ON-TIME DELIVERY IMPROVEMENT FOR HEAT RECOVERY STEAM GENERATOR

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การพัฒนาการจัดส่งสินค้าตรงต่อเวลาของผู้ผลิตเครื่องผลิตไอน้ำจากการแลกเปลี่ยนความร้อน

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รัตติยา พิมพ์ใจชน : การพัฒนาการจัดส่งสินค้าตรงต่อเวลาของผู้ผลิตเครื่องผลิตไอน้ำจากการแลกเปลี่ยนความร้อน (ON-TIME DELIVERY IMPROVEMENT FOR HEAT RECOVERY STEAM GENERATOR) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. ดร. ปารเมศ ชุติมา, 123 หน้า.

เนื่องจากการแข่งขันของธุรกิจปัจจุบันที่สูง องค์กรมีการขับเคลื่อนเปลี่ยนแปลงและพัฒนาองค์กรอยู่ตลอดเวลา เพื่อแย่งชิงกันสร้างความได้เปรียบในเชิงธุรกิจ การบริหารโครงการได้อย่างมีประสิทธิภาพจึงเข้ามาเป็นส่วนสำคัญที่ช่วยให้โครงการประสบความสำเร็จภายใต้ข้อจำกัดที่มีอยู่ และบรรลุตามวัตถุประสงค์ของโครงการที่ตั้งไว้ เพื่อทำให้โครงการเป็นส่วนที่เสริมแผนกลยุทธ์ขององค์กรและพาองค์กรไปสู่ความสำเร็จในการดำเนินธุรกิจ

วิทยานิพนธ์ฉบับนี้มีวัตถุประสงค์เพื่อปรับปรุงและพัฒนาวิธีการควบคุมโครงการเพื่อลดความล่าช้าและงานเร่งที่ไม่จำเป็นของโครงการสำหรับการผลิตเครื่องผลิตไอน้ำจากการแลกเปลี่ยนความร้อน โดยในกรณีศึกษานี้ระบบการควบคุมโครงการเดิมถูกนำมาวิเคราะห์และปรับปรุง โดยแบ่งเป็น 3 ขั้นตอนหลัก คือ การวางแผนโครงการ การดำเนินงานโครงการ และการควบคุมโครงการ จากข้อมูลในอดีตพบว่าบริษัทมีปัญหาในการควบคุมบริหารงานโครงการ โดยมีการส่งมอบงานล่าช้าและต้องเสียค่าปรับ ด้วยเหตุนี้หลักการของการบริหารจัดการเวลาตามแนวทางของ Project Management Body of Knowledge (PMBOK) ถูกนำมาประยุกต์ใช้ในขั้นตอนดังกล่าวข้างต้นกับโครงการกรณีศึกษา มีการศึกษาสาเหตุและปัจจัยที่ส่งผลกระทบต่อการดำเนินงานโครงการในอดีต เพื่อนำสาเหตุและปัจจัยดังกล่าวมาสร้างแนวทางการควบคุมงานโปรแกรมการจัดการโครงการ Microsoft Project นำมาใช้ในการวางแผนเวลา และแสดงผลเพื่อการติดตามควบคุมโครงการ วิธีเส้นทางวิกฤติ (critical path method) และเทคนิค S-curve ถูกนำมาใช้ในการประเมินผลการดำเนินงานโครงการ ผลการศึกษาแสดงให้เห็นว่าระบบการบริหารจัดการโครงการที่นำเสนอนั้น สามารถปรับปรุงการบริหารจัดการของเวลากรณีศึกษาได้มีประสิทธิภาพมากขึ้น ไม่เกิดการล่าช้าในการส่งมอบงานโครงการ

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ลายมือชื่อนิสิต ....

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Due to the high competitiveness of today's business, the organization has driven to change and develop continually in order to gain competitive advantage in business. Managing project effectively is essential to help the project succeed under existing constraints and achieve the project objectives. This could strengthen the strategic plan of the organization and lead organizations to success in business.

This thesis aims to control and improve on-time delivery performance to reduce delays and unnecessary acceleration of the project for Heat Steam Recovery Steam Generator manufacturer. In this case project study, the control system of old project was analyzed and improved by dividing into three main processes which are planning, executing, and monitoring and controlling process. Based on historical data, it was found that the company has trouble with controlling project management by delays delivery and getting fine. For this reason, the principle of time management guidelines of the Project Management Body of Knowledge (PMBOK) was applied in those processes of case project study. Microsoft project program was used to develop project schedule in greater detail which enable team to comprehend the direction of the project. The schedule illustrates sequence, network relationship between activities, estimated time to complete, start and finish date, critical path and so on. During project execution, weekly progress shall be reported to project management team, S-Curve and Critical path are mainly tools for progress measurement. The results of the study shows that project management can improve the management of the case studies more efficiently. There was no delay in delivering the completed project.

Department:	Regional Centre for Manufacturing Systems Engineering	Student's Signature	....
		Advisor's Signature	....
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CONTENTS

Page

Page

Page

Table of Tables

Table of Figures

1 Chapter 1: Introduction

1.1 Introduction

Over the past decades, the problems of delays have been found to be frequently occur in project worldwide which disrupted the success of project and led to lack of company competitiveness in long-term. There were many studies researched on causes of delay and try to develop and implement the proper method, which can be the best approach to minimise those causes in the project. According to Albinu and Jagboro (2002), the delay cannot be minimised unless their causes are known. Moreover, in order to have an accurate estimate of costs and completion time, reliable methods and commonly agreed practices must be applied throughout the project life time. Failure to meet the project deadline results in financial losses for both parties; customer and company. The control over causes of delay may help in eliminate the problem and contribute to an improvement of project performance. Normally, since the experience of time overrun, the project practitioners provide a plan with some spare time before an actual deadline or if the project is likely to be delayed, they decide to accelerate the pace of the works execution to keep the project on schedule. According to this, an additional cost is added to the project. With uncertainty and many factors that challenge the accomplishment of project on time, a suitable tool for project control should be implemented. The project planning and time control practice should be focused which the tools and techniques used for effectively control of the project is very important. There is a major challenge to choose the adequate tool for project monitoring and controlling in order to deliver project successfully. Ö. Hazır (2015) focus on development of these systems. Basically, a method of project monitoring and control help minimise the possible deviations from the project plans. The status of the project is monitored, any deviations from the plan are identified then, the optimum corrective actions are taken. An effective system should clearly define the following policies:

- Monitoring policy: what, how, where, when and by whom to monitor,

- Intervention and control policy: what, how, where, when and by whom to prevent, intervene and correct.

There are many project control methods, such as Gantt chart, Bar chart, Program Evaluation and Review Technique (PERT), and Critical Path Method (CPM) have been developed and used project professionals (Nicholas, 2001). Not all of delay factors can be eliminated, but some of them can be overcome by appropriate project management.

While many studies have studied the project management in each industry to propose and adapt the best practice that suit the organisation in order to carry outs the projects effectively and efficiently (Tantivattanasatien, 2000; Tetteh, 2014; Yimam, 2011). Hence, it is very important to apply the appropriate project management which can contribute to project success.

This study is looking into ways and framework to manage them in order to deliver the project on time. Therefore, the aim is to construct a framework to control and improve on-time delivery performance of the case study company which the concept of project time management from Project Management Body of Knowledge (PMBOK) will be applied to area that needed improvement. First, the important causes and flaws of the current process are identified. Then, the best possible tools and techniques are adopted, and the framework in controlling the project schedule can be shaped to provide adequate project control.

1.2 Background of Thesis

The Case study Company founded in 2011 to supply Heat Recovery Steam Generators for Thailand Combined Cycle Plants. The company designs, manufactures and services heat recovery steam generators (HRSGs). The HRSGs use the energy from the hot exhaust gas of the gas turbine to generate steam for electricity generation or for industrial processes. The company supplies custom-designed HRSGs for installation behind combustion turbines starting at 25 MW up to 270 MW for use in power generation, co-generation, and combined cycle system. In general, these HRSGs feature a horizontal gas path, and may have one up to three pressure levels. The Company started business in Thailand by supplying HRSGs for two Combined Cycle Power Plants;

Electricity Generating Authority of Thailand (EGAT) Wang Noi Combined Cycle Power Plant, located in Ayutthaya, and Chana Combined Cycle Power Plant, located in Songkhla. How does the HRSGs work? The exhaust gas of the gas turbine is used to generate steam, then, the steam will go to steam turbine for electricity production or go to various industrial processes. The combined cycle plant is be able to enhance the power plant's performance up to fifty per cents, not only the exhaust gas is not wasted, but also, it generates cleaner energy.

Figure 1: Heat Recovery Steam Generator

As the project based organisation structure, the company has encountered time overruns of projects. To stay competitive and gain more market share, the company must continue improve their business performance and reliability. Not only that the quality of the product, but also to deliver the product to customer on-time is very crucial. The delivery performance can be one of the main order-winning of the firm. Late delivery can cause many problems;

- Penalty occurs
- Lower profit and productivity
- Bad reputation
- Losses of customer and market share in the future

- Effects long term performance

On-time delivery should be maintained and needed to be improved to some degree to remain competitive. Quality is the significant concerned criteria and must be met alongside the on-time shipment and would then ensure a greater success of the project.

1.2.1 Overview of HRSGs Design Project

The regular project is taking 12 to 16 months cycle time. After the contract agreement has been completed with the customers. It becomes to an engineering phase in which many engineering department are working together. To manage the project that involve with several department at the same time is absolutely challenging, it also have to be the back and forth communication in order to move the project for individual stage. When the project gets started, there are all relevant departments; namely, Thermal Engineering, Mechanical Engineering, Structural Engineering, Product Engineering, Instrument and Control Engineering, involved in the very early stage. This interaction could develop to the faster delivery time and complex communication at the same time. The product engineer will issue the technical specification of each of equipment to send to vendor or subcontractor then, it begins to fabrication work and preassembly as needed. Finish work will be delivered to site for construction. Finally, after construction is done, the plant commissioning will be performed to ensure the HRSG can operate as designed.

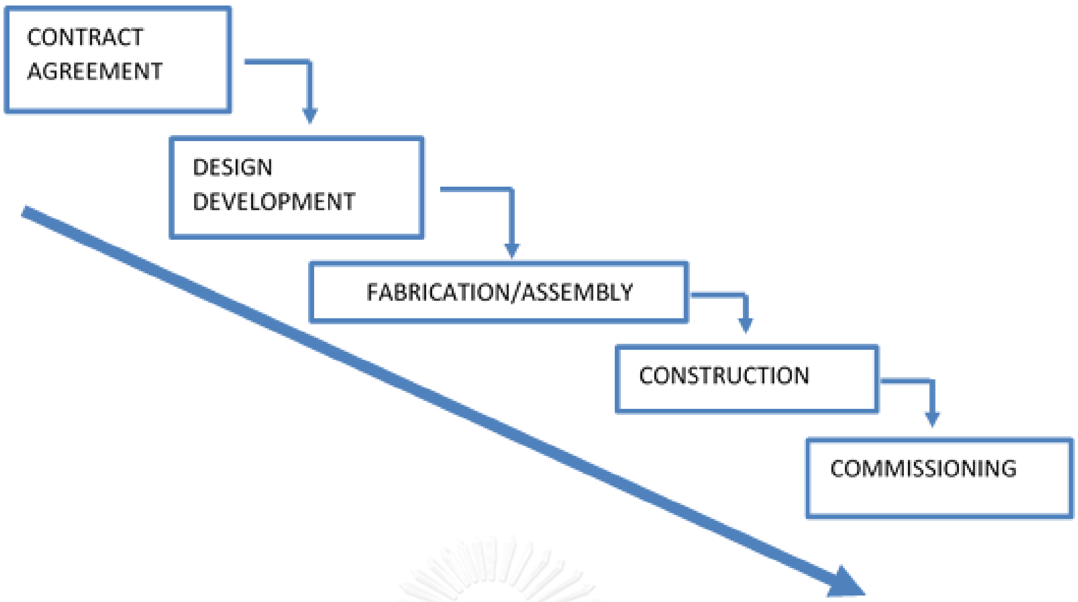

Figure 2: HRSGs Design Project

Phase 1 – Contract Agreement

The company makes a contract agreement or receives an award from customer to supply the HRSGs system to wherever the plant located. Terms and Conditions, schedule of delivery are all set up which have to be strictly follow to meet customer requirement.

Phase 2 – Design Development

This phase is engineering team's responsibility. The customer specifications are reviewed as the first tasks to understand and raise the questions if any. The scheduler then issues the schedule for each responsibility which is the master plan for project progress tracking. Weekly meeting is held to discuss on risk register and engineering issue. The design phase is a core activity of the HRSGs system, engineering team must ensure that the detailed and equipment specification are generated correctly, meet codes & engineering standards, and customer standards & requirements.

Phase 3 – Fabrication and Assembly

The technical and specification from design phase will be sent to vendor or subcontractor to begin manufacturing. HRSG components are manufactured by subcontractors in Thailand. The company has established a long-term relationship with them, this can be critical because subcontractors have to be specialised so, for specific pressure part (Module Harp, Drum, Module Box, etc.), the company has high dependency on subcontractors. At this phase, the quality engineer will take the main role and make sure that all welding procedures and quality-control requirements are met.

Phase 4 – Construction

Once the HRSGs component has been finished and approved by quality control section, it will be delivered to the construction site for installation. This is needed to make sure that every component is on schedule otherwise it will delay construction job and penalty will occur. The installation and erection will be implemented and verified in accordance with the design.

Phase 5 – Commissioning

The purposes of commissioning are to ensure that the HRSGs system is installed, tested and commissioned in accordance with the approved design and that can start operation normally, maintains the safety and integrity of the system. After that, the Operation & Maintenance training is arranged, also with documentation shall be submitted to client.

1.2.2 The Combine Cycle Power Plant Process

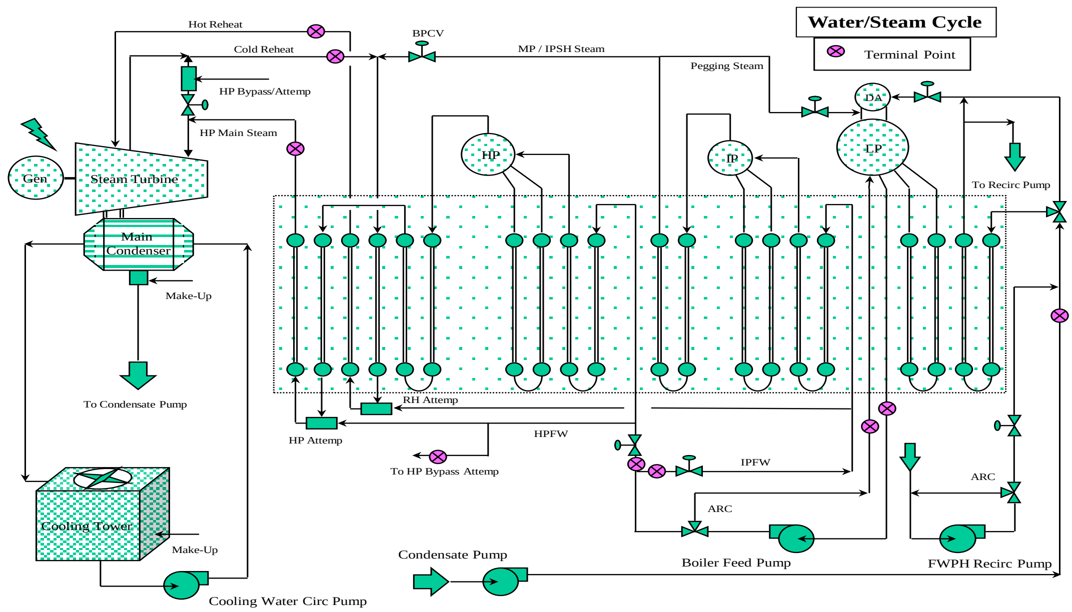

Figure 3: The Process of Combine Cycle Power Plant

The HRSG will be installed behind Gas turbine, receiving exhaust gases then use it as heat source to heat up water in tube, steam are generated after that, either going to steam turbine for electricity generation or being used in industrial process.

1.3 Statement of the problem

Apart from quality aspect that the company has to strictly control, on-time delivery performance is also critical to enable to meet the commitments to customer. Penalty has to be paid if deliveries miss the schedule; however, not only the effect of additional cost, but also delay delivery can be a serious effect to company reputation and long-term competitive advantage; for example, customer upset, bad company reputation, and loss of customer and market share, not getting the new order and so on.

It appears that delay problems are reoccurring. When the delay occurred, the factor related to it has not been addressed properly; it has been fixed as case by case. It does not specify which issue is critical or effects delivery performance the most. As a result, it hard to focus and firm could be wasting effort to the areas or issues that may not really impact delivery performance. To facilitate on-time delivery, the real causes that contribute significantly to the problem could be identified first, then it will ease for developing method to eliminate or prevent these causes; therefore, the overall situation is improved. Regarding to preliminary observation, the subcontractor performance tends to be main issue for the delay, with the challenge of limitation of a number of qualify subcontractors and the high dependency on subcontractor's work. The factors that lead to delay can be various as following:

- Customer change/add new requirement
- Delay of parts and materials receive
- Subcontractor's performance
- Failed quality
- Inadequate subcontractor's manpower
- Insufficient work flow management
- Lack of proper control to keep up work progress

Basically, the company review and approve project schedule for each of the product to ensure it can be manufactured properly and delivered as per contract date. The case study company uses subcontractors to perform selected work. Even if the plan is specific for individual project production, as the work perform, there is evidence indicated that in some part of the manufacturing process is delayed, causing schedule slippage. The failure to complete and deliver product as promised date resulted in payment, charged by customer. Not only the higher cost of the project, this negatively affects the credit of the company and customer satisfaction eventually.

Primary Problem Assessment

Very often, project management team puts hard effort in trying to control the subcontracting schedule. During the manufacturing, there are so many problems that can be occurred which are quality related, schedule related and/or design related. Subcontracting works play a vital role in the project networks because:

- Contribute a big portion of the components within the system and consume long period of time in the project,
- Quality of work is critical as it is governed by code and standard,
- Tie up with liquidate damage, and
- High risk of uncertainty

As explained above, it is raising the awareness of the highly important value but in the meantime, high risk of possibility of deadline slippage. The company is 100% outsource for manufacturing process, only design engineering is conducted in house. The specific made to order components of HRSGs are rely on subcontractor partners. Because of that it is significantly to ensure that subcontractor performances are under control and they will be able to delivery required product on specify time line. More importantly, the work that company subcontract are considered as critical components and always be the LDs items which means any delay or damage effecting the project contract will obligate company to pay for such a damage. The major component deliveries which are the LDs items per contract are heating surface, steam drum, external deaerator, blowdown tank, ductwork, casing, platform, stairway, etc. These are example of components that are using fabrication work.

The subcontractor delays impacted the progressing through project development on fabrication/ assembly and quality testing. Historically, the delay of finish order from supplier was approximately 60% for one of the major components called steam drums[1] (data obtained from company record and interview of project manager and subcontract manager). There were 5 executed projects in the last 3 years in Thailand. It was shown that 3 out of 5 projects were failed to deliver the major component on time. The data is as shown in Table 1.

No.	Project Name	Year	Overall Project Time (months)	Steam Drums Manufacturing Duration (months)	Actual Steam Drums Production Time (months)	Status
1	AA	2013	14	5	5.5	delayed
2	BB	2014	13	4	4	on-time
3	CC	2014	14	4.5	5.5	delayed
4	DD	2015	14	4.5	4.25	on-time
5	EE	2015	18	6.5	7.5	delayed

Table 1: Time plan of each project of Steam Drums Production

If projects issue's requirements are not addressed timeously and information is not efficiently managed, project activities can be destructively affected. Communication management plan need to be good in place hence, site information is appropriately channelled and coordinated. Shortage of coordination of information raises misunderstanding, possibly causing conflicts that involve resolution time. Employment of unskilled workforces at the project places obstructs execution of work to measurement and leads to error or mistakes during project. Time is then spent on adjustments and corrections. So, this cause of delay should be addressed and improved properly.

From Figure 4, the data also gathered from the company's financial record of all executed projects in the year 2014 shows the expense of the project spent by category.

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[1] Steam Drum is pressure vessel using for hot water and steam storage.

This information includes projects both in Thailand and oversea. It is clearly seen that major category of concerns is Back charges/ LD Claims which gain the highest portion as about 50 percent from total cost. This confirms the primary observation of this research that the scope of subcontracting becomes critical issue for the project. With its complexity and evidence on delay, lead to the question that whether the company currently have an effective and systematic project control management.

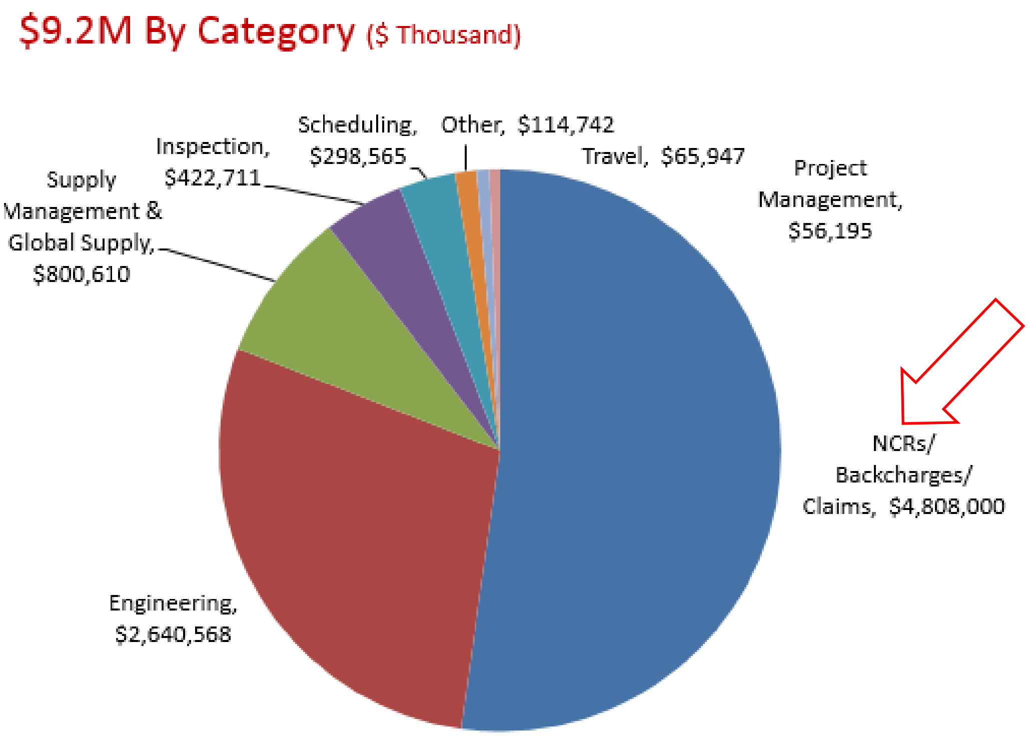


Figure 4: Financial record of project expense by category

The proactive plan and action can be developed to avoid, mitigate, and control adverse impact on the project schedule. The preliminary discussion on causes of delay is listed as follow;

- Inadequate subcontractor's manpower
- Insufficient work flow management
- Failed quality
- Lack of proper control to keep up work progress

In order to improve and eliminate the risk of delay delivery, these causes must be addressed, and an effective continuous monitoring throughout the process of work is required accordingly to avoid and prevent the delay.

