2 Phase 4.
7. Design Impact Review: • 3 no of mobile conveyor belt cost $20,000 each • $20,000 were allocated for track system and installation expenses

Revision 3 – Engineering Change (Date: 22/12/21)
1. Problem Statement: • Stockpiling of iron ore end product at the processing plant require extensive workload for wheel loader to transfer. • Limited area and flexibility for iron ore product stockpiling
2. Design Change Objective: • Increase the stockpiling capacity and area. • Increase the flexibility and utilizing the large area available on site
3. Proposed Solution: • Replace the 30m long conveyor belt with telescopic conveyor
4. Design Validation: • Integration of telescopic conveyor into the initial designed iron ore processing plant were conducted by consultant and supplier together with the engineering team. • Consultant has evaluated the feasibility of connecting part of the conveyor belt with the telescopic conveyor system.

5. Design Detail: (CAD and Product image provided by Supplier)



Top view of telescopic conveyor system integrated with the standard conveyor. Range of movement were indicated as shown.

Side view of telescopic conveyor provided by Supplier

Telescopic conveyor to be installed on the end of the iron ore processing plant

6. Design Outcome:

- The stockpiling capability of the iron ores at the end of the processing plant are expected to have increase of at least 200%.
- The usage of wheel loader is expected to be reduced, hence reducing the manpower and rental required
- Actual cost effectiveness of the utilization of telescopic conveyor against wheel loader usage is to be evaluated upon commencement of production in IOPP-2 Phase 4.

7. Design Impact Review:

- $100,000 allocated for telescopic conveyor purchase
- $20,000 allocated for system installation expenses

4.9 Project Status Update

As the project progressed with the tracking and monitoring by the project team, the author had set 10th Jan 2022 as the cut-off date for the preparation of this dissertation. Project tasks were updated with the percentage of completion throughout the project period. Approved project changes presented in subchapter 4.6 were applied in the project update as well. As of the project date, the IOPP-2 project has achieved 80% completion.

ID	Task Name	Duration	Start	Finish	Predeces	WBS	% Complete
1	NEW IRON ORE PROCESSING PLANT SETUP	256 days	19/7/21	11/7/22		1	80%
2	PHASE 1: AGREEMENTS	138 days	19/7/21	26/1/22		1.1	93%
3	Agreement Arrangement	138 days	19/7/21	26/1/22		1.1.1	93%
4	Agreement Signed	0 days	19/7/21	19/7/21		1.1.1.1	100%
5	Tranche Payments	8 days	19/7/21	28/7/21	4	1.1.1.2	100%
6	Exploration Phase	90 days	29/7/21	1/12/21	5	1.1.1.3	100%
7	Feasibility Report Phase	30 days	2/12/21	12/1/22	6	1.1.1.4	100%
8	MPI & Dept Reviews & Approval Process	10 days	13/1/22	26/1/22	7	1.1.1.5	0%
9	Mining License	0 days	26/1/22	26/1/22	8	1.1.1.6	0%

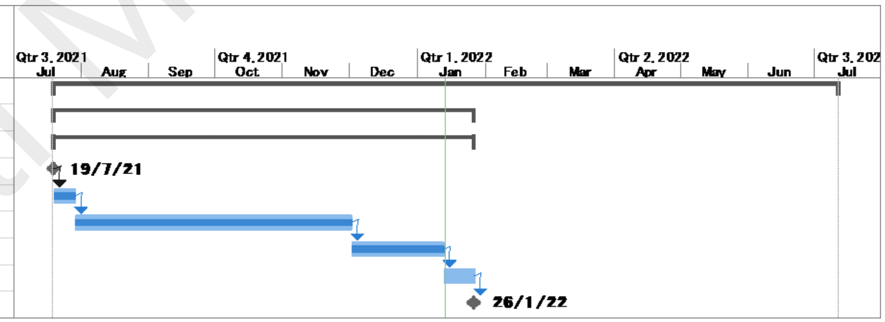


Figure 4.10: Project Update Schedule Phase 1

ID	Task Name	Duration	Start	Finish	Predeces	WBS	% Complete
12	PHASE 2: PREPARATION - Site Surveys & Plan	114 days	19/7/21	23/12/21		1.2	100%
13	Consultant	19 days	2/8/21	26/8/21		1.2.1	100%
14	Electrical & Civil Consulting Searching	19 days	2/8/21	26/8/21		1.2.1.1	100%
15	Settling Pond	14 days	2/8/21	19/8/21		1.2.1.1.1	100%
16	Civil & Structural	14 days	2/8/21	19/8/21		1.2.1.1.2	100%
17	M&E	14 days	9/8/21	26/8/21		1.2.1.1.3	100%
18	Consultant Confirmation	0 days	26/8/21	26/8/21	14	1.2.1.2	100%
19							
20	Geomagnetic Survey with Drone	50 days	30/7/21	7/10/21		1.2.2	100%
21	Final Quotation	12 days	30/7/21	16/8/21		1.2.2.1	100%
22	Issue PR	1 day	17/8/21	17/8/21	21	1.2.2.2	100%
23	Drone Team at Site	3 days	18/8/21	20/8/21	22	1.2.2.3	100%
24	Geomagnetic Team at Site	3 days	23/8/21	25/8/21	23	1.2.2.4	100%
25	Geomagnetic Drone Survey	21 days	26/8/21	23/9/21	24	1.2.2.5	100%
26	Geomagnetic Survey Report Preparation	10 days	24/9/21	7/10/21	25	1.2.2.6	100%
27							
28	Trenching Survey	44 days	2/8/21	30/9/21		1.2.3	100%
29	Approval Granted	1 day	2/8/21	2/8/21	5	1.2.3.1	100%
30	Excavators at Site	3 days	3/8/21	5/8/21	29	1.2.3.2	100%
31	Trenching Process	30 days	6/8/21	16/9/21	30	1.2.3.3	100%
32	Channeling Testing	40 days	6/8/21	30/9/21	30	1.2.3.4	100%
33	Trenching Report	0 days	30/9/21	30/9/21	31,32	1.2.3.5	100%
34							
35	Hole Drilling	55 days	8/10/21	23/12/21		1.2.4	100%
36	Drill Hole Plan	5 days	8/10/21	14/10/21	26,33	1.2.4.1	100%
37	Drill Hole Activities	30 days	15/10/21	25/11/21	36	1.2.4.2	100%
38	Drill Hole Report	20 days	26/11/21	23/12/21	37	1.2.4.3	100%