1.4 Objective of Thesis

The objective of this research is to create the framework to control and improve on-time delivery performance for Heat Recovery Steam Generator manufacturer.

1.5 Scope of Study

The study will focus on the improvement of delivery performance of HRSGs manufacturer. The scopes of the research are listed as follow:

1. The study will focus on the job that being done by subcontractor at fabrication and assembly phase.
2. Since it would require a large effort to collect data for all components, the scope of this project was limited to a representative component which is "steam drums" - manufactured by subcontractor. The scope will focus on the subcontractor's work or manufacturing process. These steps consist of all interactions between company, material vendor and subcontractor.
3. Issue list of causes of late delivery in the specified stage mention above
4. Create framework and process of developing delivery performance base on guideline of project time management from PMBOK.

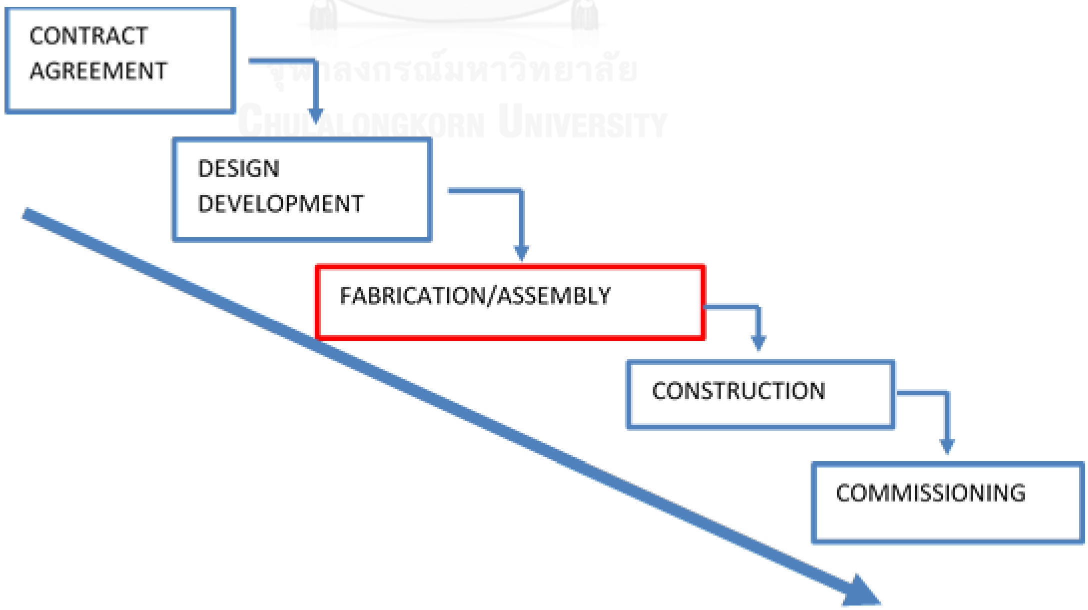


Figure 5: Scope of Study (Red Highlight)

1.6 Proposed Methodology

Step 1: Literature Review

Study the company, and review related literature. The project management concept according to PMBOK is studied with focusing on project time management. Also the related literatures are reviewed in the area of causes of delay, tools and techniques for project management, and risk assessment.

Step 2: Information Gathering and Area of Improvement Identification

Gather information, understand current project control practice, do further assessment to summarise important causes of delay, identify area of improvement. The information is obtained from interviews with quality engineers, project engineers, and from author's experience working in the project team.

Step 3: Implementation and Evaluation

Adopt project time management principle to the case study, appropriate framework could be constructed for project planning and control with the purpose to improve on-time delivery performance of the company. The results from implementation are discussed and evaluated.

Step 4: Conclusion and Recommendations

Summarise the study with recommendations, thesis write up, review and finalise

1.7 Expected Benefits

- Establish a suitable project time management framework for the study project which can also be applied to other projects, faster work flow process, and support continuous improvement.
- Improve on-time delivery performance.
- Enhance customer satisfaction, gaining competitive advantage.

2 Chapter 2: Literature Review

A review of the related theories and literatures are carried to be more understanding into the research area which consist of project management guideline, causes and effects of delay and risks management.

2.1 Related Theories

2.1.1 Project Management Guideline (PMI, 2013)

What is project management?

PMI (2013) defined the project management as "the application of knowledge, skills, tools, and techniques to project activities in order to meet the project requirements. The project management can be accomplished through the proper application and integration of management processes which include five main following groups:"

1) Initiating – a new project is defined and given authorization to start.
2) Planning – group of processes in which to construct the scope of the project, identify objectives, and establish course of necessary activities to be performed to attain those objectives.
3) Executing – the processes performed according to work defined in planning.
4) Monitoring and Controlling – process group includes tracking, review, and regulating progress and performance of the project. Any changes to the plan occur are identified, the action corresponding to those changes then created.
5) Closing – these processes are to be performed at the end phase of the project to formally close out the project.

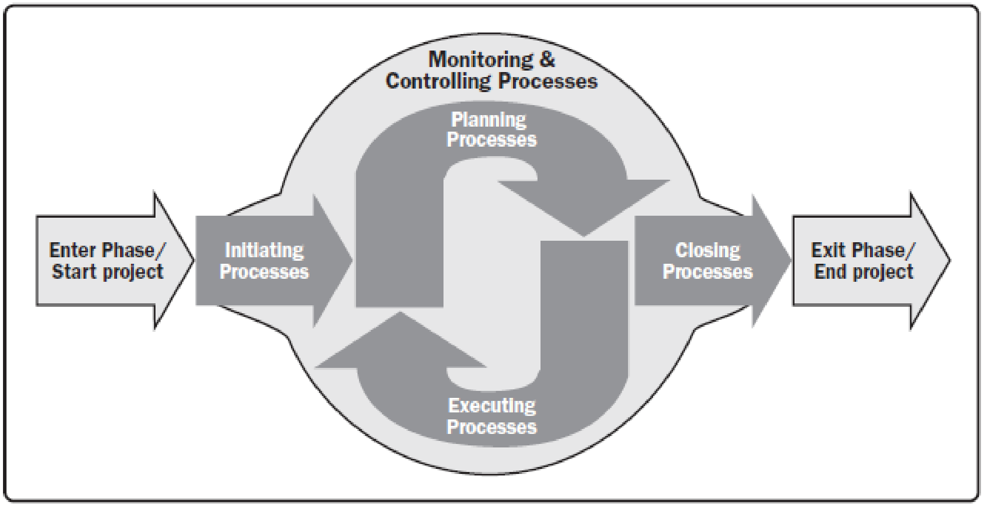


Figure 6: Project Management Process Groups (PMI, 2013)

In managing the project, it is typically included following process:

- Identifying requirements
- Addressing the various needs, concerns, and expectation of the stakeholders in project planning and execution
- Setting up, maintaining, and carrying out communications among stakeholders that are active, effective, and collaborative in nature;
- Managing stakeholders towards meeting project requirements and creating project deliverables;
- Balancing the competing project constraints, which include, but are not limited to:
  - Scope
  - Quality
  - Schedule
  - Budget
  - Resource
  - Risk

These factors are related to each other, if any one factor changes, it may affect at least one other factor. As the project progresses through its different stages, a project management team probably see some area that needed to be focused in a greater detail and the project development plans are subject to improve continuously throughout the project's life cycle.

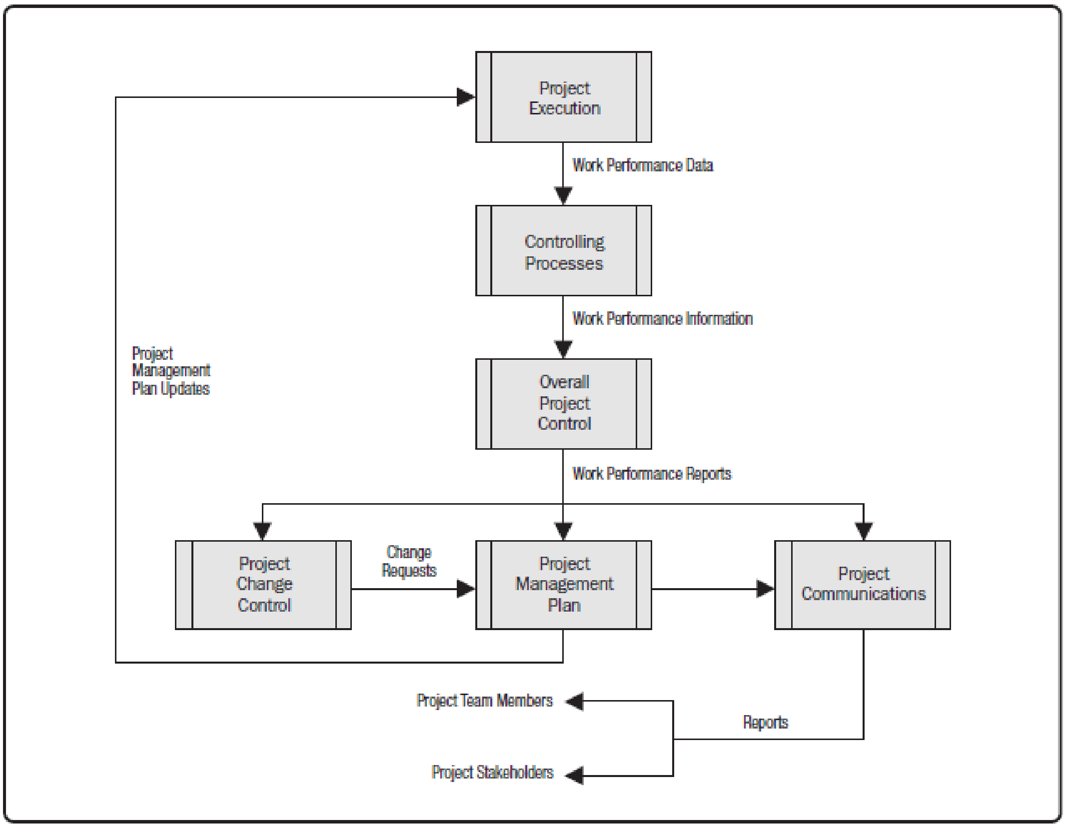


Figure 7: Project Data, Information and Report Flow (PMI, 2013)

The project data are generated throughout the project life cycle especially during the project execution. Large amount of data and information are continuously collected, analysed and distributed to project team members and stakeholders for communication purpose.

Regarding context of the project, that information is interchangeable and can be categorized into three groups: work performance data, work performance information, and work performance reports. As shown in Figure 7, the flow of project information across the evolution of the processes, these are to be contributed properly to manage the project which to increase project transparency and information sharing.

The detail for each type of information can be described below:

Work performance data. The raw observations and measurements identified during activities performed to carry out the project work. Examples include reported percent of work physically completed, quality and technical performance measures, start and finish dates of schedule activities, number of change requests, number of defects, actual costs, actual durations, etc.

Work performance information. The performance data collected from various controlling processes, analysed in context and integrated based on relationships across areas. Performance information are such as status of deliverables, implementation status for change requests, and forecasted estimates to complete.

Work performance reports. The physical or electronic representation of work performance information compiled in project documents, intended to generate decisions or raise issues, actions, or awareness, i.e. status reports, memos, justifications, information notes, electronic dashboards, recommendations, and updates.

2.1.2 Project Time Management

The project time management processes are: Plan Schedule Management, Sequence Activities, Resources, Activity Durations, Develop Schedule, and Control Schedule.

These processes interact with each other. At each group of processes, there are needed inputs which associated with tools and techniques to develop and create specific outputs. As practice in a common project, the great effort in project time management will put into the control schedule process to ensure project work in line with plan on a timely manner.

1) Plan Schedule Management – the process of initiating the policies, procedures, and documentation for managing the project schedule;

   The main focus of this process is to provide direction on how the project schedule will be managed. The schedule management plan can be shaped as broadly framework or highly detail depends on the needs of the project, which should cover the following areas:

- Project schedule model development. The scheduling methodology and the scheduling tool to be used in the development of the project schedule model are specified.
- Level of accuracy. The acceptable range used in determining realistic activity duration estimates is specified and may include an amount for contingencies.

- Units of measure. Each unit used in measurements is defined for each of the resources such as staff hours, staff days, or weeks for time measures, etc.
- Organizational procedures links. The work breakdown structure (WBS) provides the framework for the schedule management plan, allowing for consistency with the estimates and resulting schedules.
- Project schedule model maintenance. The process used to update the status and record progress of the project in the schedule model during the execution of the project is defined.
- Control thresholds. Variance thresholds for monitoring schedule performance may be specified to indicate an agreed-upon amount of variation to be allowed before some action needs to be taken. Thresholds are typically expressed as percentage deviations from the parameters established in the baseline plan.

In addition, there are a few criteria for taking into account and be specified: Rules of performance measurement (Earned Value Management (EVM), for example), reporting format, and process description.

Inputs	Tools & Techniques	Outputs
• Project Management plan • Project Charter • Enterprise Environmental Factors • Organisational Project Assets	• Expert Judgment • Analitical Techniques • Meetings	• Schedule Management Plan

Table 2: Plan Schedule Management: Inputs, Tools & Techniques, and Outputs

2) Define Activities - The process of identifying the specific actions to be performed to produce the project deliverables;

   The input of this process consists of WBS which work as a scope base line, the environmental factors, and also historical information about lists of activity used by previous or similar projects. Next, tools and techniques used are decomposition in which to divide and subdivide the project scope into smaller tasks, individual activities as all of them that required to complete a work package. Therefore, the outputs of this process are activity list which contribute a basis for project management process. A milestone is another important output which illustrate the significant event or phase in a project and this normally required by contract (tie up with payments), or optional.

Inputs	Tools & Techniques	Outputs
•Schedule Management plan •Scope baseline •Enterprise Environmental Factors •Organisational Project Assets	•Decomposition •Rolling wave planning •Expert judgment	•Activity list •Activity attributes •Milestone list

Table 3: Define Activities: Inputs, Tools & Techniques, and Outputs

3) Sequence Activities - the process of identifying and documenting relationships among the project activities;

Activity list which is defined from previous step becomes the main input to this process. The relationships among activities can be identified using following tools: Precedence diagramming method (PDM), dependency determination, and leads and lags. PDM is a technique used for develop a model which show activities linked with one another as sequence of when to be performed. Dependencies relationships are when there is a predecessor activity that comes before a dependent activity in the schedule. There are four types of dependencies or logical relationships as defined below.

• **Finish-to-start (FS);** a logical relationship in which a successor activity cannot start until a predecessor activity has finished. Example: The awards ceremony (successor) cannot start until the race (predecessor) has finished.

• **Finish-to-finish (FF);** a logical relationship in which a successor activity cannot finish until a predecessor activity has finished. Example: Writing a document (predecessor) is required to finish before editing the document (successor) can finish.

• **Start-to-start (SS);** a logical relationship in which a successor activity cannot start until a predecessor activity has started. Example: Level concrete (successor) cannot begin until pour foundation (predecessor) begins.

• **Start-to-finish (SF);** a logical relationship in which a successor activity cannot finish until a predecessor activity has started. Example: The first security guard shift (successor) cannot finish until the second security guard shift (predecessor) starts.

A project schedule network diagram is then completed which showing the logical relationships among the project schedule activities and dependencies can also be seen. Figure 8 represents a project schedule network diagram as an example.

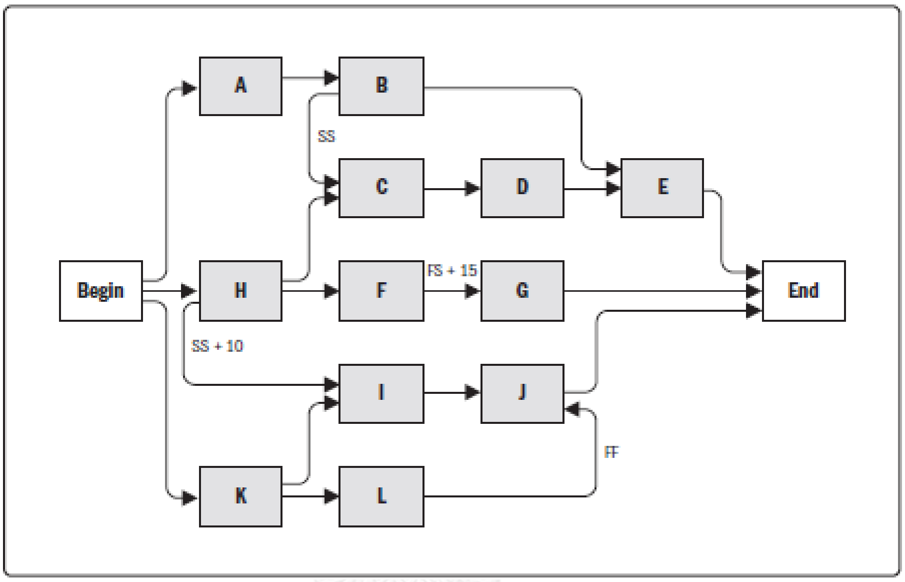


Figure 8: Project Network Diagram

Inputs	Tools & Techniques	Outputs
•Schedule Management plan •Activity list •Activity attributes •Milestone list •Project scope statement •Enterprise Environmental Factors •Organisational Process Assets	•Precedence diagramming method (PDM) •Dependency determination •Leads and lags	•Project Schedule network diagrams •Project documents updates

Table 4: Sequence Activities: Inputs, Tools & Techniques, and Outputs

4) Resources - the process of estimating the type and quantities of material, human resources, equipment, or supplies required to perform each activity;

The amount of resources is allocated to complete those tasks. Since this research will focus on the subcontracting work, the resource allocation is not in our scope, it is the full responsibility of the subcontractor.

Inputs	Tools & Techniques	Outputs
•Schedule Management plan •Activity list •Activity attributes •Resource calendars •Risk register •Activity cost estimates •Enterprise environmental factors •Organisational process assets	•Expert judgment •Alternative analysis •Published estimating data •Bottom-up estimating •Project management software	•Activity resource requirements •Resource breakdown structure •Project documents updates

Table 5: Resources: Inputs, Tools & Techniques, and Outputs

5) Activity Durations – the process of estimating the number of work periods required to complete individual activities; There are a lot of data and inputs as shown in table 6 that support the estimation of activity durations. The estimated resources will directly affect the duration of each activity. The lower-skilled of resources assigned to an activity, for example; may have lower productivity, result in longer time required. Several tools and techniques may be applied in this duration estimate based on what practical to the project. Historical data is the important parameter, combine with the expert judgment, can provide a good estimation. The maximum task durations should be recommended as well. Moreover, contingency reserves, time reserves or buffers, can sometimes be brought to an attention which reflect concern on schedule uncertainty. Contingency reserves may be separated from the individual activities and aggregated into buffers.

Inputs	Tools & Techniques	Outputs
• Schedule Management plan • Activity list • Activity attributes • Activity resource requirements • Resource calendars • Project scope statement • Risk register • Resource breakdown structure • Enterprise environmental factors • Organisational process assets	• Expert judgment • Analogous estimating • Parametric estimating • Three-point estimating • Group decision-making techniques • Reserve analysis	• Activity duration estimates • Project documents updates

Table 6: Activity durations: Inputs, Tools & Techniques, and Outputs

6) Develop Schedule – the process of analysing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model;

A schedule model is construct by putting together inputs generated from previous process (consist of activity list, project network diagram, activity duration estimates, resource requirements, project scope statement, and calendar) into tools such as critical path method, critical chain method, what-if analysis, and resource optimisation. According to those analysis, the early and late start, the early and late finish dates for each work period are identified.

6.1) Critical Path Method (CPM)

CPM is the network technique used to determine the minimum project duration and reflect the scheduling flexibility. Regarding any network path, the schedule flexibility is measured by the amount of time that an activity can be delayed or extended from its early start date without delaying the project finish dated, it can be known as “total float”. A critical path normally outline by zero total float. The critical path activities are the longest path on the project so that, the early and late start seem not necessary, the date rather indicate to when of which activity to be performed.

6.2) Schedule Compression

Schedule compression are used for shortening the schedule duration which include two techniques: Crashing and Fast tracking. **Crashing technique** is utilised by adding resources such as overtime, paying to facilitate the delivery of activity on critical path which lead to cost increase. Crashing works are only for critical path's activities. **Fast tracking** is expedited on the activities which normally done in sequence change to be carried out in parallel for at least some portion of those duration. It works for over lapped activities. There are risks to be considered such as higher cost, rework if these techniques are to be applied.

At the process of schedule development, it may require review and revision of duration estimates to get an approved schedule that can work as a baseline schedule. It then be used for progress tracking for project control. The summary of schedule development process: Inputs, Tools & Techniques, and Outputs are presented as table below.

Inputs	Tools & Techniques	Outputs
•Schedule Management plan •Activity list •Activity attributes •Project schedule network diagrams •Activity resource requirements •Resource calendars •Activity duration estimates •Project scope statement •Risk register •Project staff assignments •Resource breakdown structure •Enterprise environmental factors •Organisational process assets	•Expert judgment •Alternative analysis •Published estimating data •Bottom-up estimating •Project management software	•Activity resource requirements •Resource breakdown structure •Project documents updates

Table 7: Develop schedule: Inputs, Tools & Techniques, and Outputs

7) Control Schedule—The process of monitoring the status of project activities to update project progress and managing changes to the baseline schedule; The inputs of scheduling control contain project management plan, project schedule, work performance data, calendars, and organisational process assets. Work performance data provide the progress of the project as of how much complete each activities are. The schedule management plan outlines how the schedule will be managed and controlled. The differences between plan and actual are measured which can lead to an assessment if a change is needed, also corrective and preventive action required in correspondence with those changes. Earned value management (EVM) is one of the tools that be applicable to this research for performance review. EVM is a method for measuring time and cost in which schedule performance can be determined

from comparing the amount of planned work with what has actually spent in execution.