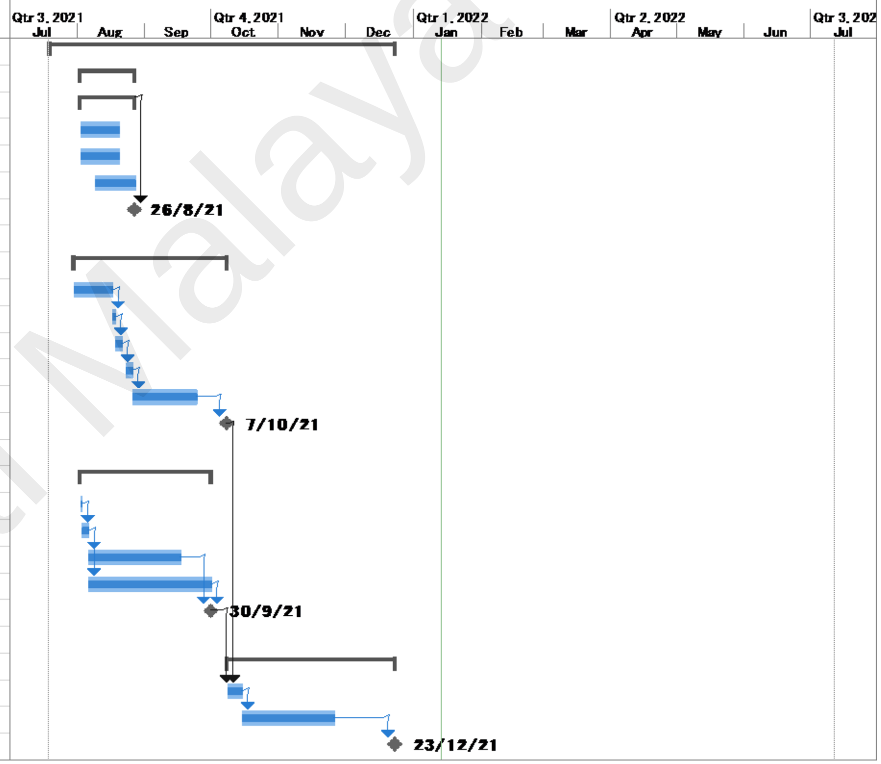


Figure 4.11: Project Schedule Update Phase 2

ID	Task Name	Duration	Start	Finish	Predeces	WBS	% Complete
40	**Site Preparation Survey**	**25 days**	**1/9/21**	**5/10/21**		**1.2.5**	**100%**
41	Factory Actual Site Survey	5 days	1/9/21	7/9/21		1.2.5.1	100%
42	Access Road	5 days	1/9/21	7/9/21		1.2.5.2	100%
43	Electricity Supply	5 days	1/9/21	7/9/21		1.2.5.3	100%
44	Water Source	5 days	1/9/21	7/9/21		1.2.5.4	100%
45	Tailing Dam & Settling Ponds	5 days	1/9/21	7/9/21		1.2.5.5	100%
46	Processing Site Confirmation	0 days	7/9/21	7/9/21	41,42,43	1.2.5.6	100%
47	**Site Layout Drawing**	**20 days**	**8/9/21**	**5/10/21**		**1.2.5.7**	**100%**
48	Site Layout & Setup Discussion	20 days	8/9/21	5/10/21	46	1.2.5.7.1	100%
49	Site Layout Confirmed	0 days	5/10/21	5/10/21	48	1.2.5.7.2	100%
50							
51	**Processing Plant Design & Equipment Specs**	**95 days**	**19/7/21**	**26/11/21**		**1.2.6**	**100%**
52	**Process Flow**	**30 days**	**19/7/21**	**27/8/21**		**1.2.6.1**	**100%**
53	Raw Materials	10 days	19/7/21	30/7/21		1.2.6.1.1	100%
54	Process Flow and Setup Discussion with Supp	30 days	19/7/21	27/8/21		1.2.6.1.2	100%
55	Conclude Process Flow	0 days	27/8/21	27/8/21	54	1.2.6.1.3	100%
56	**Extraction Equipment**	**85 days**	**2/8/21**	**26/11/21**		**1.2.6.2**	**100%**
57	Trommel Specs Searching	14 days	2/8/21	19/8/21		1.2.6.2.1	100%
58	Issue PR	1 day	20/8/21	20/8/21	57	1.2.6.2.2	100%
59	Trommel Lead Time	30 days	23/8/21	1/10/21	58	1.2.6.2.3	100%
60	**Trommel Transportation**	**40 days**	**4/10/21**	**26/11/21**	59	1.2.6.2.4	100%
61	**Current Equipment & Specs (Inspection)**	**10 days**	**2/8/21**	**13/8/21**		**1.2.6.3**	**100%**
62	Transformer	10 days	2/8/21	13/8/21		1.2.6.3.1	100%
63	Weightbridge	10 days	2/8/21	13/8/21		1.2.6.3.2	100%
64	Quality-XRF	10 days	2/8/21	13/8/21		1.2.6.3.3	100%
65	Heavy Machineries (Wheelloader & Crane)	10 days	2/8/21	13/8/21		1.2.6.3.4	100%
66	In-line Load Cells	10 days	2/8/21	13/8/21		1.2.6.3.5	100%
67	Pumps	10 days	2/8/21	13/8/21		1.2.6.3.6	100%
68	Intake	10 days	2/8/21	13/8/21		1.2.6.3.6.1	100%
69	Slurry	10 days	2/8/21	13/8/21		1.2.6.3.6.2	100%
70	Conclude Equipment	0 days	26/11/21	26/11/21	61,56	1.2.6.4	100%