Outputs from this process are work performance information, change requests and project management plan updates. These are significant for the project moving forward. The change requests may be occurred as a result of work performance information, the schedule variance from baseline so, the schedule updated need to be made. The corrective actions are issues in order to maintain the work to deliver as plan.

Inputs	Tools & Techniques	Outputs
• Project Management plan	• Performance reviews	• Work performance information
• Project schedule	• Project management software	• Schedule forecasts
• Work performance data	• Resource optimisation techniques	• Change requests
• Project calendars	• Modeling techniques	• Project management plan updates
• Schedule data	• Leads and lags	• Project documents updates
• Organisational process assets	• Schedule compression	• Organisational process assets updates
	• Schedule tool	

Table 8: Control schedule: Inputs, Tools & Techniques, and Outputs

2.1.3 Risk Management

Risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality. A risk may have one or more causes and it may have one or more impacts. A cause may be a given or potential requirement, assumption, constraint, or condition that creates the possibility of negative or positive outcomes (PMI, 2013).

The uncertainty is a nature of project and become the project risk. In project management processes, it tends to always have overlapping criteria between time and risk management and risk management is also significantly influences project success. There are two types of risk according to PMI (2013): Known and Unknown risks. It was suggested that Known risks are those that have been identified and analysed, making it possible to plan responses for those risks. Known risks that cannot be managed proactively, should be assigned a contingency reserve. Unknown risks cannot be managed proactively and therefore may be assigned a management reserve. A negative project risk that has occurred is considered an issue.

Hubbard (2009) defined risk management as “the identification, assessment, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events”.

There are five main processes to perform risk management as follow:

1. Identify, characterize, and assess threats;
2. Assess the vulnerability of critical assets to specific threats;
3. Determine the risk, i.e. the expected consequences of specific types of attacks on specific assets;
4. Identify ways to reduce those risks; and
5. Prioritise risk reduction measures based on a strategy.

2.1.4 Critical Path Method: CPM

The critical path method (CPM) is one of the most wide spread schedule control method for construction projects (Olewale and Sun, 2010). This tool can be used for managing project which helps the executor monitor progress and achievement of the project. So, from the critical path method, time that needed to complete project are identified, also it tells when and where in the project required to speed up process.

The critical path analysis involves in three phases: planning, analysis, and scheduling and controlling. This tool can be utilised to identify if there are alternate paths or plans that can be undertaken to reduce the factor adverse schedule. The critical path represent the longest activity path in project and normally has little or no float built into the activities. Hence, it is very important to monitor as if the activities on the path are subjected to delay, the project can consequently delay.

2.2 Literature Review

2.2.1 The relationship among each party

The relationship between the general contractor and subcontractors is one of the keys to successful construction project. Akintan and Morledge (2013) study the relationship between main contractor and subcontractor. The problems were explored then using the principle of integrated project delivery (IPD) and the last planner system (LPS) as tools to apply for improving collaboration between the main contractors and subcontractor. With a project base nature, the communication can be complex and the culture shows conflicts and lack of mutual respect and trust between contractor and subcontractor (Hoezen, n.d.). The quality of communication is one of major influence that leads to the efficiency and effectiveness of the construction process. The importance of improving communication is addressed. A poor communication results in waste of time; for instance, errors from early stage have to be solved later than it should be, and making adjustment later as well, this probably cause higher expenses.

2.2.2 Work Performance Evaluation

Enshassi (2010) mentioned the methods of measuring the performance level of subcontractors; it was showed by 87% of contractors that have been used bar chart and s-curve in monitoring the progress of the subcontractors. This sort of positive reflects as of a good procedures or a good tool are being used to manage the project to correct any deviation that may occur by subcontractors.

Earned Value Management (EVM) is a method used for assessing project performance and progress (PMI, 2013)

According to PMBOK guide (PMI, 2013), "Earned value management (EVM) is a methodology that combines scope, schedule, and resource measurements to assess project performance and progress. It is a commonly used method of performance measurement for projects. It integrates the scope baseline with the cost baseline, along with the schedule baseline, to form the performance baseline, which helps the project management team assess and measure project performance and progress."

The EVM is also discussed in PMBOK in detail and it is developed through there key elements:

Planned value (PV)

Planned value is the budget planned for the work at a given time which defines the work that should have been finished. It is also known as Budgeted Cost of Work Scheduled (BCWS).

Earned value (EV)

Earned value represents work performed in terms of budget for that work. EV is often used to calculate the percent complete of a project. By monitoring the EV, the long term performance trends can be shown. Earned Value is also known as Budgeted Cost of Work Performed (BCWP).

Actual cost (AC)

Actual cost is the realized cost occurred for the work performed at a time. AC is also known as Actual Cost of Work Performed (ACWP).

The plan deviation can be measured as schedule variance and cost variance.

Schedule variance (SV)

SV illustrates a schedule performance as difference between the EV and PV. Hence, it could be realise that whether the project is ahead, behind or on schedule. The SV is equal to EV minus PV (SV = EV – PV).

Cost variance (CV)

CV is the amount of actual spent money that different from earn value which is equal to EV minus the AC (CV = EV-AC)

The S-Curve showing Earned value data as for example (Figure 9) which is under budget and behind schedule.

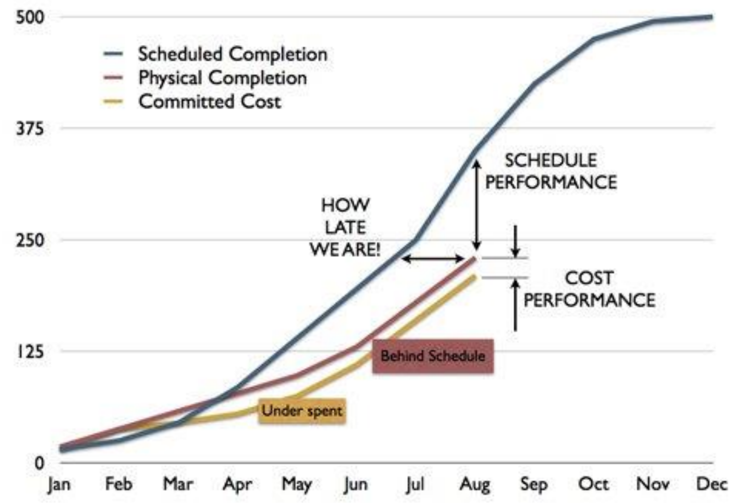


Figure 9: the example of S-Curve showing the EV data

2.2.3 Type of Delays

According to Kraiem and Diekmann (1987), delays can be classified as three main categories;

- Compensable delay
  Compensable delay is the failure caused by the owner. These delays can be in many situations; for example, incorrect design, supplied materials late to contractor, design or scope of work changed, etc. Regarding to this type of delays, the contractor is entitled to receive a time extension and also compensation for damages which have costs associated with it.
- Excusable delays
  When the delays are occurred by the events which are not originated by the contractor or owner. There are three major types of events for the excusable delays;
  - Unforeseen events
  - Events beyond the contractor’s control
  - Events without fault or negligence
- Non-excusable delays

These are the delays caused by the actions and/or inactions of the contractors themselves. In this incident, the owner is be able to recover delay damages from the contractor.

2.2.4 Reasons for the delay problems

There are many researches which study on the causes and reasons of project delays. According to Couto and Teixeira (2006), the research carried out survey in Portuguese construction to find out the causes for the delay and therefore the main reasons are; designer problems, poor productivity, procurement system, overly optimistic planning, and frequent change orders during construction and so on. The recommendations are made in order to solve the problem and improve construction competitiveness.

- The national database – having data of quantity of works list for different construction project.
- Building a more appropriate and efficient organizational systems within design teams
- A carefully plan on the schedule and preliminary programmes.

The study pointed out the problem in the construction sector result in lack of competitiveness. The issues are quite common in many projects: time and budget overruns lack of safety and insufficient quality.

Most studies identified the causes of construction delays by survey using questionnaire, and interviews the professional or the involved parties.

The survey results were categorised and ranked so that, the causes of delays in constructions and projects can be perceived of what is highly critical reason and occur frequently. A preventive actions and recommendations upon this are made in order to resolve such problems.

According to Aiyetan, Smallwood and Shakantu (2011), the study identified involved stages of construction project delivery and investigate to find which activities in these stages that could reduce the negative influences. The interventions category is the most influence on the elimination of delays in project delivery. The crucial issue can be summarised;

- Client satisfaction will increase and result in competitive advantage
- Both external and internal forces influence the delivery time of projects.
- Lack of project management competence could adversely affect delivery time of a project
- Project management is a tool for project success

The recommendations are purposed to reduce the delay as following;

- Adequate planning
- Pre-qualification of suppliers
- Provision of work schedule
- Built environment education programmes
    - Operational planning
    - Quality
    - Design
    - Generic management

The cause of delay should be properly identified. Olawale and Sun (2010) listed out the factors that causing the ineffective project time control and ranked them respectively from the highest ranking base on the effect to ability to control time of projects.

Table 9: Top twenty problems causing construction/ project delays in previous studies

Rank	Time control inhibiting factors
1	Design changes
2	Inaccurate evaluation of projects time/ duration
3	Complexity of works
4	Risk and uncertainty associated with projects
5	Non-performance of subcontractors and nominated suppliers
6	Lack of proper training and experience of PM
7	Discrepancies in contract documentation
8	Low skilled manpower
9	Conflict between project parties
10	Unpredictable weather conditions
11	Financing and payment for completed works
12	Contract and specification interpretation disagreement
13	Dependency on imported materials
14	Lack of appropriate software
15	Inflation of prices
16	Weak regulation and control
17	Project fraud and corruption
18	Unstable government policies
19	Unstable interest rate
20	Fluctuation of currency/exchange rate

According to Frank Fugar, et al. (2010), they studied the causes of delay in construction project in Ghana and the possible causes of delay were identified as below:

Main factor	Possible causes of delay
Material	Shortages of materials on site or market Late delivery of material
Manpower	Shortage of unskilled labour Shortage of skilled labour
Equipment	Equipment failure or breakdown Unskilled equipment operators
Financing	Delay in honouring payment certificates Difficulties in assessing credit Fluctuation of prices
Environmental	Bad weather conditions Unfavourable site conditions
Changes	Client initiated variations Necessary variations Mistakes in soil investigation Poor design Foundation conditions encountered on site
Government action	Delays in obtaining permit from municipality Public holidays Discrepancy between design specification and building code
Contractual relations	Legal disputes Insufficient communication between parties Poor professional management Delay in instructions from consultants Delay by subcontractors

Table 10: Possible causes of delay

Main factor	Possible causes of delay
Scheduling and controlling techniques	Poor site management Poor supervision Lack of programme of works Accidents during construction Construction methods Underestimation of costs of projects Underestimation of complexity of projects Underestimation of time of completion

Table 11: Possible causes of delay (cont.)

Toor and Ogunlana (2008) stated that delay problems are always seen in construction projects in many countries, Thailand is no exception. The research showed main reasons of the delay in project in Thailand which were gathered from surveys and interviews. Most popular issues were listed:

- lack of resources
- poor contractor management
- shortage of labour
- design delays
- planning scheduling deficiencies
- changed orders and contractors' financial difficulties

A literature review would be useful for identifying most common factors that often lead to project time overruns for the case study.

According to this, project manager can mitigate the possibility of construction delays. Furthermore, the recommendations are made in order to effectively overcome those delay issues by reforming project control management systems. Furthermore, to cope with the risk of delay problem, not only just project manager, but also the project team members should be aware of the risk and have plan to manage them if something goes wrong.

2.2.5 Effects of delay on each party

Delays are always a problem affecting overall construction project. The schedule delayed, extra become concern for every party since additional capital associated with it. It is often will result in clash, claims, total desertion and difficulty for project growth. According to Haseeb, et al. (2011), the study identified the critical delay factors toward project delay that resulted by each participant group; client, consultant, contractor and external factor. The most important causes due to each party are listed out as shown in Figure 10 below.

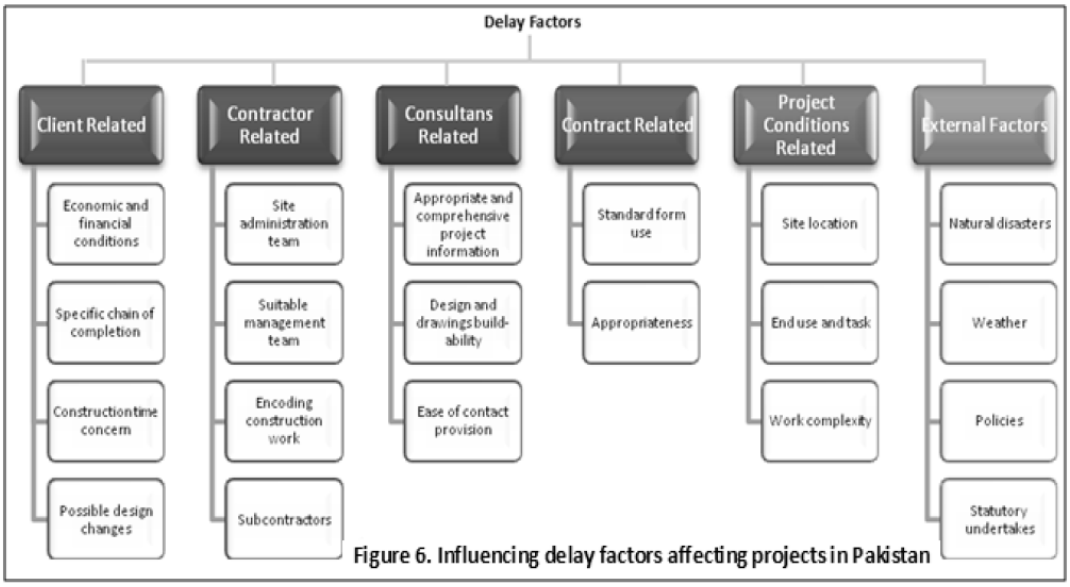


Figure 10: Delay factors affecting projects in Pakistan

The consequences of delay are different for different parties. The general consequences are the loss of wealth, time and capacity.

1) For owner - delay means the loss of income and unavailability of facilities.
2) For contractor - delay means the loss of money for extra spending on equipment and material and hiring the labour and loss of time.

2.2.6 Liquidated Damages

Liquidated damages are the legal concept, which refer to an amount of money that contracting parties agree on as the amount of damages one of them can recover if the party violates the contract. Normally, in construction contract, if the company fails to complete the work on time, the money will be paid as specified per contract (Glazov, 2009). It usually specifies the liquidated damage rate; for example, failure to deliver the major components to buyer, it shall result in the payment for $2000 per calendar day.

2.2.7 Subcontracting Relationships

According to Ragnarson (2000), there are three main types of subcontracting relationships:

- Capacity subcontractors
  When there is fluctuation in demand, this subcontractor will serve and fulfil required orders. Subcontracting can smoothen out the production cycle and sometimes the order can be transferred to local competitors.
- Competence subcontractors
  The firms themselves may not own some of components such as machinery, skills, know-how, labour and so on. Regarding to the case that company needs to access those abilities, they may engage in a competence subcontracting in order to generate what is needed. Since, it often relates to valuable production process, the relationship requires trust between customer and subcontractor. They work close together and should be in a strong relationship position.
- Outsourcing subcontractors
  When a firm used to have an in-house production, but then decide to outsource some of activities and keep focusing on their core activity. This is a result of increase in market competition and technological development, the firm need to maintain and develop their core competence for long-term advantages.

The Case Study Company has high dependency on subcontractors. The company design the equipment within HRSG system, then the production are done by subcontractors. The type of subcontracting relationship should be competence subcontractors and with this type of relationship, the organisation should build up a long-term relationship, and maintain trust and partnership between each other.

3 Chapter 3: Information Gathering and Area of Improvement

The relevant information from Case Study Company is gathered in order to analyse the detail of problems in scope of the research and establish optimum and effective framework to control subcontracting work project. Information consists of company profile, project management structure, and current situation of the firm. After that, problems and cause of problems are critical analysed and hence, the area of improvement could be outlined.

3.1 Overall process study

As mentioned in chapter 1, the case study company provides the HRSGs system. The project performed by the company can be categorised as complex projects because there are many engineering disciplines involved. The company basically does the engineering works, and uses the subcontractors for the required components fabrications.

In undertaking HRSG projects, the scope of activities usually embraces:

1) Engineering:

- Thermal Design
- Process and Instrument Diagram (P&IDs) Development
- Structural Design
- Mechanical Design
- Basic and Detail engineering (e.g. piping isometric drawing)
- Operational and Maintenance Plan
- Engineering support to construction (e.g. field engineering assistance).
- Commissioning Procedure

2) Procurement:

- Procurement planning
- Purchasing (e.g. issue purchase order)
- Expediting (e.g. delivery control)
- Logistic control (e.g. shipping and forwarding)
- Subcontracting works

3) Project Management

4) Service and Warranty

3.1.1 Project Execution Process (Overall Process Study)

As mention earlier five major phases are taken in coordinating project, there are five major phases: contract agreement, design development, fabrication and assembly, construction, and commissioning. In Project Execution System, there are many discipline involve from the preparation of the project until the project is closed-out and delivered. A project manager (PM) along with project engineer (PE), work together with team actively throughout the project life cycle. The PM is responsible for control the overall project with the main focus on commercial aspect. The PM is decision maker and must gain control over the project plan which to ensure the project will be deliver as timeline requirement. The PE is mainly the channel for technical related issue who manage other engineering disciplines to work in line with the schedule and technical requirement. The project manager control the project in overall, project scheduler is responsible for supporting the entire project team, distribute the schedule and make sure schedule is up to date as the project move forward. Other engineering disciplines focus mainly on the area of technical and design specification. Project group basically consists of members as in Figure 11.

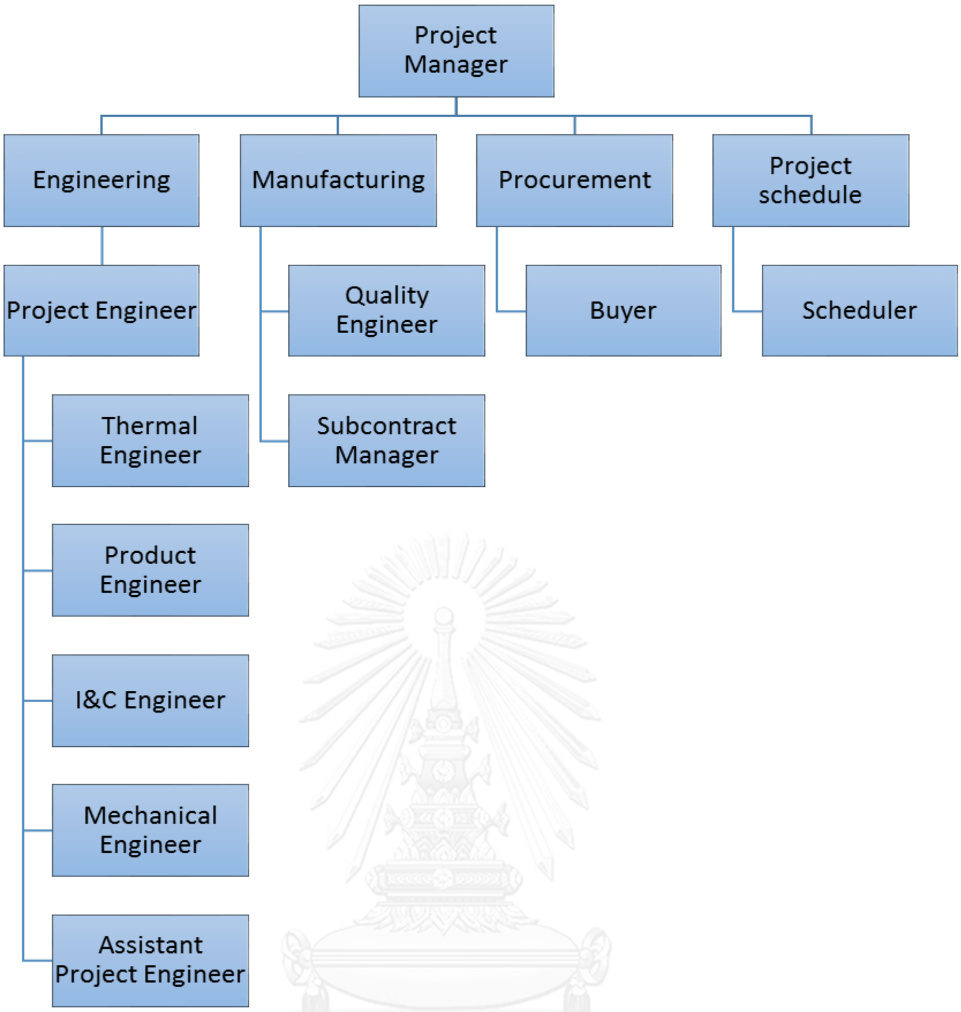
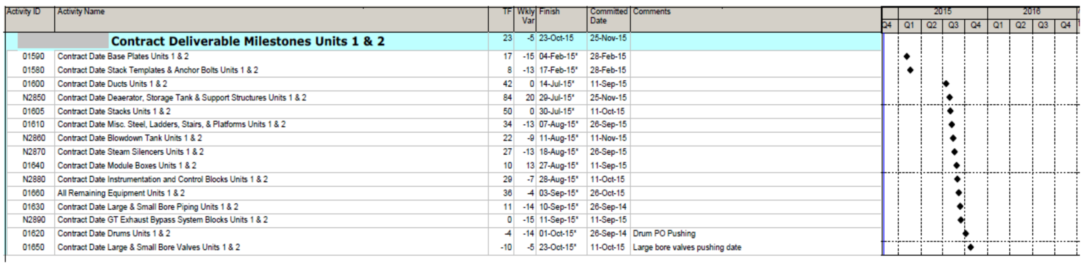


Figure 11: Level of project disciplines.

Master schedule or Full schedule

The project full schedule is issued at initial stage of the project. It covers all the major activities, and project milestone. Project milestones present the delivery contract date that each of major equipment is tied up with. This schedule is generally developed based on historical data and the contract due date. This schedule is linked to other detail schedule.