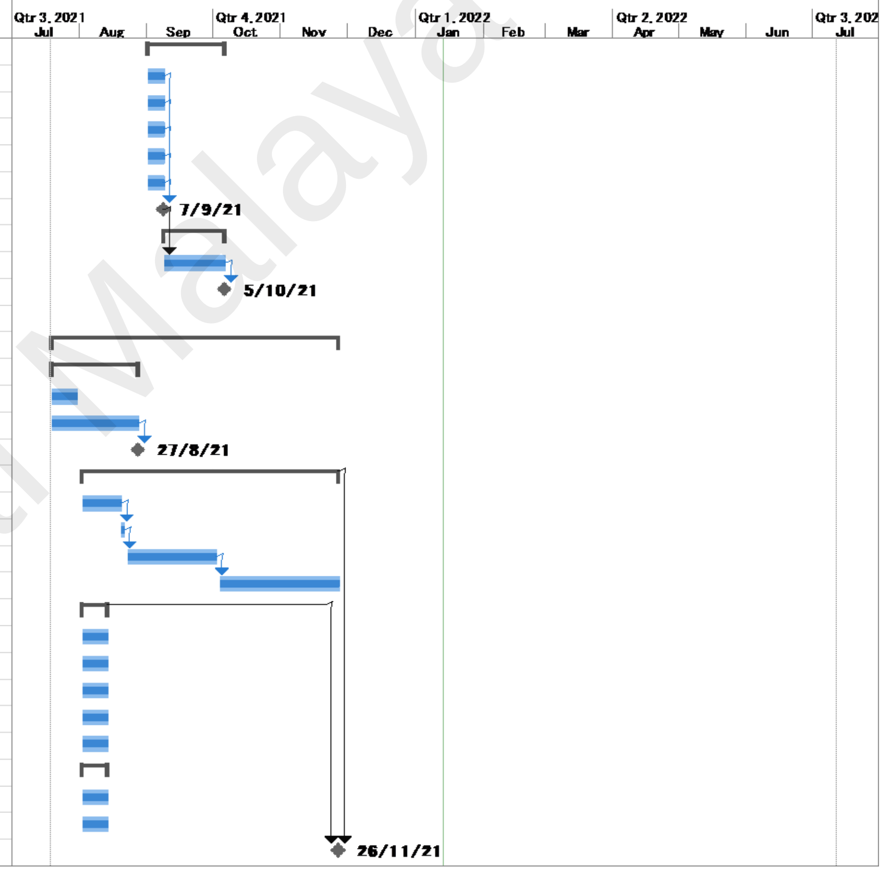


Figure 4.11, continued

ID	Task Name	Duration	Start	Finish	Predeces	WBS	% Complete
73	**PHASE 3: SETUP**	**213 days**	**27/8/21**	**21/6/22**		**1.3**	**67%**
74	**Consultant**	**76 days**	**27/8/21**	**10/12/21**		**1.3.1**	**100%**
75	Consultant Proposal Discussion	50 days	30/8/21	5/11/21	18,55	1.3.1.1	100%
76	Drawing	30 days	30/8/21	8/10/21	55	1.3.1.2	100%
77	**Contractor**	**76 days**	**27/8/21**	**10/12/21**		**1.3.1.3**	**100%**
78	Earthwork	60 days	27/8/21	18/11/21	18	1.3.1.3.1	100%
79	Civil	60 days	27/8/21	18/11/21	18	1.3.1.3.2	100%
80	Electrical	60 days	27/8/21	18/11/21	18	1.3.1.3.3	100%
81	Transportation	60 days	27/8/21	18/11/21	18	1.3.1.3.4	100%
82	**Government Application**	**76 days**	**27/8/21**	**10/12/21**		**1.3.1.3.5**	**100%**
83	Electric Supply	45 days	11/10/21	10/12/21	76	1.3.1.3.5.1	100%
84	Transportation Permit	10 days	27/8/21	9/9/21	18	1.3.1.3.5.2	100%
85	Conclude Proposal	0 days	5/11/21	5/11/21	75	1.3.1.4	100%
86							
87	**Transition from Old Plant**	**124 days**	**13/12/21**	**2/6/22**		**1.3.2**	**7%**
88	**Transfer Equipment from Old Plant**	**35 days**	**7/4/22**	**25/5/22**		**1.3.2.1**	**0%**
89	Last Day of Production	1 day	7/4/22	7/4/22	132	1.3.2.1.1	0%
90	Disassembly	20 days	8/4/22	5/5/22	89	1.3.2.1.2	0%
91	Packing	7 days	6/5/22	16/5/22	90	1.3.2.1.3	0%
92	Transportation to New Site	7 days	17/5/22	25/5/22	91	1.3.2.1.4	0%
93	**Employee Transfer**	**124 days**	**13/12/21**	**2/6/22**		**1.3.2.2**	**33%**
94	1st Batch	3 days	13/12/21	15/12/21	100	1.3.2.2.1	100%
95	2nd Batch	3 days	26/5/22	30/5/22	92	1.3.2.2.2	0%
96	3rd Batch	3 days	31/5/22	2/6/22	95	1.3.2.2.3	0%
97							
98	**Pre-extraction**	**14 days**	**29/11/21**	**16/12/21**		**1.3.3**	**100%**
99	**Trommel Unit Operation**	**13 days**	**29/11/21**	**15/12/21**		**1.3.3.1**	**100%**
100	Trommel Installation & Platform Prep	10 days	29/11/21	10/12/21	60	1.3.3.1.1	100%
101	Extraction Team on Site	3 days	13/12/21	15/12/21	100	1.3.3.1.2	100%
102	Trommel Operation Start	0 days	15/12/21	15/12/21	101	1.3.3.1.3	100%
103	**Excavation Team**	**1 day**	**16/12/21**	**16/12/21**		**1.3.3.2**	**100%**
104	Excavator on Site	1 day	16/12/21	16/12/21	101	1.3.3.2.1	100%
105	Extraction Start	0 days	16/12/21	16/12/21	104	1.3.3.3	100%

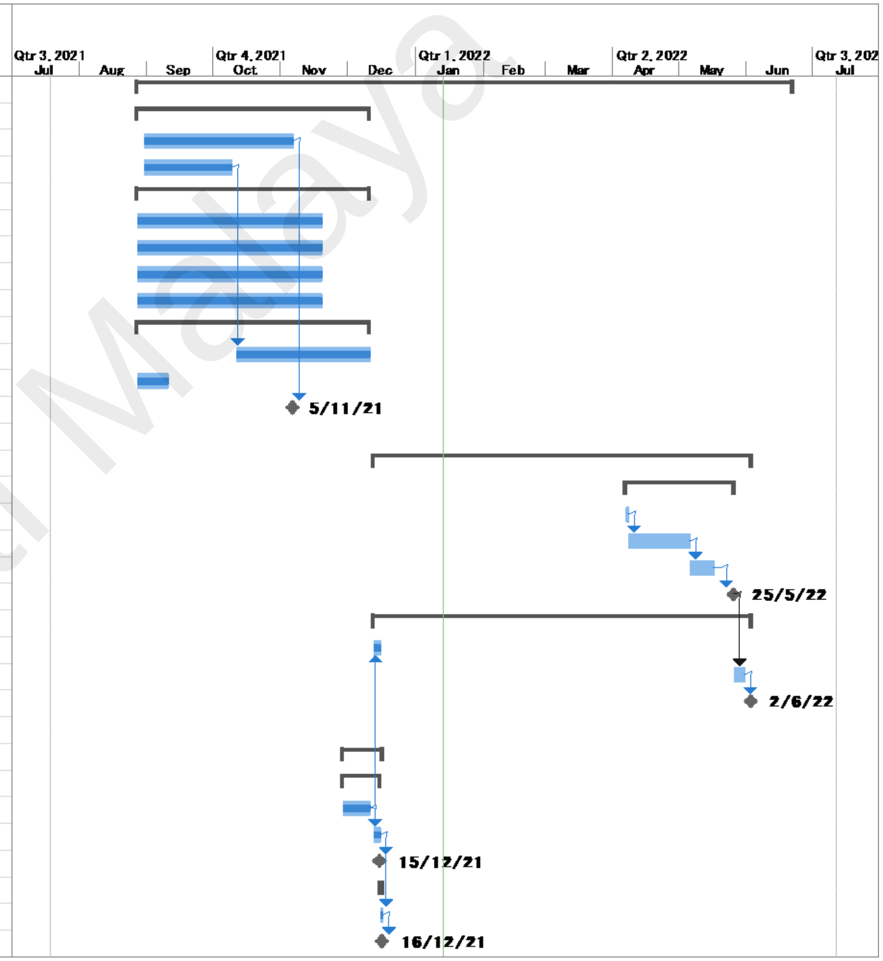


Figure 4.12: Project Schedule Update Phase 3

ID	Task Name	Duration	Start	Finish	Predecessors	WBS	% Complete
107	**Purchase of Processing Equipment from Supplier**	**48 days**	**29/11/21**	**2/2/22**		**1.3.4**	**57%**
108	Final Quotation	3 days	29/11/21	1/12/21	70,55	1.3.4.1	100%
109	Issue PR	1 day	2/12/21	2/12/21	108	1.3.4.2	100%
110	Conclude Equipment Order	1 day	3/12/21	3/12/21	109	1.3.4.3	100%
111	Equipment Lead Time	30 days	6/12/21	14/1/22	110	1.3.4.4	75%
112	Equipment Transport Lead Time	10 days	17/1/22	28/1/22	111	1.3.4.5	0%
113	Equipment Arrive on Site	3 days	31/1/22	2/2/22	112	1.3.4.6	0%
114							
115	**Site Setup**	**162 days**	**8/11/21**	**21/6/22**		**1.3.5**	**25%**
116	**Infrastructure**	**10 days**	**3/2/22**	**16/2/22**		**1.3.5.1**	**0%**
117	Office	10 days	3/2/22	16/2/22	125	1.3.5.1.1	0%
118	Living Quarters	10 days	3/2/22	16/2/22	125	1.3.5.1.2	0%
119	**Earthworks**	**63 days**	**8/11/21**	**2/2/22**		**1.3.5.2**	**68%**
120	Final Quotation	1 day	8/11/21	8/11/21	85	1.3.5.2.1	100%
121	Issue PR	1 day	9/11/21	9/11/21	120	1.3.5.2.2	100%
122	Conclude Earthworks Contract	1 day	10/11/21	10/11/21	121	1.3.5.2.3	100%
123	Processing Plant Earthworks Lead Time	40 days	11/11/21	5/1/22	122	1.3.5.2.4	100%
124	Stockpile Earthworks Lead Time	20 days	6/1/22	2/2/22	123	1.3.5.2.5	0%
125	Conclude Earthworks Construction	0 days	2/2/22	2/2/22	124	1.3.5.2.6	0%
126	**Plant Construction**	**108 days**	**8/11/21**	**6/4/22**		**1.3.5.3**	**6%**
127	Final Quotation	1 day	8/11/21	8/11/21	85	1.3.5.3.1	100%
128	Issue PR	1 day	9/11/21	9/11/21	127	1.3.5.3.2	100%
129	Conclude Construction Contract	1 day	10/11/21	10/11/21	128	1.3.5.3.3	100%
130	Processing Plant Construction Lead Time	30 days	3/2/22	16/3/22	129,113	1.3.5.3.4	0%
131	Stockpile Construction Lead Time	15 days	17/3/22	6/4/22	130	1.3.5.3.5	0%
132	Conclude Plant Construction	0 days	6/4/22	6/4/22	131	1.3.5.3.6	0%
133	**Factory Installation**	**54 days**	**7/4/22**	**21/6/22**		**1.3.5.4**	**0%**
134	**Electrical Equipment**	**10 days**	**7/4/22**	**20/4/22**		**1.3.5.4.1**	**0%**
135	Setup	10 days	7/4/22	20/4/22	132	1.3.5.4.1.1	0%
136	**Processing Equipment**	**44 days**	**21/4/22**	**21/6/22**		**1.3.5.4.2**	**0%**
137	Setup & Connection	30 days	21/4/22	1/6/22	135	1.3.5.4.2.1	0%
138	Test & Commisioning	14 days	2/6/22	21/6/22	137	1.3.5.4.2.2	0%
139							
140	**Mining Plan**	**31 days**	**27/1/22**	**10/3/22**		**1.3.6**	**0%**
141	Mining Engineer Arrival on Site	1 day	27/1/22	27/1/22	9	1.3.6.1	0%
142	Review & Revise of Mining Plan	30 days	28/1/22	10/3/22	141	1.3.6.2	0%
143	Mining Plan Confirmation	0 days	10/3/22	10/3/22	9,142	1.3.6.3	0%