Activity ID	Activity Name	TF	Wkly Var	Finish	Committed Date	Comments
	Contract Deliverable Milestones Units 1 & 2	23	-5	23-Oct-15	25-Nov-15	
01590	Contract Date Base Plates Units 1 & 2	17	-15	04-Feb-15*	28-Feb-15	
01580	Contract Date Stack Templates & Anchor Bolts Units 1 & 2	8	-13	17-Feb-15*	28-Feb-15	
01600	Contract Date Ducts Units 1 & 2	42	0	14-Jul-15*	11-Sep-15	
N2850	Contract Date Deaerator, Storage Tank & Support Structures Units 1 & 2	84	20	29-Jul-15*	25-Nov-15	
01605	Contract Date Stacks Units 1 & 2	50	0	30-Jul-15*	11-Oct-15	
01610	Contract Date Misc. Steel, Ladders, Stairs, & Platforms Units 1 & 2	34	-13	07-Aug-15*	26-Sep-15	
N2860	Contract Date Blowdown Tank Units 1 & 2	22	-9	11-Aug-15*	11-Nov-15	
N2870	Contract Date Steam Silencers Units 1 & 2	27	-13	18-Aug-15*	26-Sep-15	
01640	Contract Date Module Boxes Units 1 & 2	10	13	27-Aug-15*	11-Sep-15	
N2880	Contract Date Instrumentation and Control Blocks Units 1 & 2	29	-7	28-Aug-15*	11-Oct-15	
01660	All Remaining Equipment Units 1 & 2	36	-4	03-Sep-15*	26-Oct-15	
01630	Contract Date Large & Small Bore Piping Units 1 & 2	11	-14	10-Sep-15*	26-Sep-14	
N2890	Contract Date GT Exhaust Bypass System Blocks Units 1 & 2	0	-15	11-Sep-15*	11-Sep-15	
01620	Contract Date Drums Units 1 & 2	-4	-14	01-Oct-15*	26-Sep-14	Drum PO Pushing
01650	Contract Date Large & Small Bore Valves Units 1 & 2	-10	-5	23-Oct-15*	11-Oct-15	Large bore valves pushing date

Engineering schedule

The engineering schedule shows all activities regarding each engineering discipline. All activities are indicated with the start date, finish date, percent complete, and time float. The related engineering tasks; for example, update assembly drawings, issue assembly drawing package, issue and review technical specification. This schedule can also be generated to each discipline in specific which is called the 4 weeks look ahead schedule update by responsibility. Each discipline can be able to follow the schedule and clearly see the upcoming activity on their responsibility within forward four week timeline. It is required for every team members to update their work progress every week, then the scheduler will incorporate all data and update schedule. The internal engineering team meeting is carried weekly and this schedule update is one of the topics to be discussed as to monitor and review the overall status of the project. If there are any tasks delay or tend to be behind schedule, it will be brought to attention and rectified as necessary.

Supply management full schedule

The schedule associates with equipment that the company buys in and subcontracting work. Basically, it shows the start date, finish date, percent of work complete, and total float. The activity listed out is such as manufacturing of such a component, shipping from vendor to site, required date.

3.2 Subcontractors' Work Process Study

3.2.1 Process of subcontractors' work

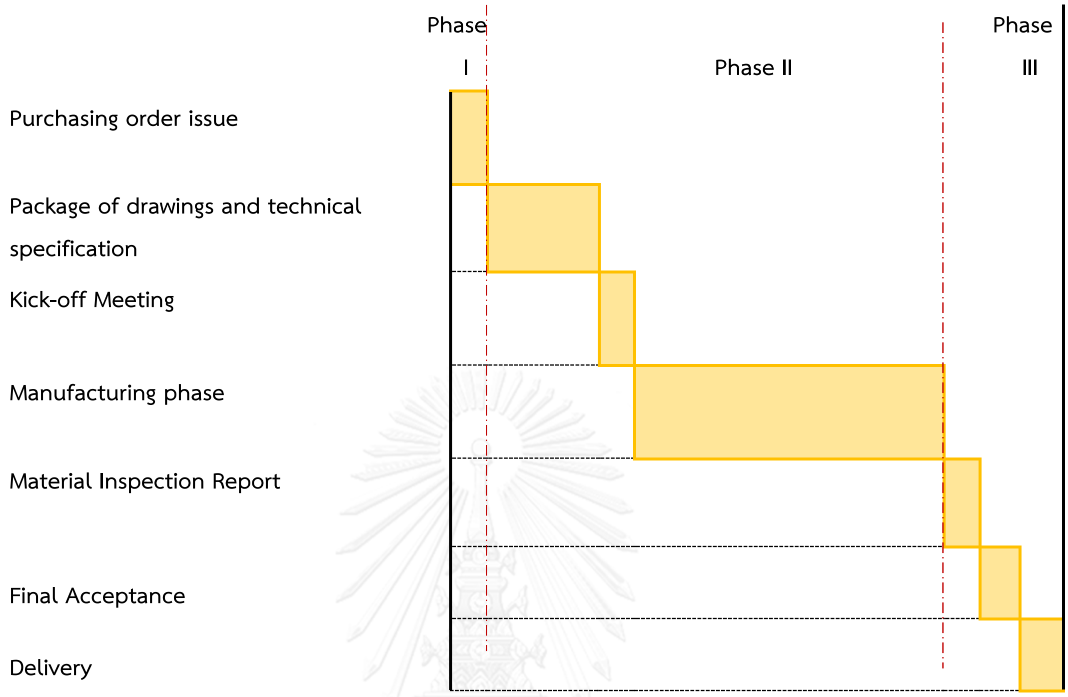


Figure 12: work process of subcontractor

From Figure 12, there are three basic phases: phase I, II, and III where time and effort spent at each stage are different. Phase 1 - the work can get started after purchasing order has been issued from the company to subcontractor. At phase II, this requires a lot of time for accomplishment. Subcontractor review the design drawings and specifications. Then, the kick-off meeting will be held in order to communicate project goals, time line and deliverables, and to ensure that everyone has a common understanding of the project and their responsibilities. Afterwards, the project start to be manufactured. Before the job can be accepted, phase III is reached where the final inspection shall be expedited. Subcontractor need to submit the material inspection report to company, and if the work is acceptable, the project can be close out.

3.2.2 Project Control Practice

There are three main disciplines who directly responsible in controlling fabrication process.

- Subcontract Manager (SM); starting with the procurement process, the purchasing order is issued to the subcontractor. If the materials are to be provided by the company, SM shall expedite that process. Throughout the project cycle, SM monitor and control the work progress closely, and deal with any issues occur during the execution.
- Quality Engineer (QE); QE play significant role at this stage since the final equipment is governed by codes and standards i.e. ASME, ASCE, Fabrication Code, and so on. Thus, the fabrication work is not only strictly controlled under those standards, but also need to meet what specified per design and customer requirement. Moreover, QE review the work progress at a time, if the work tends to be delayed, QE will report and notify the project team.
- Project Engineer; Basically PE is the one who control the overall project progress. Regarding to this area, PE also approach on targeted schedule and approve on any deviation or problem that may have.

Basically, the company has to define the required ship date of product and review the fabrication schedule for each of the product to be manufactured properly and delivered to meet customer contract date. The case study company uses subcontractors to perform selected work.

At the beginning phase of manufacturing, subcontractor is required to submit list of documents as following;

- Drawing and technical data sheets
- Manufacturing or fabrication schedule.

The drawing and technical data sheets are to be reviewed by engineer to ensure that all data comply with job specification, none of any requirements omitted. These documents will have to be approved before fabrication process gets started.

Project engineer, subcontract manager and scheduler are responsible for reviewing of fabrication schedule. This is to acknowledge and to confirm whether the schedule is acceptable referring to the master schedule. The revision of schedule maybe requested if needed.

After the fabrication schedule is approved, kick off meeting will be arranged. QE leads the meeting, with the participants from subcontractor side. The purpose is to discuss the scope of work, schedule and specification. Meeting report can be issued and distributed to PM and SM accordingly. During the development of work, the progress is reported through biweekly meeting which mainly discuss current problems, work progress, and making decisions. Regard to each fabrication, it is the project-base system which is required the schedule of work, resource allocation and budget plan. It is therefore, could be considered as the sub-project or small project. The proper project management system shall be arranged to run the project smoothly.

3.2.3 Current Fabrication Project Schedule

Date	6-Aug-14			MODULE HARP WELDING STATUS																			
	Description			UNIT 52																			
					4.0%	10.0%	1.0%	10.0%	1.0%	10.0%	5.0%		4.0%	10.0%	1.0%	10.0%	1.0%	10.0%	5.0%	10.0%	4.0%	4.0%	100.00%
Box	Title	Module	Dwg.No.	Top	1 FIT	1 WELD	2 FIT	2 WELD	3 FIT	3 WELD	PWHT	Bottom	1 FIT	1 WELD	2 FIT	2 WELD	3 FIT	3 WELD	PWHT	NDE	Fin. Ins.	Hydro.	100%
1	HPSH1	HAH10MS301	MSND-002	MH01	4/8/14	5/8/14	5/8/14	6/8/14	6/8/14	6/8/14		MH02	4/8/14	5/8/14	5/8/14	6/8/14	6/8/14	6/8/14					
	HPSH2	HAH10MS302	MSND-003	MH03	31/7/14	3/8/14	5/8/14	6/8/14	6/8/14	6/8/14		MH04	31/7/14	3/8/14	5/8/14	6/8/14	6/8/14	6/8/14					
	HPSH3	HAH10MS303	MSND-004	MH05	31/7/14	3/8/14	5/8/14	6/8/14	6/8/14	6/8/14		MH06	31/7/14	3/8/14	5/8/14	6/8/14	6/8/14	6/8/14					
	HPEV1	HAD10MS201	MSND-005	MH07	26/7/14	27/7/14	28/7/14	31/7/14	31/7/14	31/7/14	24/7/14	MH08	26/7/14	27/7/14	28/7/14	31/7/14	31/7/14	31/7/14	24/7/14	4/8/14	2/8/14	5/8/14	
	HPEV2	HAD10MS202	MSND-006	MH9	28/7/14	29/7/14	30/7/14	30/7/14	31/7/14	31/7/14	24/7/14	MH10	28/7/14	29/7/14	30/7/14	30/7/14	31/7/14	31/7/14	24/7/14	4/8/14	2/8/14	5/8/14	
	HPEV3	HAD10MS203	MSND-007	MH11	26/7/14	27/7/14	28/7/14	29/7/14	30/7/14	31/7/14	24/7/14	MH12	26/7/14	27/7/14	28/7/14	29/7/14	30/7/14	31/7/14	24/7/14	4/8/14	1/8/14	6/8/14	
	HPEV4	HAD10MS204	MSND-008	MH13	28/7/14	29/7/14	29/7/14	31/7/14	2/8/14	2/8/14	24/7/14	MH14	28/7/14	29/7/14	29/7/14	31/7/14	2/8/14	2/8/14	24/7/14	4/8/14	2/8/14	6/8/14	
	HPEV5	HAD10MS205	MSND-009	MH15	25/7/14	26/7/14	27/7/14	28/7/14	29/7/14	29/7/14	24/7/14	MH16	25/7/14	26/7/14	27/7/14	28/7/14	29/7/14	29/7/14	24/7/14	30/7/14	30/7/14	1/8/14	
	HPEC1	HAC10MS101	MSND-010	MH17	25/7/14	27/7/14	28/7/14	28/7/14	29/7/14	29/7/14	24/7/14	MH18	25/7/14	27/7/14	28/7/14	28/7/14	29/7/14	29/7/14	24/7/14	30/7/14	29/7/14	1/8/14	
	HPEC2	HAC10MS102	MSND-011	MH19	25/7/14	28/7/14	28/7/14	29/7/14	30/7/14	30/7/14	23/7/14	MH20	25/7/14	28/7/14	28/7/14	29/7/14	30/7/14	30/7/14	23/7/14	30/7/14	31/7/14	4/8/14	
													Box 1 % complete										
													Box 1 Number of Harps to complete										7
2	HPEC3	HAC10MS103	MSND-012	MH21	25/7/14	26/7/14	27/7/14	28/7/14	29/7/14	29/7/14	21/7/14	MH22	25/7/14	26/7/14	27/7/14	28/7/14	29/7/14	29/7/14	21/7/14	2/8/14	31/7/14	4/8/14	
	LPSH1	HAH50MS301	MSND-013	MH23	16/7/14	17/7/14	19/7/14	19/7/14	19/7/14	19/7/14	19/7/14	MH24	16/7/14	17/7/14	19/7/14	19/7/14	19/7/14	19/7/14	19/7/14	25/7/14	19/7/14	26/7/14	
	HPEC4	HAC10MS104	MSND-014	MH25	22/7/14	23/7/14	23/7/14	24/7/14	25/7/14	25/7/14	18/7/14	MH26	22/7/14	23/7/14	23/7/14	24/7/14	25/7/14	25/7/14	18/7/14	26/7/14	25/7/14	29/7/14	
	HPEC5	HAC10MS105	MSND-015	MH27	22/7/14	22/7/14	23/7/14	23/7/14	24/7/14	24/7/14	18/7/14	MH28	22/7/14	22/7/14	23/7/14	23/7/14	24/7/14	24/7/14	18/7/14	28/7/14	26/7/14	30/7/14	
	LPEV1	HAD50MS201	MSND-016	MH29	19/7/14	20/7/14	21/7/14	21/7/14	22/7/14	24/7/14	25/7/14	MH30	19/7/14	20/7/14	21/7/14	21/7/14	22/7/14	24/7/14	25/7/14	1/8/14	25/7/14	2/8/14	
	LPEV2	HAD50MS202	MSND-017	MH31	18/7/14	19/7/14	20/7/14	20/7/14	21/7/14	21/7/14	21/7/14	MH32	18/7/14	19/7/14	20/7/14	20/7/14	21/7/14	21/7/14	21/7/14	25/7/14	21/7/14	28/7/14	
	LPEV3	HAD50MS203	MSND-018	MH33	13/7/14	13/7/14	14/7/14	15/7/14	16/7/14	16/7/14	21/7/14	MH34	13/7/14	13/7/14	14/7/14	15/7/14	16/7/14	16/7/14	21/7/14	25/7/14	19/7/14	29/7/14	
	LPEV4	HAD50MS204	MSND-019	MH35	16/7/14	17/7/14	18/7/14	19/7/14	21/7/14	21/7/14	14/7/14	MH36	16/7/14	17/7/14	18/7/14	19/7/14	21/7/14	21/7/14	14/7/14	1/8/14	22/7/14	2/8/14	
	HPEC6	HAC10MS106	MSND-020	MH37	21/7/14	22/7/14	22/7/14	23/7/14	23/7/14	23/7/14	18/7/14	MH38	21/7/14	22/7/14	22/7/14	23/7/14	23/7/14	23/7/14	18/7/14	26/7/14	24/7/14	29/7/14	
	HPEC7	HAC10MS107	MSND-021	MH39	21/7/14	22/7/14	23/7/14	23/7/14	24/7/14	24/7/14	18/7/14	MH40	21/7/14	22/7/14	23/7/14	23/7/14	24/7/14	24/7/14	18/7/14	28/7/14	26/7/14	30/7/14	
													Box 2 % complete										
													Box 2 Number of Harps to complete										10
3	LPEC1	HAC50MS101	MSND-022	MH41	12/7/14	13/7/14	14/7/14	14/7/14	14/7/14	14/7/14	14/7/14	MH42	12/7/14	13/7/14	14/7/14	14/7/14	14/7/14	14/7/14	14/7/14	22/7/14	21/7/14	24/7/14	
	HPEC8	HAC10MS108	MSND-023	MH43	13/7/14	13/7/14	14/7/14	14/7/14	15/7/14	16/7/14	5/7/14	MH44	13/7/14	13/7/14	14/7/14	14/7/14	15/7/14	16/7/14	5/7/14	18/7/14	17/7/14	22/7/14	
	LPEC2	HAC50MS102	MSND-024	MH45	14/7/14	15/7/14	16/7/14	16/7/14	16/7/14	16/7/14	16/7/14	MH46	14/7/14	15/7/14	16/7/14	16/7/14	16/7/14	16/7/14	16/7/14	18/7/14	18/7/14	23/7/14	
	HPEC9	HAC10MS109	MSND-025	MH47	13/7/14	13/7/14	14/7/14	15/7/14	15/7/14	16/7/14	5/7/14	MH48	13/7/14	13/7/14	14/7/14	15/7/14	15/7/14	16/7/14	5/7/14	18/7/14	17/7/14	23/7/14	
	LPEC3	HAC50MS103	MSND-026	MH49	8/7/14	9/7/14	9/7/14	10/7/14	10/7/14	10/7/14	10/7/14	MH50	8/7/14	9/7/14	9/7/14	10/7/14	10/7/14	10/7/14	10/7/14	12/7/14	12/7/14	21/7/14	
	HPECA	HAC10MS110	MSND-027	MH51	18/7/14	19/7/14	21/7/14	21/7/14	22/7/14	22/7/14	15/7/14	MH52	18/7/14	19/7/14	21/7/14	21/7/14	22/7/14	22/7/14	15/7/14	25/7/14	23/7/14	26/7/14	
	LPEC4	HAC50MS104	MSND-028	MH53	8/7/14	9/7/14	13/7/14	14/7/14	14/7/14	14/7/14	14/7/14	MH54	8/7/14	9/7/14	13/7/14	14/7/14	14/7/14	14/7/14	14/7/14	15/7/14	16/7/14	21/7/14	
	HPECB	HAC10MS111	MSND-029	MH55	8/7/14	10/7/14	12/7/14	13/7/14	14/7/14	16/7/14	5/7/14	MH56	8/7/14	10/7/14	12/7/14	13/7/14	14/7/14	16/7/14	5/7/14	22/7/14	18/7/14	24/7/14	
	HPECC	HAC10MS112	MSND-030	MH57	8/7/14	9/7/14	10/7/14	12/7/14	13/7/14	14/7/14	5/7/14	MH58	8/7/14	9/7/14	10/7/14	12/7/14	13/7/14	14/7/14	5/7/14	18/7/14	16/7/14	22/7/14	
	HPECD	HAC10MS113	MSND-031	MH59	18/7/14	19/7/14	20/7/14	20/7/14	21/7/14	21/7/14	15/7/14	MH60	18/7/14	19/7/14	20/7/14	20/7/14	21/7/14	21/7/14	15/7/14	25/7/14	22/7/14	26/7/14	
													Box 3 % complete										
													Box 3 Number of Harps to complete										10

Not Applicable to this project

Fill in Green shaded area Only

Box 1		7
Box 2		10
Box 3		10

Figure 13: Example of project schedule (1)

The current project schedule was done in excel format which showing activity related to expected date to perform work. At each activity there was a complete percent as of the overall 100 percent. This schedule seemed to be too broad, did not present relation of each activity which gave unclear of the overall picture of the project, the sequence of tasks can be omitted. It lacks of the flexibility for the schedule to be updated as the project develop. Hence this is considered as ineffective tool in order to control and monitoring the work progress throughout the cycle.

It can be concluded that; Subcontracting work does not have proper schedule.

- Not show network diagram relation
- No Critical Path Identification
- Not flexible for regular schedule update

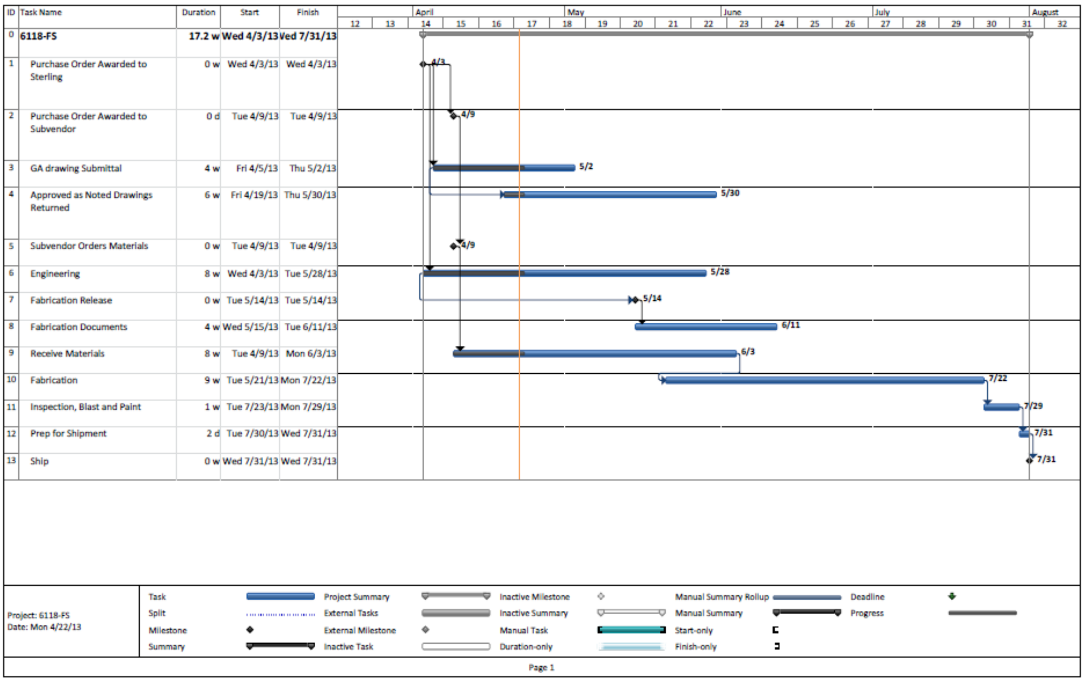


Figure 14: Example of project schedule (2)

3.2.4 Meeting and Report

The main purpose of this activity is to track the progress of the work from time to time, review the status of inspection, and solve any issues that happening on fabrication shop. This is the main channel of how the subcontractor communicates with the company. The example of the meeting report is as below.

Figure 15: current form of Minute of meeting (1)

3

*** =O (open), C (closed)**

****=C (critical) - must be addressed ASAP to avoid project impact**

I (important) – needs to be addressed to avoid moderate project impact

N (non critical) – general comment for information/review

*		Engineering Issues	Resp. Party	Date	**
	1	No Issue			

*		Material Issues	Resp. Party	Date	**
	1	No issue			

*		Schedule Issues	Resp. Party	Date	**
	1	Progress of fined tube ahead schedule.			

*		Action Items	Resp. Party	Date	**
	1	No issue			

1. <u>Engineering</u>

N/A

2. <u>Material</u>

2.1 Free issue material status.

ID	Description	ETA	Status	Actual Finish	Remark
1	CS Bare tubes	Jan 24,2014	Arrived	Feb 11,2014	
2	T11 & T22 Bare tubes/Stubs	Jan 24,2014	Arrived	Jan 13,2014	
3	CS Header pipe	Jan 24,2014	Arrived	Jan 13,2014	
4	P11&P22 Header Pipe	Jan 24,2014	Arrived	Jan 27,2014	
5	MH Carbon steel nozzle	Mar 1,2014	Arrived	Mar 12,2014	
6	MH Alloy steel nozzle	Mar 1,2014	Arrived	Mar 12,2014	
7	MH End plug, plate	Mar 1,2014	Arrived	Mar 12,2014	
8	MAPI interconnecting (LB)	Mar 20,2014	Arrived	Mar 12,2014	
9	MAPI interconnecting (SB)	May 8,2014	Arrived	Mar 12,2014	
10	Spring Assembly	May 8,2014	Arrived	Apr 29,2014	
11	Hanger rod	May 8,2014	Arrived	Apr 29,2014	
12	EJ shop installed	May 8,2014	Arrived	May 8,2014	

3. <u>Document Status (MDR)</u>

3.1 , No issue.

4. <u>Quality issue at Box shop</u>

4.1 **Lasted IUN no. 0.**
4.2 **Lasted NCR no. 0.**
4.3 **Lasted SDR no. 025,** No pending.
4.4 **Lasted TQ no. 24,** No pending.

5. <u>Welder</u>

5.1) Total **32** welders now at Vipco harp shop, the detail are as follows.
- 5.1.1) 16 welders qualified for tube to header (both full pen and full straight).
- 5.1.2) 10 welders qualified for pipe to pipe.
- 5.1.3) 6 welders qualified for non pressure part.

Page 2 of 6

Figure 16: current form of Minute of meeting (2)

6. Fabrication

- Fined tube MT 01 Completed 100 % (116 of 116 Pieces)
- Fined tube MT 02 Completed 100 % (116 of 116 Pieces)
- Fined tube MT 03 Completed 100 % (116 of 116 Pieces)
- Fined tube MT 04 Completed 100% (432 of 432 pieces)
- Fined tube MT 05 Completed 100 % (2,016 of 2,016 pieces)
- Fined tube MT 06 Completed 100% (1,008 of 1,008 pieces)
- Fined tube MT 07 Completed 100% (72 of 72 pieces)
- Fined tube MT 08 Completed 100% (144 of 144 pieces)
- Fined tube MT 09 Completed 100% (72 of 72 pieces)
- Fined tube MT 10 Completed 100 % (432 of 432 pieces)
- Fined tube MT 11 Completed 100% (216 of 216 pieces)
- Fined tube MT 12 Completed 100% (144 of 144 pieces)
- Fined tube MT 13 Completed 100 % (144 of 144 pieces)
- Fined tube MT 14 Completed 100% (432 of 432 pieces)

Note: Fined fabrication are 100% completed.

7. Inspection

7.1 No activity for inspection as of this week.

8. Header fabrication

8.1 Monitoring and random check fit up end plate and nozzle to header of header no. MH0501-B1-U52, MH0601-B1-U52, MH1201-B1-U52, MH1301-B1-U52, MH1501-B1-U52, MH1601-B1-U52, MH0101-B1-U52, MH0201-B1-U52, MH0301-B1-U52and MH0401-B1-U52 as per 17481-MSND-XXX-00 found fit up gap and dimension within tolerance and acceptable per 17481-MHNJ-005-00 and 17481-EBND-106.

8.2 Monitoring workmanship during welding process of nozzle to header and division plate to visual root pass, weldment, welder ID as per VIPCO's WPS found satisfactory

Page 3 of 6

Figure 17: current form of Minute of meeting (3)

8.3 Witness and dimension check with TPSC-T of Top and Bottom header no. MH0301-B1-U51, MH0401-B1-U51, MH0101-B1-U51, MH0201-B1-U51, MH5501-B3-U52, MH5601-B3-U52, MH5701-B3-U52 and MH5801-B3-U52 as per 17481-MSND-XXX Rev.00, to verified marking, nozzle height, visual weld found free of defects (root pass and weld size) and header bow, dimension within tolerance and acceptable per 17481-MHNJ-005-00.

8.4 Witness UT test of header end plate as per ASME Sec.I, PW52 found satisfactory.

8.5 Witness PT test 100% of lifting lug and 10% of header nozzle after PWHT as per ASME sec.VIII Div.1 and VPI spec. found satisfactory.

Figure 18: current form of Minute of meeting (4)

9. Harp Inspection, Hydro Test & Dry out

9.1 Monitoring workmanship during welding tube to header; to verify fined tube number, orientation of nozzle, joint configuration, tack welder, and preheat and workmanship were in accordance with ASME Sec.I, VPI spec. and WPS.

9.2 Witness and dimension check TPSC-T inspectors of harp no.HAC10MS111-B3-U51, HAD50MS101-B3-U51, HAD50MS102-B3-U51, HAD50MS103-B3-U51 and HAD50MS104-B3-U51 for check diagonal (±1/4"), length of harp (±1/8") and orientation of header, nozzle as per 17481-MSND-XXX, 17481-EBND-107and 17481-MSNJ-005-00 found satisfactory.

9.3 Monitoring workmanship during for fit up tube to header (row 1st) of harp no HAD50MS204-B2-U41; to verify fined tube number, orientation of nozzle, joint configuration, tack welder, preheat and workmanship were in accordance with the drawing V17481-MSND-016 found satisfactory.

Figure 19: current form of Minute of meeting (5)

9.4 Witness Hydro test with TPSC-T of Module harp assembly no. HAD10MS205-B1-U41, HAC10MS104-B2-U41, HAD10MS204-B1-U41 and HAC10MS102-B1-U41as per 17480-MSND-001-00 and 17480 hydro test procedures found satisfactory.

10. Conclusion inspection this week

10.1 Due to backlog from paint and insulation process. MWS confirmed that they can complete the casing fabrication and release to VIPCO5 approximately 10 days before start the module box assembly. VIPCO will close monitor to ensure that they are still in line until finish the task.

 # END REPORT #

Page 6 of 6

Figure 20: current form of Minute of meeting (6)

There are four main components of the report: Engineering issues, Material issues, Schedule issues, Action items. The report cover the major areas of the overall project. During the meeting, if there are any issues related to those aspects, it could be discussed and find a solution to solve i.e. if the work tend to fall behind the schedule, it shall be pushed and recovered by appropriate method. The resources that has been allocated to each activities and the inspection status are also be reported here. Nevertheless, the progress is currently report as the plain context of how many percent of work completed. It could be improved to be way more effectively in order to have a proper control, capture flaws or schedule deviations as obvious and precise. The trend of schedule performance has not done, this could be quite risky for project to miss the expected complete date since delay cannot be detected at the earliest possible. Schedule control and monitoring requires an approach of progress measurement system to compare progress against the time scale that was planned. According to PMI (2013), S-curves could be an optimum tool which is used to compare work progress against baseline. Moreover, at this step is the regular follow up activity which project management used to control both quality and work completion. The meeting is held bi-weekly, which may be too low because the progress should be measure regularly. The gap of time could lead to delay of communication, problem not be addressed in time, the more difficult in recover the schedule.

3.2.5 Identification of Problems in Current Process

Based on the above analysis, the major problems that company is facing in the area of control subcontracting work by implementing the existing project control systems can be summarised as following table. There were two major problems which are;

- Inappropriate project schedule
- Inefficient schedule control

Table 12: summary of problems in current project management.

Area	Problems	Significant Effects
Planning	**Improper project management plan** The fabrication schedule was done in excel format, showing the date to perform each activities but lack of detail in relation and sequence of each activities, and more importantly, critical path was not shown.	-Network relation of each activities could not be seen, thus not practical for decision making process in order to adjust the plans. -Critical Path was not in attention of project team. Since this path is driven the end date of the project, and float time. They should be acknowledge as scheduling constraints. The effect to this path will critically cause schedule slippage.
Schedule Control	**Schedule control** Scheduling format does not provide flexibility for adjust and update.	Schedule may fall behind the target according to improper update with the actual work perform.

Area	Problems	Significant Effects
Schedule Control	**Inefficient project performance measurement** S-Curve was not done, the performance index was rarely shown. Subcontractors usually operate slowly at the beginning of the project, the project seem to delay near due date.	-The overall trend line of the progress of the actual work complete compare with baseline would be clearer in access the project performance at a time. Delay in accomplish the project completion cannot be detected at the earliest stage. -Cost overruns due to crash activities.
Schedule Control	**less frequency on official follow-up activities** Bi-weekly meeting is held.	The gap of time between each meeting seems too long which lead to delay of communication, problem not be addressed in time, and more complicate to recover the schedule.

Table 13: summary of problems in current project management (cont).

The problems discovered are significantly negative effect to project execution, disrupting the project accomplishment. The consequences of a delayed schedule is always a financial losses, this has negative impact directly to profitability of the project. With the cause awareness, the problem can be mitigate and lead to an improvement of project productivity, then it will be result in a greater scale to company competitive advantage.

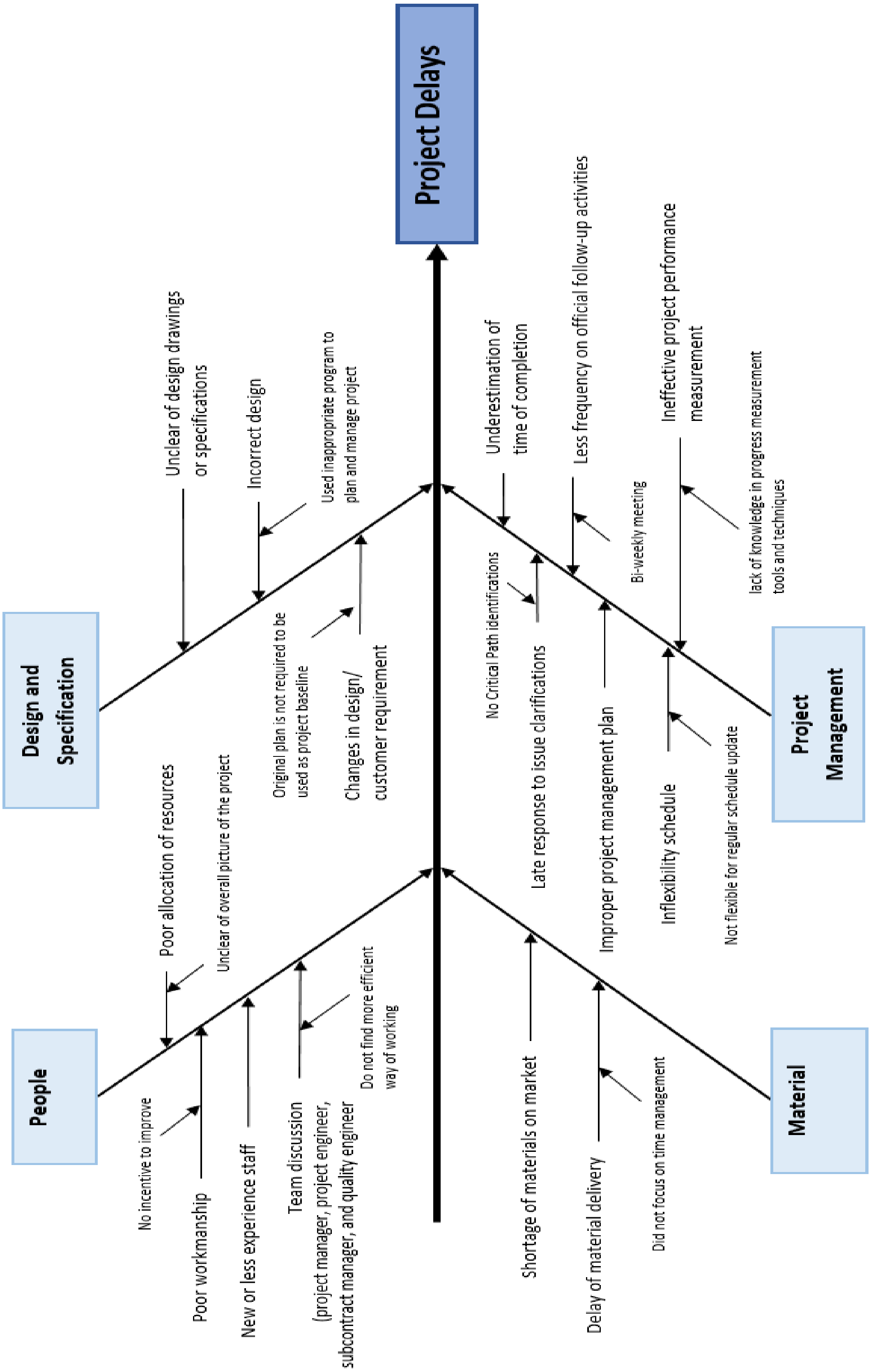
3.3 Causes of Delay

By nature of the project, the delay consequences could possibly be caused by various factors. In order to effectively mitigate delays in project, the greater detail investigation into overall area of project execution should be conducted. To investigate more, the researcher collects more data from literature review (chapter 1) and from primary observed result – actual situation. The related cause gathered is to be screened by professional thereafter. Then, the cause of the significant reasons causing delays are listed. Alwi and Hampson (2003), identified the important causes of delays in building construction projects, and suggested that by ranking the importance of delay variables is enable to seek best alternative solutions.

In order to find the root cause of project delay, the fishbone analysis can be applied to identity the potential causes of project delay as presented in following figure.

Project team members brainstorm and discuss to list root causes of the current problems that lead to project delay. According to the fishbone diagram below, there are four main causes that have an effect to project delay that consists of People, Design and Specification, Material and Project Management that the concept of project time management from PMBOK can be applied to solve the root causes that needed improvement and generate the preventive action that can help the project management team assess and measure project performance and progress effectively.

Figure 21: Fishbone Diagram



The summary of causes of delays or failure to perform as plan are listed below.

Area	Causes of Delay
People	Poor workmanship Poor allocation of resources New or less experience staff Team discussion not result in proper solutions, lack of proper discussion and communication within team
Design and Specification	Unclear of design drawings or specifications Incorrect design Changes in design/ customer requirement
Material	Delay of material delivery Shortage of material on market
Project Management	Late response to issue clarifications Improper project management plan Inflexibility schedule Ineffective project performance measurement less frequency on official follow-up activities (bi-weekly meeting)

Table 14: List of cause of delay for case study company

3.4 Area of Improvement

The purpose of this chapter is to propose the appropriate framework to control and improve on-time project delivery of the company as outlined in objective of the research. As above discussion on cause and effect of delay problem, the solution are purposed to improve the problems in each area as illustrated in Table 12 and 13. By guideline of PMBOK (PMI, 2013), the project time management is developed. Weekly meeting, preventive action plans are recommended to be done.

Table 15: propose methodology for improvement

Area	Causes of Delay	Proposed Methodology
People	- Workmanship - Poor allocation of resources - New or less experience staff - Team discussion not result in proper solutions, lack of proper discussion and communication within team	- Weekly meeting
Design and Specification	- Unclear of design drawings or specifications - Incorrect design - Changes in design/ customer requirement	- Preventive action plan, Contingency plan, Risk management
Material	- Delay of material delivery	- Procurement plan
Project Management	- Late response to issue clarifications - Improper project management plan - Inflexibility schedule - Ineffective project performance measurement	- Project time management plan development by PMBOK guideline.

Area	Causes of Delay	Proposed Methodology
	- less frequency on official follow-up activities	

Table 16: propose methodology for improvement (cont.)

3.5 The Proposed Planning and Control Framework

Since the study is focus on project time management so the area of implementation is mainly in these three process groups; planning, executing, and monitoring and controlling process group.

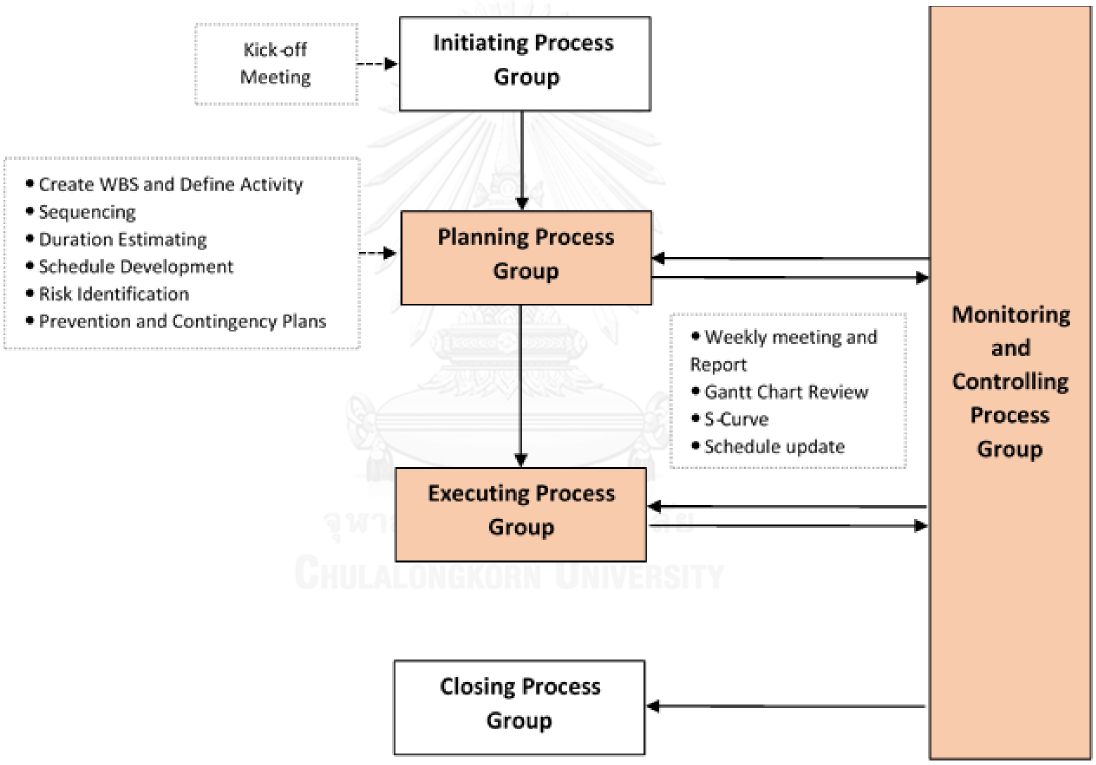


Figure 22: the project control framework for case study

4 Chapter 4: Project Time Management Framework Implementation and Evaluation

The project management body of knowledge (PMBOK) is well recognised internationally with knowledge areas that have been accepted as best practice of project management. This chapter will apply the project time management principle that was scoped in the last section to the on-going project. Tools and techniques will be used to control the project. Periodically result of project performance will be reviewed.

4.1 Project Initiating

4.1.1 Project Charter

The initiating processes are performed to initiate a new project and obtain authorisation to start the project or phase of project. Project charter is included in these processes. Project charter provides an introductory description of roles and responsibilities, outlines the project objectives, classifies the main stakeholders, and expresses the authority of the project manager. For the fabrication project investigated in this study, can be presented as following Figure 23 and 24.

The project charter document indicates the key information of the project: the project objectives, assumptions, project scopes, project milestones, success measurements, roles and responsibilities, and project risks. There are three project objectives. First objective is to implement project time management concept to track and report on the impact of the schedule. Second is to ensure that project team members especially project manager, project engineer, subcontract manager and quality engineer are aware and understand the importance of project time control. Finally, to be able to deliver project on time. The project is based on following assumptions: all materials will be supplied on time, proper control is expedited to keep up work progress, get on-time delivery performance to meet the commitments to customer. Scopes of the project is provided to setting out the clearly scope of work which are the technical specification package from design phase will be sent to vendor or subcontractor to begin

manufacturing, subcontractor have to be specialised and qualified in manufacturing for such a component (steam drum), and the quality engineer will take the main role and make sure that all welding procedure and quality control requirements are met.
Moreover, the major project milestones are defined. There are six main milestones which consist of Design approval, Material preparation, Main part fabrication, Inspection and hydrostatic test and Final inspection. Next, it is important to set the success measurements so, the accomplishment of the project can be measured by the actual result of the project, if the work can be perform in line with the plan? It is also the ability to track the project progress, monitor project risks, and create recovery plan or corrective action if necessary. The final success measurement is the project completion date which need to be met.

Furthermore, roles and responsibilities of team members are described. Regarding this project, project team members who will involve with the subcontracting project consist of project manager, project engineer, subcontract manager, and quality engineer. The team will contribute towards the project to meet its objectives.
The key purpose of this project charter is to provide the vision of the project, goals, scope and high level deliverables. The team members in the project understand how to work and what is need to be attained to deliver project successfully.

Project Charter

Project Title:	Fabrication and Assembly of Steam Drums for Heat Recovery Steam Generator		
Project Start Date:	07-May-2015	**Completion Date:**	30-Oct-2015
Prepare Date:	16-Apr-2015	**Revision:**	00

Project Objectives:

- Implement project time management from PMBOK concept to track and report on the impact of the schedule
- Ensure project management team members (project manager, project engineer, subcontract manager and quality engineer) are aware and understand the importance of project time control
- Deliver project on time

Assumptions:

- All materials will supply by supplier on-time
- Having proper control to keep up work progress
- Get on-time delivery performance to meet the commitments to customer

Project Scope:

- The technical and specification from design phase will be sent to vendor or subcontractor to begin manufacturing.
- A subcontractor have to be specialised and qualified in manufacturing for such a component (steam drum).
- The quality engineer will take the main role and make sure that all welding procedure and quality-control requirement are met.

Project Milestones:

Milestones	**Deliverables**	**Date**
Design approval	Equipment fabrication drawing submission	23-Apr-2015
Material preparation	Materials ready for fabrication and assembly	24-Aug-2015
Main part fabrication	Finish fabrication and assembly	02-Oct-2015
Inspection and hydrostatic test	Equipment is ready for final inspection	26-Oct-2015
Final inspection	Final inspection by inspector and ready for shipment	29-Oct-2015
Project completion	Finish inspection and deliver to site	30-Oct-2015

Success Measurements:

- Each activity to be start and finish in line with the project baseline
- Review and track weekly progress, monitor project risks and, issue recovery plan if necessary
- Deliver project on time

Figure 23: Project Charter (1)

Roles and Responsibilities:

Project manager Performing the day-to-day management of the project and has specific accountability for managing the project within the approved constraints of scope, quality, time and cost, to deliver the specified requirements and deliverables
Project engineer Controlling the overall project progress. Regarding to this area, PE also approach on targeted schedule and approve on any deviation or problem that may have.
Subcontract manager Responsible with the procurement process, the purchasing order is issued to the subcontractor. Monitoring and controlling the work progress closely, and deal with any issues occur during the execution.
Quality engineer Playing significant role at this stage since the final equipment is governed by codes and standards i.e. ASME, ASCE, Fabrication Code, and so on.