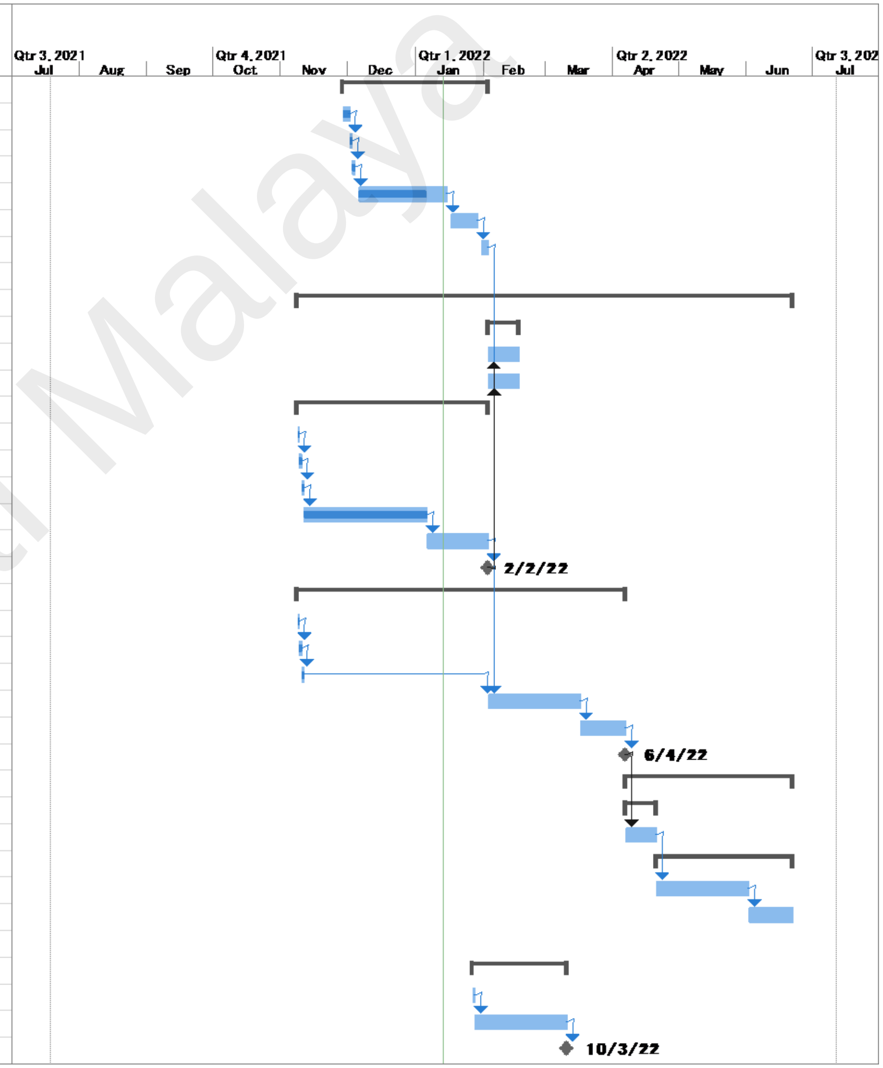


Figure 4.12, continued

ID	Task Name	Duration	Start	Finish	Predeces	WBS	% Complete
146	PHASE 4: PRODUCTION	147 days	17/12/21	11/7/22		1.4	6%
147	Extraction Operation	1 day	17/12/21	17/12/21		1.4.1	100%
148	Extraction (Hackers), Wheelloaders & Trucks on	1 day	17/12/21	17/12/21	105	1.4.1.1	100%
149							
150	Processing Plant Operation	14 days	22/6/22	11/7/22		1.4.2	0%
151	Processing Plant Sign-off	1 day	22/6/22	22/6/22	138,96,1	1.4.2.1	0%
152	SOP Setup	14 days	22/6/22	11/7/22	138	1.4.2.2	0%
153	Production Sign-off	1 day	23/6/22	23/6/22	151	1.4.2.3	0%