Project Risks:

Risk	Mitigation Strategy
Shop Surveillance & Quality Control	Ensuring fabricators deliver the equipment as designed. Rework should be minimized
Unclear design and specification	Engineering finish with the design
Design Changes - Internal parts	Ensuring design changes are finalized on reasonably timed when possible
Late arrival of raw material	Plan ahead, and Give an advance notice of raw material vendor of when they can expect the PO, so some process can get prepared.

PROJECT CHARTER APPROVAL

The undersigned acknowledge they have reviewed the project charter and authorize and fund the Fabrication and Assembly Project in Heat Recovery Steam Generator Manufacturer. Changes to this project charter will be coordinated with and approved by the undersigned or their designated representatives.

Signature: ______________________ Date: __________
Print Name: ______________________
Title: ______________________
Role: ______________________

Signature: ______________________ Date: __________
Print Name: ______________________
Title: ______________________
Role: ______________________

Figure 24: Project Charter (2)

4.2 Project Planning

4.2.1 Plan Schedule Management

Microsoft project program will be used to develop project schedule in greater detail which enable team to comprehend the direction of the project. The schedule illustrates sequence, network relationship between activities, estimated time to complete, start and finish date, critical path and so on. During project execution, weekly progress shall be reported to project management team, S-Curve and Critical path are mainly tools for progress measurement. To control the schedule, approved changes and correction actions may updated to current schedule.

Schedule Management Plan should outline the following components:

- Project Milestone
- WBS (work breakdown structure)
- Performance measurement technique
- Control thresholds which define amount of allowed variation before some action needs to be taken.
- Preventive action plan

4.2.2 Activity Definition

The study of the fabrication project is carried out. All activities in the project shall be listed which to break down the main activities in to small task using decomposition technique. The group of activities can be split into individual activity. The sequence and estimated completion time of each activity are identified thereafter. The great details of activities are more suitable for planning and keeping the project on track.

The activity lists of the project can be shown in Table 17, 18 and 19.

Table 17: Activity list of the project

Work Package	Sub-Work Package	Activity Description
1. MARK CUT AND PART PREPARATION PROCESS	1.1 HEAD 2:1 ELLIIPTICAL HEAD FOR 4 OFF	1.1.1 RAW PLATE ARRIVED AT SHOP 1.1.2 INCOMING MATERIAL INSPECTION 1.1.3 BLANK PLATE LAY OUT 1.1.4 INSPECTION 1.1.5 CUTTING 1.1.6 PRESSING AND FORMING 1.1.7 PRE-BLASTING 1.1.8 JOINT PREPARATION AND BEVELING 1.1.9 MANWAY LAY OUT AND INSPECTION 1.1.10 OPENING AND EDGE PREPARATION 1.1.11 FIT UP AND WELD MANWAY RING TO HEAD
	1.2 SHELL PLATE FOR 2 OFF	1.2.1 RAW PLATE ARRIVED AT SHOP 1.2.2 INCOMING MATERIAL INSPECTION 1.2.3 MARK CUT AND INSPECTION 1.2.4 PRE-BLASTING 1.2.5 ROLLING 1.2.6 INSPECTION 1.2.7 LONG SEAM WELDING 1.2.8 RE ROLL 1.2.9 LAY OUT NOZZLES ON SHELL AND INSPECTION 1.2.10 CUTTING AND EDGE PREPARATION NDE. AND INSPECTION
	1.3 NOZZLES FOR 50 OFF	1.3.1 MARK CUT AND INSPECTION 1.3.2 FIT UP AND WELD (IF REQUIRED...) 1.3.3 MACHINING 1.3.4 FINISHING AND INSPECTION
	1.4 SADDLES FOR 4 OFF	1.4.1 MARK CUT AND INSPECTION 1.4.2 FIT UP AND WELD 1.4.3 FINISHING AND INSPECTION
	1.5 INTERNAL PART	1.5.1 MARK CUT AND INSPECTION 1.5.2 FIT UP AND WELD 1.5.3 FINISHING AND INSPECTION
	1.6 ACCESSORIES PART	1.6.1 MARK CUT AND INSPECTION 1.6.2 FIT UP AND WELD 1.6.3 FINISHING AND INSPECTION

Table 18: Activity list of the project (cont)

Work Package	Sub-Work Package	Activity Description
2. MAIN PART FABRICATION	2.1 LP STEAM DRUM 55015 S98	2.1.1 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8" SCH.40 BW)
		2.1.2 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6" SCH.80 BW)
		2.1.3 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8" SCH.40 BW)
		2.1.4 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6" SCH.40 BW)
		2.1.5 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6" SCH.80 SW)
		2.1.6 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2" 3000# SW)
		2.1.7 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1" SCH.40 SW)
		2.1.8 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1" 3000# SW)
		2.1.9 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2" 3000# SW)
		2.1.10 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1" 3000# SW)
		2.1.11 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2" SW)
		2.1.12 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1" 3000# SW)
		2.1.13 NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1" 3000# SW)
		2.1.14 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)
		2.1.15 FIRST HEAD FIT UP AND WELD TO SHELL
		2.1.16 NDE. AND INSPECTION
		2.1.17 INTERNAL BLASTING BEFORE FIT UP INTERNAL PART
		2.1.18 FIT UP AND WELD INTERNAL PART
		2.1.19 FINISHING AND INSPECTION
		2.1.20 SECOND HEAD FIT UP AND WELD
		2.1.21 FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL
		2.1.22 FIT UP AND WELD ACCESSORIES PART
		2.1.23 FINISHING AND INSPECTION
	2.2 LP STEAM DRUM 55015 S99	2.2.1 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8" SCH.40 BW)
		2.2.2 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6" SCH.80 BW)
		2.2.3 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8" SCH.40 BW)
		2.2.4 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6" SCH.40 BW)
		2.2.5 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6" SCH.80 SW)
		2.2.6 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2" 3000# SW)
		2.2.7 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1" SCH.40 SW)
		2.2.8 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1" 3000# SW)
		2.2.9 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2" 3000# SW)
		2.2.10 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1" 3000# SW)
		2.2.11 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2" SW)
		2.2.12 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1" 3000# SW)
		2.2.13 NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1" 3000# SW)
		2.2.14 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)
		2.2.15 FIRST HEAD FIT UP AND WELD TO SHELL
		2.2.16 NDE. AND INSPECTION
		2.2.17 INTERNAL BLASTING BEFORE FIT UP INTERNAL PART

Table 19: Activity list of the project (cont)

Work Package	Sub-Work Package	Activity Description
		2.2.18 FIT UP AND WELD INTERNAL PART 2.2.19 FINISHING AND INSPECTION 2.2.20 SECOND HEAD FIT UP AND WELD 2.1.21 FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL 2.1.22 FIT UP AND WELD ACCESSORIES PART 2.1.23 FINISHING AND INSPECTION
3. FINAL INSPECTION BY INSPECTOR		3.1 LP STEAM DRUM 55-0115 S98 3.2 LP STEAM DRUM 55-0115 S99
4. VISUAL DIMENSION BY AI.		4.1 LP STEAM DRUM 55-0115 S98 4.2 LP STEAM DRUM 55-0115 S99
5. POST WELD HEAT TREATMENT		5.1 LP STEAM DRUM 55-0115 S98 5.2 LP STEAM DRUM 55-0115 S99
6. HYDROSTATIC TEST	6.1 LP STEAM DRUM 55-0115 S98	6.1.1 PRE HYDROSTATIC TEST 6.1.2 HYDROSTATIC TEST 6.1.3 DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING 6.1.4 FINAL DIMENSION
	6.2 LP STEAM DRUM 55-0115 S99	6.2.1 PRE HYDROSTATIC TEST 6.2.2 HYDROSTATIC TEST 6.2.3 DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING 6.2.4 FINAL DIMENSION
7. BLASTING / PAINTING / CLEANING		7.1 LP STEAM DRUM 55-0115 S98 7.2 LP STEAM DRUM 55-0115 S99
8.INSTALL INTERNAL PART AND WEIGHTING		8.1 LP STEAM DRUM 55-0115 S98 8.2 LP STEAM DRUM 55-0115 S99
9. PACKING AND MARKING		9.1 LP STEAM DRUM 55-0115 S98 9.2 LP STEAM DRUM 55-0115 S99
10. FINAL INSPECTION BY INSPECTOR AND READY FOR SHIP		10.1 LP STEAM DRUM 55-0115 S98 10.2 LP STEAM DRUM 55-0115 S99

4.2.3 Activity Sequencing Project Control

According to the list of activity has been established previously, next they should be prioritised in logical sequence. The dependencies and sequence between each activity are presented as below.

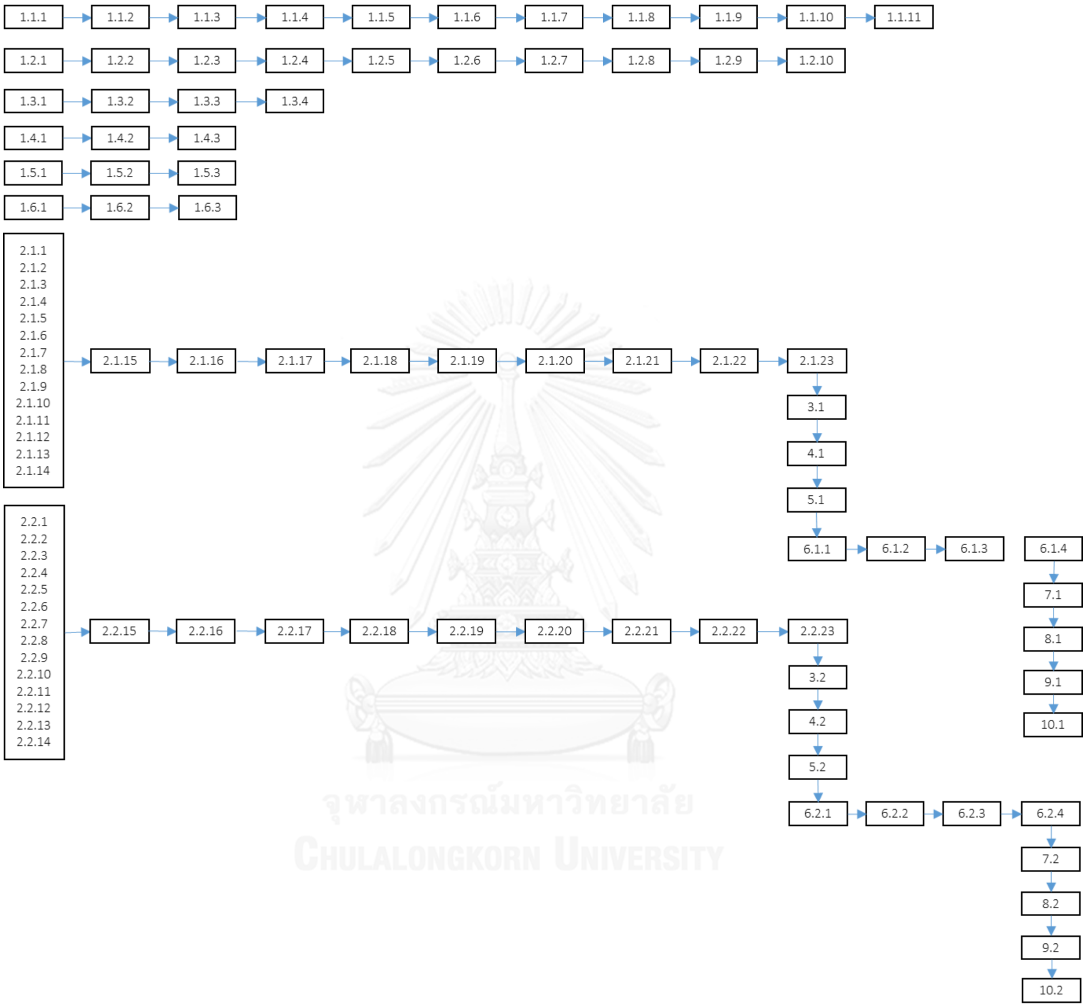


Figure 25: Activity Network Diagram

4.2.4 Activity Duration Estimating

To estimate the activity and duration, historical data and expert judgement are incorporated. The time spent on previous project is analysed combined with the data given by the experience staffs, and information from vendor. This process is used to provide reliable estimation. From step 4.3.2, 4.3.3 and 4.3.4, the activity plan could be developed as below table.

Table 20: Activity List Break Down with Estimated Duration

Activity List	Duration (days)	Predecessors
Project Duration	**126**	
1. MARK CUT AND PART PREPARATION PROCESS	**84**	
1.1 HEAD 2:1 ELLIIPTICAL HEAD FOR 4 OFF	**78**	
1.1.1 RAW PLATE ARRIVED AT SHOP	2	
1.1.2 INCOMING MATERIAL INSPECTION	3	1.1.1
1.1.3 BLANK PLATE LAY OUT	4	1.1.2
1.1.4 INSPECTION	3	1.1.3
1.1.5 CUTTING	6	1.1.4
1.1.6 PRESSING AND FORMING	28	1.1.5
1.1.7 PRE-BLASTING	4	1.1.6
1.1.8 JOINT PREPARATION AND BEVELING	5	1.1.7
1.1.9 MANWAY LAY OUT AND INSPECTION	3	1.1.8
1.1.10 OPENING AND EDGE PREPARATION	8	1.1.9
1.1.11 FIT UP AND WELD MANWAY RING TO HEAD	12	1.1.10
1.2 SHELL PLATE FOR 2 OFF	42	
1.2.1 RAW PLATE ARRIVED AT SHOP	2	
1.2.2 INCOMING MATERIAL INSPECTION	3	1.2.1
1.2.3 MARK CUT AND INSPECTION	5	1.2.2
1.2.4 PRE-BLASTING	3	1.2.3
1.2.5 ROLLING	8	1.2.4
1.2.6 INSPECTION	3	1.2.5
1.2.7 LONG SEAM WELDING	8	1.2.6
1.2.8 RE ROLL	4	1.2.7
1.2.9 LAY OUT NOZZLES ON SHELL AND INSPECTION	3	1.2.8
1.2.10 CUTTING AND EDGE PREPARATION NDE. AND INSPECTION	3	1.2.9
1.3 NOZZLES FOR 50 OFF	40	
1.3.1 MARK CUT AND INSPECTION	6	
1.3.2 FIT UP AND WELD (IF REQUIRED…)	16	1.3.1
1.3.3 MACHINING	14	1.3.2
1.3.4 FINISHING AND INSPECTION	4	1.3.3

Table 21: Activity List Break Down with Estimated Duration (cont)

Activity List	Duration (days)	Predecessors
1.4 SADDLES FOR 4 OFF	28	
1.4.1 MARK CUT AND INSPECTION	10	
1.4.2 FIT UP AND WELD	14	1.4.1
1.4.3 FINISHING AND INSPECTION	4	1.4.2
1.5 INTERNAL PART	32	
1.5.1 MARK CUT AND INSPECTION	14	
1.5.2 FIT UP AND WELD	14	1.5.1
1.5.3 FINISHING AND INSPECTION	4	1.5.2
1.6. ACCESSORIES PART	26	
1.6.1 MARK CUT AND INSPECTION	4	
1.6.2 FIT UP AND WELD	18	1.6.1
1.6.3 FINISHING AND INSPECTION	4	1.6.2
2. MAIN PART FABRICATION	42	
2.1 LP STEAM DRUM 55015 S98	42	
2.1.1 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8" SCH.40 BW)	15	
2.1.2 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6" SCH.80 BW)	15	
2.1.3 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8" SCH.40 BW)	15	
2.1.4 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6" SCH.40 BW)	15	
2.1.5 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6" SCH.80 SW)	15	
2.1.6 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2" 3000# SW)	15	
2.1.7 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1" SCH.40 SW)	15	
2.1.8 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1" 3000# SW)	15	
2.1.9 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2" 3000# SW)	15	
2.1.10 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1" 3000# SW)	15	
2.1.11 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2" SW)	15	
2.1.12 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1" 3000# SW)	15	
2.1.13 NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1" 3000# SW)	15	
2.1.14 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)	15	
2.1.15 FIRST HEAD FIT UP AND WELD TO SHELL	5	2.1.14
2.1.16 NDE. AND INSPECTION	3	2.1.15
2.1.17 INTERNAL BLASTING BEFORE FIT UP INTERNAL PART	2	2.1.16
2.1.18 FIT UP AND WELD INTERNAL PART	4	2.1.17
2.1.19 FINISHING AND INSPECTION	2	2.1.18
2.1.20 SECOND HEAD FIT UP AND WELD	4	2.1.19
2.1.21 FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	3	2.1.20
2.1.22 FIT UP AND WELD ACCESSORIES PART	2	2.1.21
2.1.23 FINISHING AND INSPECTION	2	2.1.22

Table 22: Activity List Break Down with Estimated Duration (cont)

Activity List	Duration (days)	Predecessors
2.2. LP STEAM DRUM 55015 S99	42	
2.2.1 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8" SCH.40 BW)	15	
2.2.2 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6" SCH.80 BW)	15	
2.2.3 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8" SCH.40 BW)	15	
2.2.4 NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6" SCH.40 BW)	15	
2.2.5 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6" SCH.80 SW)	15	
2.2.6 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2" 3000# SW)	15	
2.2.7 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1" SCH.40 SW)	15	
2.2.8 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1" 3000# SW)	15	
2.2.9 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2" 3000# SW)	15	
2.2.10 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1" 3000# SW)	15	
2.2.11 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2" SW)	15	
2.2.12 NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1" 3000# SW)	15	
2.2.13 NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1" 3000# SW)	15	
2.2.14 NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)	15	
2.2.15 FIRST HEAD FIT UP AND WELD TO SHELL	5	2.2.14
2.2.16 NDE. AND INSPECTION	3	2.2.15
2.2.17 INTERNAL BLASTING BEFORE FIT UP INTERNAL PART	2	2.2.16
2.2.18 FIT UP AND WELD INTERNAL PART	4	2.2.17
2.2.19 FINISHING AND INSPECTION	2	2.2.18
2.2.20 SECOND HEAD FIT UP AND WELD	4	2.2.19
2.2.21 FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	3	2.2.20
2.2.22 FIT UP AND WELD ACCESSORIES PART	2	2.2.21
2.2.23 FINISHING AND INSPECTION	2	2.2.22
3. FINAL INSPECTION BY INSPECTOR	1	
3.1 LP STEAM DRUM 55-0115 S98	1	2.1.22
3.2 LP STEAM DRUM 55-0115 S99	1	2.2.22
4. VISUAL DIMENSION BY AI.	1	
4.1 LP STEAM DRUM 55-0115 S98	1	3.1
4.2 LP STEAM DRUM 55-0115 S99	1	3.2
5. POST WELD HEAT TREATMENT	1	
5.1 LP STEAM DRUM 55-0115 S98	1	4.1
5.2 LP STEAM DRUM 55-0115 S99	1	4.2
6. HYDROSTATIC TEST	7	
6.1 LP STEAM DRUM 55-0115 S98	7	
6.1.1 PRE HYDROSTATIC TEST	1	5.1
6.1.2 HYDROSTATIC TEST	1	6.1.1

Activity List	Duration (days)	Predecessors
6.1.3 DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	4	6.1.2
6.1.4 FINAL DIMENSION	1	6.1.3
6.2 LP STEAM DRUM 55-0115 S99	7	
6.2.1 PRE HYDROSTATIC TEST	1	5.2
6.2.2 HYDROSTATIC TEST	1	6.2.1
6.2.3 DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	4	6.2.2
6.2.4 FINAL DIMENSION	1	6.2.3
7. BLASTING / PAINTING / CLEANING	4	
7.1 LP STEAM DRUM 55-0115 S98	4	6.1.4
7.2 LP STEAM DRUM 55-0115 S99	4	6.2.4
8. INSTALL INTERNAL PART AND WEAIGHTING	2	
8.1 LP STEAM DRUM 55-0115 S98	2	7.1
8.2 LP STEAM DRUM 55-0115 S99	2	7.2
9. PACKING AND MARKING	2	
9.1 LP STEAM DRUM 55-0115 S98	2	8.1
9.2 LP STEAM DRUM 55-0115 S99	2	8.2
10. FINAL INSPECTION BY INSPECTOR AND READY FOR SHIP	1	
10.1 LP STEAM DRUM 55-0115 S98	1	9.1
10.2 LP STEAM DRUM 55-0115 S99	1	9.2

Table 23: Activity List Break Down with Estimated Duration (cont)

4.2.5 Schedule Development

As the activity list with estimated duration are ready, the schedule can be developed using Microsoft Project. The start and finish dates for each activity are specified. In the project schedule, there are list of activities, duration time, start date, finish date, and predecessor tasks. The bar chart presents the relationship of each task to be performed in sequence and the width of each bar reflect duration in completing that task. The schedule can be seen in Figure 26, 27 and 28.

ID	Task Name	Duration	Start	Finish	Pred
1	**Project Duration**	**126 days**	**Thu 5/7/15**	**hu 10/29/15**	
2	**1. MARK CUT AND PART PREPARATION PROCESS**	**78 days**	**Thu 5/7/15**	**lon 8/24/15**	
3	**1.1 HEAD 2:1 ELLIIPTICAL HEAD FOR 4 OFF**	**78 days**	**Thu 5/7/15**	**lon 8/24/15**	
4	RAW PLATE ARRIVED AT SHOP	2 days	Thu 5/7/15	Fri 5/8/15	
5	INCOMING MATERIAL INSPECTION	3 days	Mon 5/11/15	Ved 5/13/15	4
6	BLANK PLATE LAY OUT	4 days	Thu 5/14/15	Tue 5/19/15	5
7	INSPECTION	3 days	Wed 5/20/15	Fri 5/22/15	6
8	CUTTING	6 days	Mon 5/25/15	Mon 6/1/15	7
9	PRESSING AND FORMING	28 days	Tue 6/2/15	Thu 7/9/15	8
10	PRE-BLASTING	4 days	Fri 7/10/15	Ved 7/15/15	9
11	JOINT PREPARATION AND BEVELING	5 days	Thu 7/16/15	Ved 7/22/15	10
12	MANWAY LAY OUT AND INSPECTION	3 days	Thu 7/23/15	lon 7/27/15	11
13	OPENING AND EDGE PREPARATION	8 days	Tue 7/28/15	Thu 8/6/15	12
14	FIT UP AND WELD MANWAY RING TO HEAD	12 days	Fri 8/7/15	lon 8/24/15	13
15	**1.2 SHELL PLATE FOR 2 OFF**	**42 days**	**Thu 5/7/15**	**Fri 7/3/15**	
16	RAW PLATE ARRIVED AT SHOP	2 days	Thu 5/7/15	Fri 5/8/15	
17	INCOMING MATERIAL INSPECTION	3 days	Mon 5/11/15	Ved 5/13/15	16
18	MARK CUT AND INSPECTION	5 days	Thu 5/14/15	Ved 5/20/15	17
19	PRE-BLASTING	3 days	Thu 5/21/15	lon 5/25/15	18
20	ROLLING	8 days	Tue 5/26/15	Thu 6/4/15	19
21	INSPECTION	3 days	Fri 6/5/15	Tue 6/9/15	20
22	LONG SEAM WELDING	8 days	Wed 6/10/15	Fri 6/19/15	21
23	RE ROLL	4 days	Mon 6/22/15	Thu 6/25/15	22
24	LAY OUT NOZZLES ON SHELL AND INSPECTION	3 days	Fri 6/26/15	Tue 6/30/15	23
25	CUTTING AND EDGE PREPARATION NDE. AND INSPECTION	3 days	Wed 7/1/15	Fri 7/3/15	24
26	**1.3 NOZZLES FOR 50 OFF**	**40 days**	**Thu 5/7/15**	**Wed 7/1/15**	
27	MARK CUT AND INSPECTION	6 days	Thu 5/7/15	Thu 5/14/15	
28	FIT UP AND WELD (IF REQUIRED...)	16 days	Fri 5/15/15	Fri 6/5/15	27
29	MACHINING	14 days	Mon 6/8/15	Thu 6/25/15	28
30	FINISHING AND INSPECTION	4 days	Fri 6/26/15	Wed 7/1/15	29
31	**1.4 SADDLES FOR 4 OFF**	**28 days**	**Mon 5/18/15**	**Ved 6/24/15**	
32	MARK CUT AND INSPECTION	10 days	Mon 5/18/15	Fri 5/29/15	
33	FIT UP AND WELD	14 days	Mon 6/1/15	Thu 6/18/15	32
34	FINISHING AND INSPECTION	4 days	Fri 6/19/15	Ved 6/24/15	33
35	**1.5 INTERNAL PART**	**32 days**	**Fri 5/22/15**	**Mon 7/6/15**	
36	MARK CUT AND INSPECTION	14 days	Fri 5/22/15	Ved 6/10/15	
37	FIT UP AND WELD	14 days	Thu 6/11/15	Tue 6/30/15	36
38	FINISHING AND INSPECTION	4 days	Wed 7/1/15	Mon 7/6/15	37
39	**1.6 ACCESSORIES PART**	**26 days**	**Wed 5/27/15**	**Wed 7/1/15**	
40	MARK CUT AND INSPECTION	4 days	Wed 5/27/15	Mon 6/1/15	
41	FIT UP AND WELD	18 days	Tue 6/2/15	Thu 6/25/15	40
42	FINISHING AND INSPECTION	4 days	Fri 6/26/15	Wed 7/1/15	41
43	**2. MAIN PART FABRICATION**	**42 days**	**Thu 8/6/15**	**Fri 10/2/15**	

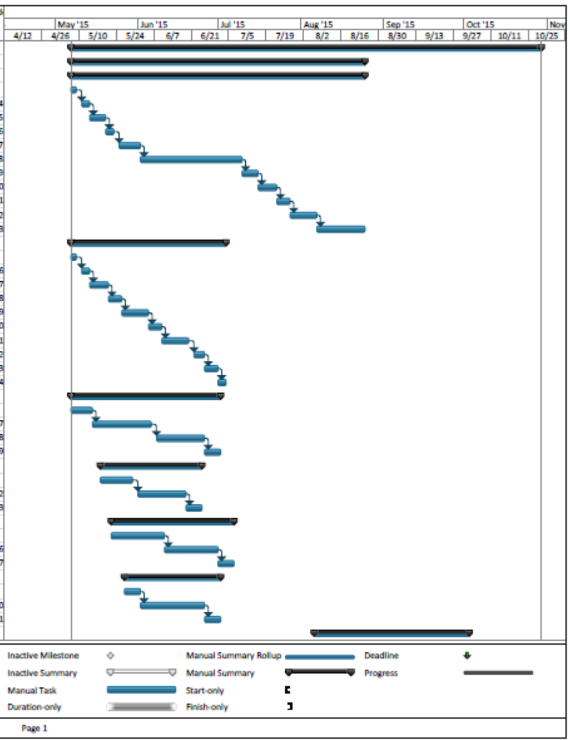
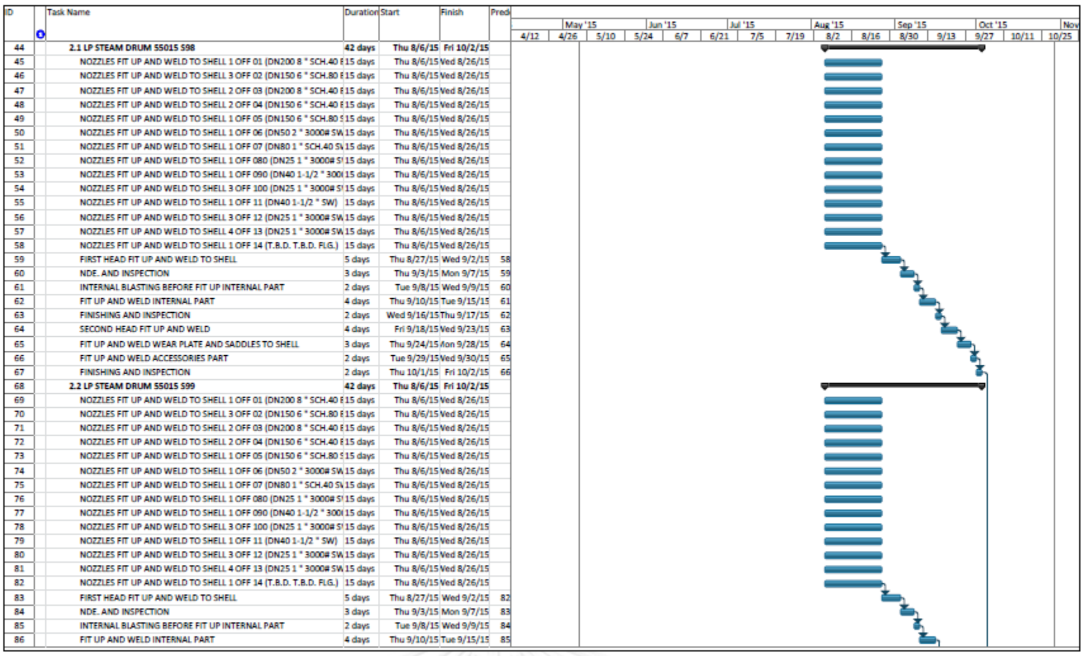
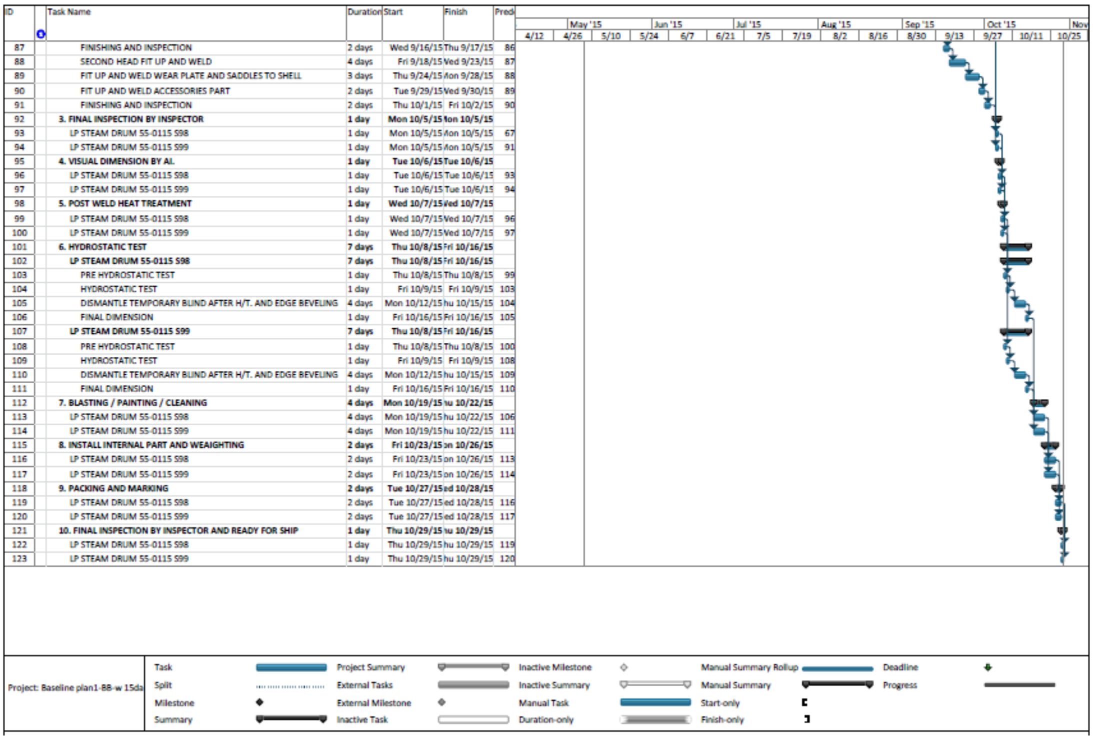


Figure 26: Detail Fabrication Schedule for Steam Drum (1)



ID	Task Name	Duration	Start	Finish	Pred
44	**2.1 LP STEAM DRUM 55015 S98**	**42 days**	**Thu 8/6/15**	**Fri 10/2/15**	
45	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8 " SCH.40 E	15 days	Thu 8/6/15	Ved 8/26/15	
46	NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6 " SCH.80 E	15 days	Thu 8/6/15	Ved 8/26/15	
47	NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8 " SCH.40 E	15 days	Thu 8/6/15	Ved 8/26/15	
48	NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6 " SCH.40 E	15 days	Thu 8/6/15	Ved 8/26/15	
49	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6 " SCH.80 S	15 days	Thu 8/6/15	Ved 8/26/15	
50	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2 " 3000# SW	15 days	Thu 8/6/15	Ved 8/26/15	
51	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1 " SCH.40 SV	15 days	Thu 8/6/15	Ved 8/26/15	
52	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1 " 3000# S'	15 days	Thu 8/6/15	Ved 8/26/15	
53	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2 " 300	15 days	Thu 8/6/15	Ved 8/26/15	
54	NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1 " 3000# S'	15 days	Thu 8/6/15	Ved 8/26/15	
55	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2 " SW)	15 days	Thu 8/6/15	Ved 8/26/15	
56	NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1 " 3000# SW	15 days	Thu 8/6/15	Ved 8/26/15	
57	NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1 " 3000# SW	15 days	Thu 8/6/15	Ved 8/26/15	
58	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)	15 days	Thu 8/6/15	Ved 8/26/15	
59	FIRST HEAD FIT UP AND WELD TO SHELL	5 days	Thu 8/27/15	Wed 9/2/15	58
60	NDE. AND INSPECTION	3 days	Thu 9/3/15	Mon 9/7/15	59
61	INTERNAL BLASTING BEFORE FIT UP INTERNAL PART	2 days	Tue 9/8/15	Wed 9/9/15	60
62	FIT UP AND WELD INTERNAL PART	4 days	Thu 9/10/15	Tue 9/15/15	61
63	FINISHING AND INSPECTION	2 days	Wed 9/16/15	Thu 9/17/15	62
64	SECOND HEAD FIT UP AND WELD	4 days	Fri 9/18/15	Ved 9/23/15	63
65	FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	3 days	Thu 9/24/15	Aon 9/28/15	64
66	FIT UP AND WELD ACCESSORIES PART	2 days	Tue 9/29/15	Ved 9/30/15	65
67	FINISHING AND INSPECTION	2 days	Thu 10/1/15	Fri 10/2/15	66
68	**2.2 LP STEAM DRUM 55015 S99**	**42 days**	**Thu 8/6/15**	**Fri 10/2/15**	
69	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8 " SCH.40 E	15 days	Thu 8/6/15	Ved 8/26/15	
70	NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6 " SCH.80 E	15 days	Thu 8/6/15	Ved 8/26/15	
71	NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8 " SCH.40 E	15 days	Thu 8/6/15	Ved 8/26/15	
72	NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6 " SCH.40 E	15 days	Thu 8/6/15	Ved 8/26/15	
73	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6 " SCH.80 S	15 days	Thu 8/6/15	Ved 8/26/15	
74	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2 " 3000# SW	15 days	Thu 8/6/15	Ved 8/26/15	
75	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1 " SCH.40 SV	15 days	Thu 8/6/15	Ved 8/26/15	
76	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1 " 3000# S'	15 days	Thu 8/6/15	Ved 8/26/15	
77	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2 " 300	15 days	Thu 8/6/15	Ved 8/26/15	
78	NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1 " 3000# S'	15 days	Thu 8/6/15	Ved 8/26/15	
79	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2 " SW)	15 days	Thu 8/6/15	Ved 8/26/15	
80	NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1 " 3000# SW	15 days	Thu 8/6/15	Ved 8/26/15	
81	NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1 " 3000# SW	15 days	Thu 8/6/15	Ved 8/26/15	
82	NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)	15 days	Thu 8/6/15	Ved 8/26/15	
83	FIRST HEAD FIT UP AND WELD TO SHELL	5 days	Thu 8/27/15	Wed 9/2/15	82
84	NDE. AND INSPECTION	3 days	Thu 9/3/15	Mon 9/7/15	83
85	INTERNAL BLASTING BEFORE FIT UP INTERNAL PART	2 days	Tue 9/8/15	Wed 9/9/15	84
86	FIT UP AND WELD INTERNAL PART	4 days	Thu 9/10/15	Tue 9/15/15	85

Figure 27: Detail Fabrication Schedule for Steam Drum (2)



ID	Task Name	Duration	Start	Finish	Pred
87	FINISHING AND INSPECTION	2 days	Wed 9/16/15	Thu 9/17/15	86
88	SECOND HEAD FIT UP AND WELD	4 days	Fri 9/18/15	Ved 9/23/15	87
89	FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	3 days	Thu 9/24/15	Aon 9/28/15	88
90	FIT UP AND WELD ACCESSORIES PART	2 days	Tue 9/29/15	Ved 9/30/15	89
91	FINISHING AND INSPECTION	2 days	Thu 10/1/15	Fri 10/2/15	90
92	**3. FINAL INSPECTION BY INSPECTOR**	**1 day**	**Mon 10/5/15**	**Aon 10/5/15**	
93	LP STEAM DRUM 55-0115 S98	1 day	Mon 10/5/15	Aon 10/5/15	67
94	LP STEAM DRUM 55-0115 S99	1 day	Mon 10/5/15	Aon 10/5/15	91
95	**4. VISUAL DIMENSION BY AI.**	**1 day**	**Tue 10/6/15**	**Tue 10/6/15**	
96	LP STEAM DRUM 55-0115 S98	1 day	Tue 10/6/15	Tue 10/6/15	93
97	LP STEAM DRUM 55-0115 S99	1 day	Tue 10/6/15	Tue 10/6/15	94
98	**5. POST WELD HEAT TREATMENT**	**1 day**	**Wed 10/7/15**	**Ved 10/7/15**	
99	LP STEAM DRUM 55-0115 S98	1 day	Wed 10/7/15	Ved 10/7/15	96
100	LP STEAM DRUM 55-0115 S99	1 day	Wed 10/7/15	Ved 10/7/15	97
101	**6. HYDROSTATIC TEST**	**7 days**	**Thu 10/8/15**	**Fri 10/16/15**	
102	**LP STEAM DRUM 55-0115 S98**	**7 days**	**Thu 10/8/15**	**Fri 10/16/15**	
103	PRE HYDROSTATIC TEST	1 day	Thu 10/8/15	Thu 10/8/15	99
104	HYDROSTATIC TEST	1 day	Fri 10/9/15	Fri 10/9/15	103
105	DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	4 days	Mon 10/12/15	hu 10/15/15	104
106	FINAL DIMENSION	1 day	Fri 10/16/15	Fri 10/16/15	105
107	**LP STEAM DRUM 55-0115 S99**	**7 days**	**Thu 10/8/15**	**Fri 10/16/15**	
108	PRE HYDROSTATIC TEST	1 day	Thu 10/8/15	Thu 10/8/15	100
109	HYDROSTATIC TEST	1 day	Fri 10/9/15	Fri 10/9/15	108
110	DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	4 days	Mon 10/12/15	hu 10/15/15	109
111	FINAL DIMENSION	1 day	Fri 10/16/15	Fri 10/16/15	110
112	**7. BLASTING / PAINTING / CLEANING**	**4 days**	**Mon 10/19/15**	**hu 10/22/15**	
113	LP STEAM DRUM 55-0115 S98	4 days	Mon 10/19/15	hu 10/22/15	106
114	LP STEAM DRUM 55-0115 S99	4 days	Mon 10/19/15	hu 10/22/15	111
115	**8. INSTALL INTERNAL PART AND WEAIGHTING**	**2 days**	**Fri 10/23/15**	**on 10/26/15**	
116	LP STEAM DRUM 55-0115 S98	2 days	Fri 10/23/15	on 10/26/15	113
117	LP STEAM DRUM 55-0115 S99	2 days	Fri 10/23/15	on 10/26/15	114
118	**9. PACKING AND MARKING**	**2 days**	**Tue 10/27/15**	**ed 10/28/15**	
119	LP STEAM DRUM 55-0115 S98	2 days	Tue 10/27/15	ed 10/28/15	116
120	LP STEAM DRUM 55-0115 S99	2 days	Tue 10/27/15	ed 10/28/15	117
121	**10. FINAL INSPECTION BY INSPECTOR AND READY FOR SHIP**	**1 day**	**Thu 10/29/15**	**hu 10/29/15**	
122	LP STEAM DRUM 55-0115 S98	1 day	Thu 10/29/15	hu 10/29/15	119
123	LP STEAM DRUM 55-0115 S99	1 day	Thu 10/29/15	hu 10/29/15	120

Figure 28: Detail Fabrication Schedule for Steam Drum (3)

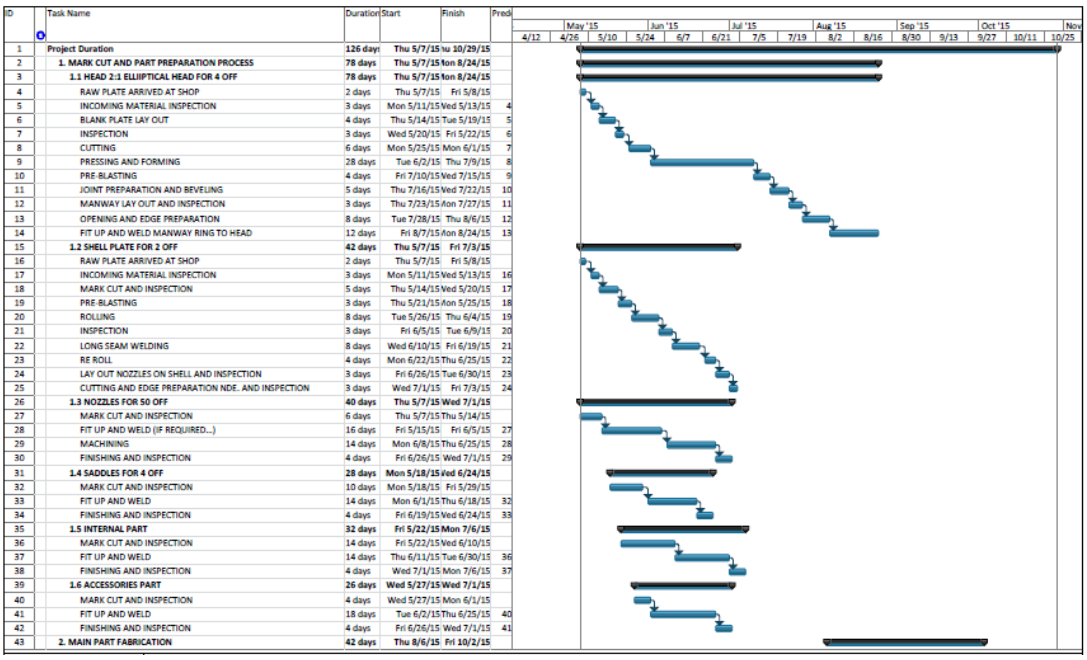
<u>Define the Critical Path</u>

Critical path is the longest path through the project, which determines the earliest possible project completion. To identify critical path, Microsoft project can support the CPM calculation and it gives a result in red task showing in Figure 30 and 31.

The critical path should be carefully managed since if tasks on critical path slip, the entire project is delayed. After determining the critical path, project team need to monitor and remains aware of its importance throughout the project execution process.

Typically, it is noticed that most activities in project are in the critical path because most of them need to be performed in sequent. The critical path technique is very useful when there is a problem because it helps project manager to decide how serious the problem is.

The risk of a critical activity running late can be reduced either through reduction in the scale of the activity or by ensuring that there is sufficient buffer at the end of the project to deal with the outcome – the project being delayed. For the case study project, the 30 days of slack are set up, meaning the completion date can be pushed out from the end date per initial plan for 30 days, and it still not affect the actual contract delivery date. The baseline schedule has finish date at Oct 29, 2015 and the actual committed date is Nov 30, 2015.