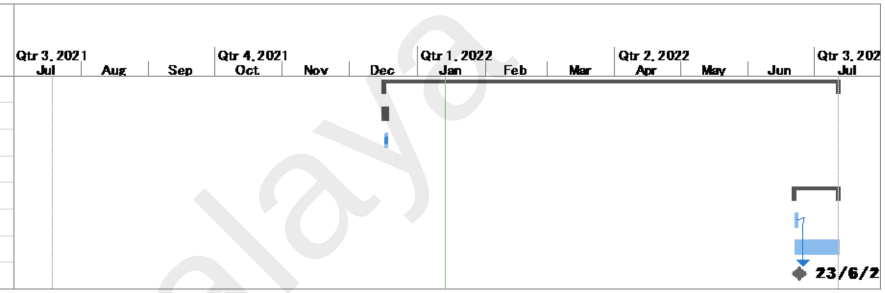


Figure 4.13: Project Schedule Update Phase 4

CHAPTER 5: DISCUSSION

This case study began with the initial planning of developing a new iron ore processing plant in the designated site proposed by Company H. From table 4.1, the project charter and management plan generated by the project manager has clearly defined the Project Plan Summary. This would provide the necessary information for any parties to understand the general knowledge of this project in a short amount of time. In the project management plan, the project objective was identified based on the problem statement relevant to this case study. Specific measurable elements such as the project cost and time constraints to be achieved for the project were tabulated in it. Summarized budget and resources distribution had been revealed for the general understanding of budget allocation. With the main project objective in consideration, the author's project team has expanded and divided the project scopes into phases as shown in the plan. Subsequently, the project deliverables and milestones linked to the project phases were presented with the key items or documents and data to be acquired. These would aid the project team and stakeholders to have appropriate expectations and arrangements throughout the project progression. The stakeholders and project team list had also been established in the document. This includes the governing body, consultants and suppliers involved in the project. The person in charge of the team leaders for each department had been assigned as per the project team and communication among the project team and stakeholders on relevant project tasks were encouraged to ensure the project runs smoothly. In addition, the transparency of actions during the project period was guaranteed. Finally, the approval of the project charter and management plan had been presented by the project manager with authorization from the project sponsor and governing body which is the CEO of company H and the Department of Mining respectively in this case.

With case study of the international railway station project indicated in Chapter 2.3.1 as benchmark, the iron ore processing plant development project has outlined far more in detail in subsequent layering of level. The project details comprise all the major information are presented systematic unlike the one displayed in the benchmark case study.

Next, the project team generated the project schedule (Figures 4.1 to 4.4) for the development of an iron ore processing plant with the use of the Microsoft Project. All project tasks involved were analysed and assigned project duration, WBS coding and costing based on the hierarchy level task. Each task was categorized into phases for ease of management. Milestones were associated for each deliverable to be obtained throughout the project progress. The predecessor of each linked task was pictured in the Gantt chart and displayed for demonstrative tracking and monitoring of the project. This outlined the project period that would occur from July 2021 and eventually complete its final task with deliverables on the 12^{th} of May (Week 2) of May 2022. One of the tasks in phase 4 which are planned to finish on 30^{th} May were neglected from the project completion period as mentioned in the project scope assumption. Subsequently, from the defined WBS coding, the project team developed the WBS chart based on the structure categorising by phase similarly as shown in the project schedule. From figure 4.5, the compact version of WBS coding up to level 3 was presented to show the relevance by phase. After that, the details of each task were expanded to indicate the responsibilities for each phase of the project (Figures 4.6 to 4.9). This would avoid duplication of task assignments and improve the understanding and connection for all subjects involved. From the created WBS, Project Scope Plan has been produced as presented in Table 4.2. As stated, the project scope statement for the project phases has been identified in Table 4.1, hence the acceptance criteria were listed as shown. This would greatly avoid miscommunication throughout the project and ensure the stakeholders, and decision-makers of the project stay on the same page. Several assumptions have also been made to avoid any fluctuation of data in reporting and further reduce the risk and set up a benchmark for the project team to revisit ultimately helping them to keep the project in scope.

With most of the project tasks and expected deliverables and milestones set in stone, the project cost breakdown was provided. Correspondingly to the project schedule format, the project cost breakdown (Table 4.3) was tabulated by phase in the category. From the experience of the project team in the past project with resemblances, analysis and investigation were carried out to estimate and evaluate the cost for each project task and inputted in the table more accurately. The miscellaneous expenses and contingency fund value was also determined to produce the project budget as shown in the project charter and management plan. The clear expectancy of cost in this document would provide the transparency for the project team to manage the project margin, return on investment and efficiently track and respond with correction action for the project if required.

From the established plan, schedule, scope and cost of the project, the project team proceeded the project to execution while initiating the project tracking and monitoring approaches. The project team were tasked to update the completion of tasks throughout the project progress. In this case study, the project schedule was updated by the end of the working week. Whenever events occurred that may affect the project scope or duration, the project team were responsible to plan, adjusting, monitor and measuring the preventive or corrective action to be taken. For this matter, the project team were subjected to submit the project change request and impact form to indicate the date of events, description of scenario and scale of impact to seek approval from the project stakeholders. As shown in Table 4.4, planned and unplanned events were recorded and evaluated to estimate the effect on the project deliverables and scope. With the aid of Microsoft Project, the project team were able to input the project changes into the ongoing project schedule to gauge the outcome.

In comparison to the stated aspect of scheduling, scopes and project tasks details, the case study benchmark scheduling shown in Figure 2.6, it only displayed the key deliveries date of project starting date and completion date without further elaboration of project tasks. Although, the case studies did not display the usage of project management tools in this regard, the author and the project team has utilized the Microsoft Project in order to tabulate the majority project tasks and key milestones as shown in Chapter 4.

In further elaboration of the project design changes conducted in Chapter 4, the detail engineering design workflow were also showcased by the author outlining the mechanical designing aspect of the case study. The engineering team has worked closely together with the consultant and supplier to generate the project engineering design report in order to further improve the newly developed iron ore processing plant efficiency and effectiveness. Both design changes were declared to be a success despite the cost changes that occurred due to it. The project design changes outcome were approved by the stakeholders and the project were still progressing smoothly towards the project objectives.

As mentioned by the author, the project status update was set to cut off on 10^{th} Jan 2022 as presented in Figures 4.10 to 4.13. The project completion rates up to the date were tabulated in Table 5.1 as shown below.

Table 5.1: Project Status Update, Dated 10th Jan 2022

IOPP-2 PROJECT STATUS UPDATE (DATE: 10/1/2022)	
Phase / Tasks	*% Complete*
Phase 1	93%
Phase 2	100%
Phase 3	67%
Phase 4	0%
IOPP-2 Project Progress	**80%**
Project Status	*No. of days*
Initial Planning	297 days
Updated 10/1/2022	330 days
IOPP-2 Project Duration Increase	**11.11%**
Project Status	*Cost*
Initial Planning	$1,000,000
Updated 10/1/2022	$1,200,000
IOPP-2 Project Cost Increase	**20%**

As the project team finalized the project status on 10th Jan 2022, the overall project tasks have a completion rate of 80%. The project duration has increased by 11.11% and pushed back the project completion date to 23rd Jun 2022 as a result of Covid-19 and flood occurrence. The Project cost has also increased by 20% due to the engineering changes and proposals by the project team. Despite the project changes and impact that took place, the project team still managed to maintain the high rate of completion. Although there is an increase in project duration, the project stakeholders had considered the delay unavoidable hence approval has been granted to continue with the project. Finally, the project cost has also increased by USD 200,000 which is 20% of the initially planned amount. Although this has led to the utilisation of the contingency fund of the project, reducing it to USD 300,000 (From USD 500,000). The project sponsor still authorized the engineering changes implemented and determined that it would conclusively be beneficial to the project outcome by increasing the productivity of the processing plant built and improving the plant maintenance downtime.

CHAPTER 6: CONCLUSION

In this case study, the author and the project team began the development of an iron ore processing plant with the implementation of a project management approach as stated in the dissertation objective. In the initial stage of the project, the project team has successfully applied the project management aspect of planning, schedule management, scope management and cost management. The instituted system aided the project team to define and classifying the key information required to execute the project accordingly. In addition, the tracking, monitoring, and controlling of the project were also conducted as mentioned in the objectives. Timely guidelines and application of project management knowledge by the project team have guaranteed the project to be progressed efficiently. All project changes and requests that emerged had been effectively resolved by the project team with authorization from the project sponsor and stakeholders. The engineering design changes that occurred were further elaborated of its mechanical engineering aspect with the design process flow applied resulting in a successful improvement to the initial design. Therefore, it can be deduced that both objective of developing the iron ore processing plant utilising project management approaches within the allocated budget and time and the monitoring of project changes inclusive of the engineering design changes that occurred during the project progress were achieved. Furthermore, from the results and discussion presented in Chapters 4 and 5 of this dissertation, this project had been deduced to be on track towards a successful project with well-implemented project management approaches.

CHAPTER 7: RECOMMENDATION

However, the author has suggested several improvements that can be made to the remaining section of the project or similar projects in the future. The main reason is that project management is a broad process and tool that could be adapted towards any project with a certain degree of modification. In this case, the risk management project management tool could be one of the suitable approaches to be implemented. With the correct method applied, this project could greatly reduce the probability of unwanted events happening and eventually affecting the project performance. Preventive and predictive action could be utilized to significantly boost the chance of project success. Apart from that, excellent management of project communication is also a key element in this case study. Considering the communication media for this project involved more than one language and nationalities in respective project team members and stakeholders, mistranslation or miscommunication may be one of the concerns during the project period. Therefore, it is vital to set up an effective communication strategy for monitoring and interaction among the project team members.

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