ID	Task Name	Duration	Start	Finish	Pred
1	**Project Duration**	**126 days**	**Thu 5/7/15**	**hu 10/29/15**	
2	**1. MARK CUT AND PART PREPARATION PROCESS**	**78 days**	**Thu 5/7/15**	**lon 8/24/15**	
3	**1.1 HEAD 2:1 ELLIIPTICAL HEAD FOR 4 OFF**	**78 days**	**Thu 5/7/15**	**lon 8/24/15**	
4	RAW PLATE ARRIVED AT SHOP	2 days	Thu 5/7/15	Fri 5/8/15	
5	INCOMING MATERIAL INSPECTION	3 days	Mon 5/11/15	Ved 5/13/15	4
6	BLANK PLATE LAY OUT	4 days	Thu 5/14/15	Tue 5/19/15	5
7	INSPECTION	3 days	Wed 5/20/15	Fri 5/22/15	6
8	CUTTING	6 days	Mon 5/25/15	Mon 6/1/15	7
9	PRESSING AND FORMING	28 days	Tue 6/2/15	Thu 7/9/15	8
10	PRE-BLASTING	4 days	Fri 7/10/15	Ved 7/15/15	9
11	JOINT PREPARATION AND BEVELING	5 days	Thu 7/16/15	Ved 7/22/15	10
12	MANWAY LAY OUT AND INSPECTION	3 days	Thu 7/23/15	lon 7/27/15	11
13	OPENING AND EDGE PREPARATION	8 days	Tue 7/28/15	Thu 8/6/15	12
14	FIT UP AND WELD MANWAY RING TO HEAD	12 days	Fri 8/7/15	lon 8/24/15	13
15	**1.2 SHELL PLATE FOR 2 OFF**	**42 days**	**Thu 5/7/15**	**Fri 7/3/15**	
16	RAW PLATE ARRIVED AT SHOP	2 days	Thu 5/7/15	Fri 5/8/15	
17	INCOMING MATERIAL INSPECTION	3 days	Mon 5/11/15	Ved 5/13/15	16
18	MARK CUT AND INSPECTION	5 days	Thu 5/14/15	Ved 5/20/15	17
19	PRE-BLASTING	3 days	Thu 5/21/15	lon 5/25/15	18
20	ROLLING	8 days	Tue 5/26/15	Thu 6/4/15	19
21	INSPECTION	3 days	Fri 6/5/15	Tue 6/9/15	20
22	LONG SEAM WELDING	8 days	Wed 6/10/15	Fri 6/19/15	21
23	RE ROLL	4 days	Mon 6/22/15	Thu 6/25/15	22
24	LAY OUT NOZZLES ON SHELL AND INSPECTION	3 days	Fri 6/26/15	Tue 6/30/15	23
25	CUTTING AND EDGE PREPARATION NDE. AND INSPECTION	3 days	Wed 7/1/15	Fri 7/3/15	24
26	**1.3 NOZZLES FOR 50 OFF**	**40 days**	**Thu 5/7/15**	**Wed 7/1/15**	
27	MARK CUT AND INSPECTION	6 days	Thu 5/7/15	Thu 5/14/15	
28	FIT UP AND WELD (IF REQUIRED...)	16 days	Fri 5/15/15	Fri 6/5/15	27
29	MACHINING	14 days	Mon 6/8/15	Thu 6/25/15	28
30	FINISHING AND INSPECTION	4 days	Fri 6/26/15	Wed 7/1/15	29
31	**1.4 SADDLES FOR 4 OFF**	**28 days**	**Mon 5/18/15**	**Ved 6/24/15**	
32	MARK CUT AND INSPECTION	10 days	Mon 5/18/15	Fri 5/29/15	
33	FIT UP AND WELD	14 days	Mon 6/1/15	Thu 6/18/15	32
34	FINISHING AND INSPECTION	4 days	Fri 6/19/15	Ved 6/24/15	33
35	**1.5 INTERNAL PART**	**32 days**	**Fri 5/22/15**	**Mon 7/6/15**	
36	MARK CUT AND INSPECTION	14 days	Fri 5/22/15	Ved 6/10/15	
37	FIT UP AND WELD	14 days	Thu 6/11/15	Tue 6/30/15	36
38	FINISHING AND INSPECTION	4 days	Wed 7/1/15	Mon 7/6/15	37
39	**1.6 ACCESSORIES PART**	**26 days**	**Wed 5/27/15**	**Wed 7/1/15**	
40	MARK CUT AND INSPECTION	4 days	Wed 5/27/15	Mon 6/1/15	
41	FIT UP AND WELD	18 days	Tue 6/2/15	Thu 6/25/15	40
42	FINISHING AND INSPECTION	4 days	Fri 6/26/15	Wed 7/1/15	41
43	**2. MAIN PART FABRICATION**	**42 days**	**Thu 8/6/15**	**Fri 10/2/15**	

Figure 29: Project Schedule with Critical Path (1)

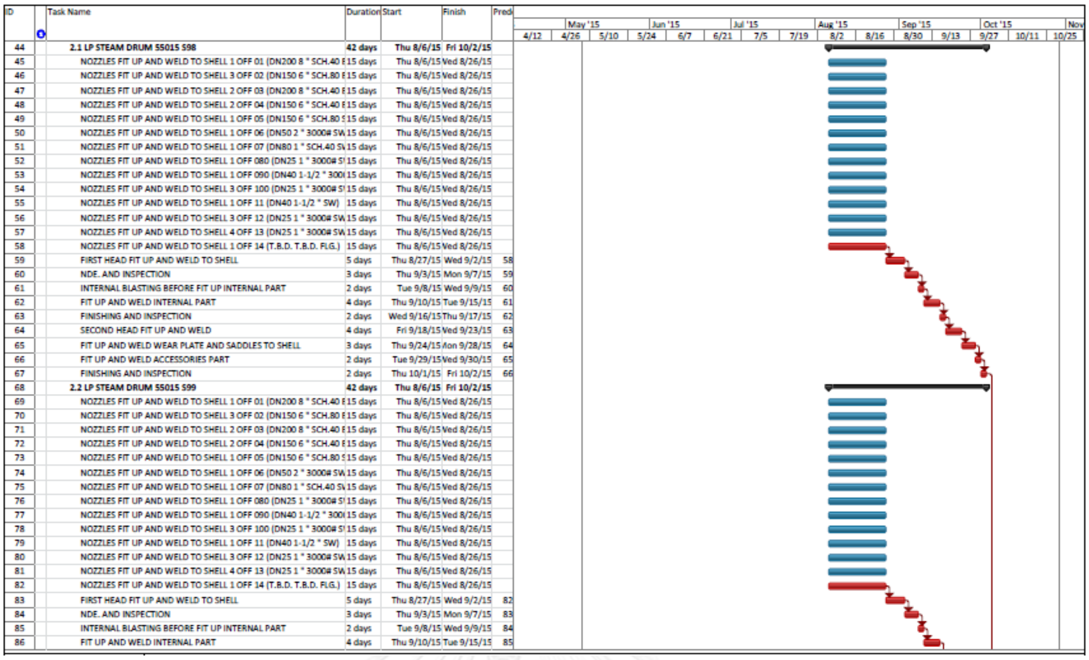


Figure 30: Project Schedule with Critical Path (2)

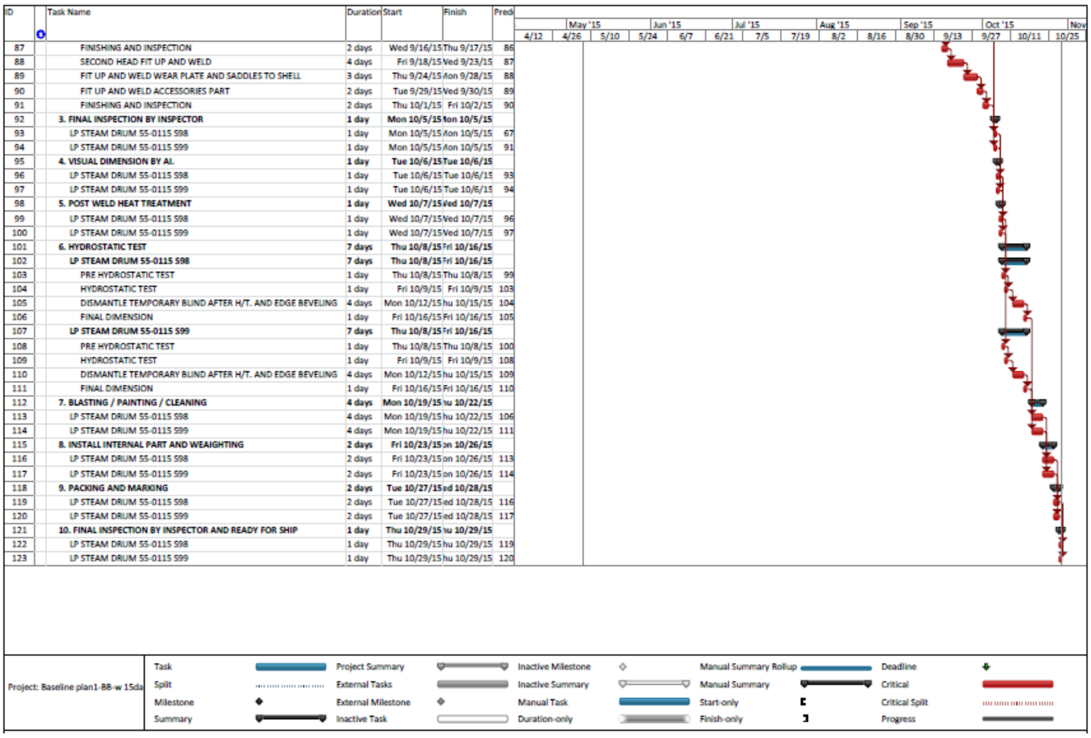


Figure 31: Project Schedule with Critical Path (3)

Milestone charts

Project milestone chart can be presented in Figure 32. This chart identifies the start and finish date of the project. It shows the major deliverables of project. The project management can review project milestone to measure the performance of project during execution. Achieving of each milestone within the plan will lead to the success of project.

ID	Activity Name	Finish	Committed Date
1	Purchase Order Awarded	3-Apr-15	
2	Drawing Submittal	10-Apr-15	
3	Approved as Noted Drawing Returned	23-Apr-15	
4	Orders Materials	10-Apr-15	
5	Fabrication Release	7-May-15	
6	Fabrication Documents	8-Jun-15	
7	Receive Materials	24-Aug-15	
8	Fabrication	10-Oct-15	
9	Inspection and Hydrostatic test	16-Oct-15	
10	Blast and Paint	26-Oct-15	
11	Final Inspection	29-Oct-15	
12	Ship - Project Completion	30-Oct-15	*30-Nov-15

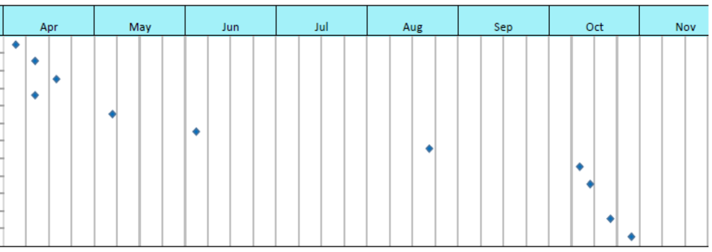


Figure 32: Project Milestone Chart

4.2.6 Risk Management

To be successful in a project, there are three aspects needed to keep a balance in order to investigate or recognize the difficulties that might arise when executing the project which are Time, Cost and Quality (Rezaian, 2011).

Time – Amount of time to complete a project can be either taken longer or shorter. Time is a critical factor that cannot be control. Moreover, if the deadlines of a project are unsuccessful to meet, negative effects can be occurred.

Cost – It is vital for the project manager to estimate cost when having responsibility on a project. Budgets will make sure that project is implemented under an assured cost. Additional resources have to be allocated by project managers to complete the project by the deadlines with no more project costs.

Quality - The concept that 'high quality comes with high cost' are perceived by many project managers. It seems to be true in some extent. Success of the overall project might not ensure if the project uses low quality resources to meet the deadline.

A process of risk management can be performed, which risks will be identified, assessed, and controlled. This helps in the analysis by identifying, quantifying and finding a way to manage those risks. At this stage, possible risks shall be identified and evaluated regarding the impact, and likelihood of that risk. The risk matrix is presented in Figure 33. This risk matrix has been using within the company for more than decades, the project manager use this to carry out risk evaluation.

The process of risk management can be involved with brainstorming among project team members, or gaining consultants' advice. Regarding this project, brainstorming is used as tool to accomplish risk management. Team members are brainstorming to identify possible risks that might harm the success of the project. The risks are identified and assessed base on two criteria; impact and probability of occurrence (two axes of risk graph). Attendees at this meeting may include the project manager, and selected project team members.

At this stage, project management team shall prioritise risks in the project. Ranking of risks is performed which the score is equal to probability multiply by impact (probability x impact) for each risk.

If the project risk is in the red area, the project is considered as high risk as a whole which will be monitored closely during project execution and controlling; while, the project is indicated as moderate risk if any risks are in the yellow zone; and the project might be considered as acceptable or low risk if the risks are green zones. Obviously, the longer it takes to decrease a risk to acceptable, particularly if the activities are on the critical path, the more the project will cost and the longer it will take.

			Impact				
			1 Very low	2 Low	3 Medium	4 High	5 Very High
			Insignificant Schedule Impact	Delivery Plan Milestone delay within 7 Days	Delivery Plan Milestone delay of one 8 to 14 Days	Delivery Plan Milestone delay of one 15 to 21 Days	Delivery Plan Milestone delay of more than 21 Days
Probability	5	60-99%	5	10	20	40	80
	4	40-59%	4	8	16	32	64
	3	20-39%	3	6	12	24	48
	2	10-19%	2	4	8	16	32
	1	1-9%	1	2	4	8	16

Figure 33: Risk Assessment Table

Score (Probability x Impact)	
1 - 6	Low
7 - 14	Med
15 - 80	High

Ranking of the risk impact and probability give the overall risk ranking

Once all of risks are assessed, it should define activities of risk mitigation. Risk identifications and preventive actions in response to those risks can be illustrated as Table 24.

From the risk evaluation, quality control is the concerned issue with high risk rating. Especially, problem with the quality of some parts that are on critical path that result in rework. This will delay project progress and completion consequently. Since these factors are acknowledged, the preventive action is created in response to those risks which subcontractor is to ensure adequate workmanship or experienced staffs are allocated to perform these jobs. Subcontractor is responsible to maintain its own performances. Furthermore, Pareto’s 80-20 rule (the law of the vital few), is highly applicable in managing projects, hence efforts need to be focused on few and important or critical items (Carmichael, 2004 cited in Yimam, 2011).

Table 24: Risk identification and Preventive action

Risk Description	Probability	Impact	Score	Objective	Risk Rating	Preventive Action
Shop Surveillance & Quality Control	4 = 50%	4 = Med	16	Quality	High	We must ensure fabricators deliver the equipment as designed. Rework should be minimized. Shop inspections are strictly controlled.
Problem with the quality of some parts, or of activities on critical path, rework required.	4 = 40%	4 = Med	16	Time/ Quality	High	Same as above; however, time is critical at these stages. Good workmanship, experienced staff should be allocated to perform these jobs.
Technical Design Changes	3 = 30%	4 = Med	12	Time	Medium	Ensure design changes are finalised on reasonably timed when possible. List of additional material should be well prepared. If change order is made later at inappropriate time, customer is to be advised in writing that company will not accept LD's
Unclear design and specification	2 = 10%	2 = Low	4	Time/ Quality	Low	Engineering finish with the design.
Late arrival of raw material	2 = 10%	2 = Low	4	Time	Low	Plan ahead, and Give an advance notice of raw material vendor of when they can expect the PO, so some process can get prepared. Reliable expediting plans are recommended to be prepared for vendors who are at risk of being late.
Late of fabrication drawings approval	1 = 1-9 %	2 = Low	2	Time	Low	Engineering to review and approve drawings per time specific time required.
Not enough labour	2 = 10%	2 = Low	4	Time	Low	Fabricator to ensure to put adequate resource to the job.

Risks which are on the critical path have significant impact to the schedule, and definitely delay the completion time of project. This is the reason why some slack should be considered and added to plan schedule. After all, it need to be ensure that risk register is communicated, and is open to all relevant member of the project team. In addition, during project execution, project risks have to be in monitoring process in order to identify risks, monitor outstanding risks and identify new risks, ensure the execution of risk plans, and assess their effectiveness in decreasing risk.

4.3 Execution and Controlling

4.3.1 Schedule Control

The weekly meeting is arranged for updating the progress of the project. Weekly meeting will benefit the control of project as its performance is measured and tracked closer at regular periodic. The main issues discussed include Engineering, Quality, Schedule, and Risk register. To review the project performance, it will require project Gantt chart, critical path and S-Curve, presenting the actual work perform at a time.

Gantt chart schedule format is used to track progress of activities in the project. In the Gantt chart, each activity is presented by a bar of a time line where the left edge of the bar indicated start date and the right edge of the bar indicated finish date. This allows project members to clearly see when activity should be started and completed. Moreover, Project Gantt chart is also used by project management team to track progress of project.

The current percent completions of the actual work compare with the target plan are presented by S-Curve. The trend line will indicate the situation of the project, whether it is on plan, ahead schedule, or behind schedule. This is sort of simple tool but efficient in report the project status. Critical path; moreover, need to be reviewed in order to see if it is affected during project execution.

Regarding the plan schedule that was done before, S-curve baseline then could be constructed as well. The plan S-curve can be plotted by using percent completion vs. time (figure 34). The total project duration is 25 weeks.

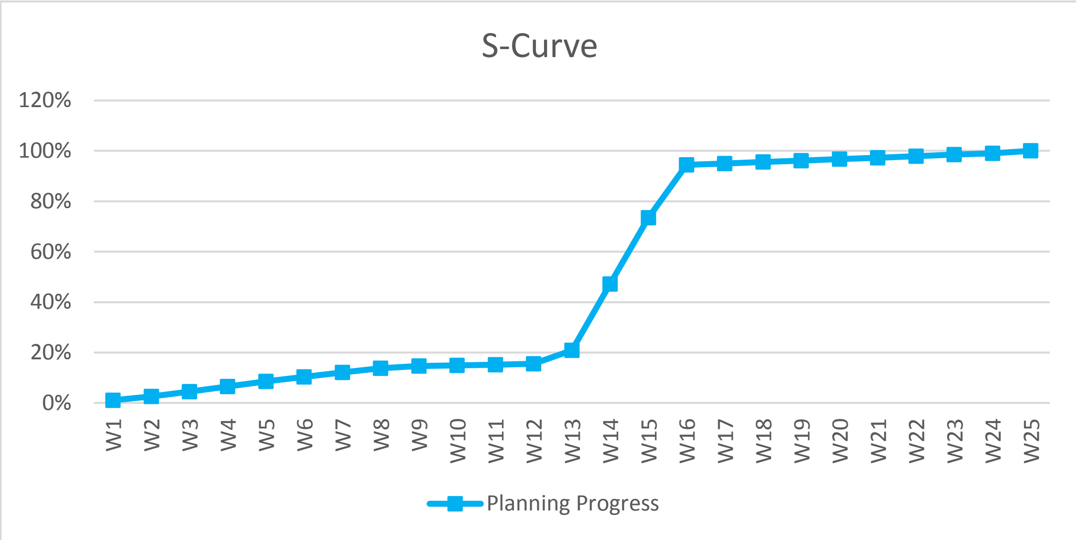


Figure 34: S-Curve of project

Note: the S-curve on daily basis can be seen in Appendix 2

Once project schedule is approved, the planned schedule becomes the baseline. During project execution, work progress could be measured weekly and evaluated base on plan.

4.3.2 The Project Tracking

To tracking the progress of the project, the weekly review is done in which the performance of the project could be measured and perceived if there are variances from the plan. In the meeting, the current progress is to be seen on S-curve, and zigzag on Gantt chart format. Moreover, the related issues which are happening will be discussed. One of the weekly meeting reports can be shown as following:

Minute of meeting as of June 5, 2015

Weekly Report

Job No.: B17480	Project Name:B17480-Drum	Date: Jun 5, 2015
VPI: Krissada	PO Number: B7727	Report No: B17480-002
Inspector: Ch.Wuttisak Vendor: UEC	Location: THA Pratumtani MWS V2	Week End: Jun 7, 2015

* =O (open), C (closed)
**=C (critical) - must be addressed ASAP to avoid project impact
I (important) – needs to be addressed to avoid moderate project impact
N (non critical) – general comment for information/review

Item	Engineering Issues	Respon-sible	Note	Status
1	All drawing and specification been received, nothing pending.	VPI		C
2				
3				

Item	Material Issues	Respon-sible	Note	Status
1	Free Issue Material >> Arrived since Jun 01, 2015 >> waiting to be inspected. - Standard Internals - Mesh / Demister Pads – - (1) Set Manway Gasket for Hydro test	VPI	Inspection shall be done within 7 days after material arrived.	O
2				
3				

Item	Quality Issues	Respon-sible	Note	Status
1	Fabricator to be submit welder reject rate by weekly basis	UEC		O
2				
3				

Item	Schedule Issues	Respon-sible	Note	Status
1	**Master schedule delivery date;**			
2	17480 Project **2. LP drums S118, S119 (FS-0144-ABP V Rev.0, April-20-15)** **- Item 35 internal part – start on May-22-15 / behind schedule** - Item 20 – plate rolling / On schedule - Item 28 nozzle fit up Jun-04-15 / On schedule	Vendor		

Figure 35: Minute of meeting – 04-June-2015 (1)

Weekly Report

3	Schedule update for item 35 internal part, start date will be on Jun-11-15 / issue schedule rev.01		Schedule Rev 01. To be used for reference.	

Item	Risk Registers	Respon-sible	Note	Status
1	Shop Surveillance & Quality Control	QA		N
2	Unclear design and specification	VPI		N
3	Design Changes - Internal parts	VPI		N
4	Late arrival of raw material	UEC		N

Inspection & Quality

- Detail of inspection work. (Photo to be attached)
- Manpower Assign (if applicable)

Welder		Fitter/ Helper		QC		Total	
Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
4	4	10	10	2	2	16	16

Schedule

- Gantt chart review
- Critical path review
- Milestone achievement (Start - finish – delivery date)
- S-Curve review

Overall Progress Summary

Unit	Progress (%)		Diff (%)	Schedule			Remark
	Plan	Actual		Start	Finish	Expected Delivery	
Drum Unit 1	6.54%	5.8%	-0.74	7/May/15	29/Oct/15	1st Shipment (25/Nov/2015)	
Drum Unit 2	6.54%	5.8%	-0.74	7/May/15	29/Oct/15	2nd Shipment (25/Nov/2015)	

Figure 36: Minute of meeting – 04-June-2015 (2)

Weekly Report

Activities are as follow:

Welding
- Shell Plate start fit up and welding joint no.B2, B3, B4, B5 references Dwg no. GA-8094-17480-D6171-02 R.2, WPS no. WP11-21247P rev.0, WPS no. WP11-21249P rev.0

Figure 37: Minute of meeting – 04-June-2015 (3)

Weekly Report

Checking dimension process

Welding long aseam

- Welding long seam started and verified weld consume references WPS no. WP11-21247P rev.0 found acceptable

Figure 38: Minute of meeting – 04-June-2015 (4)

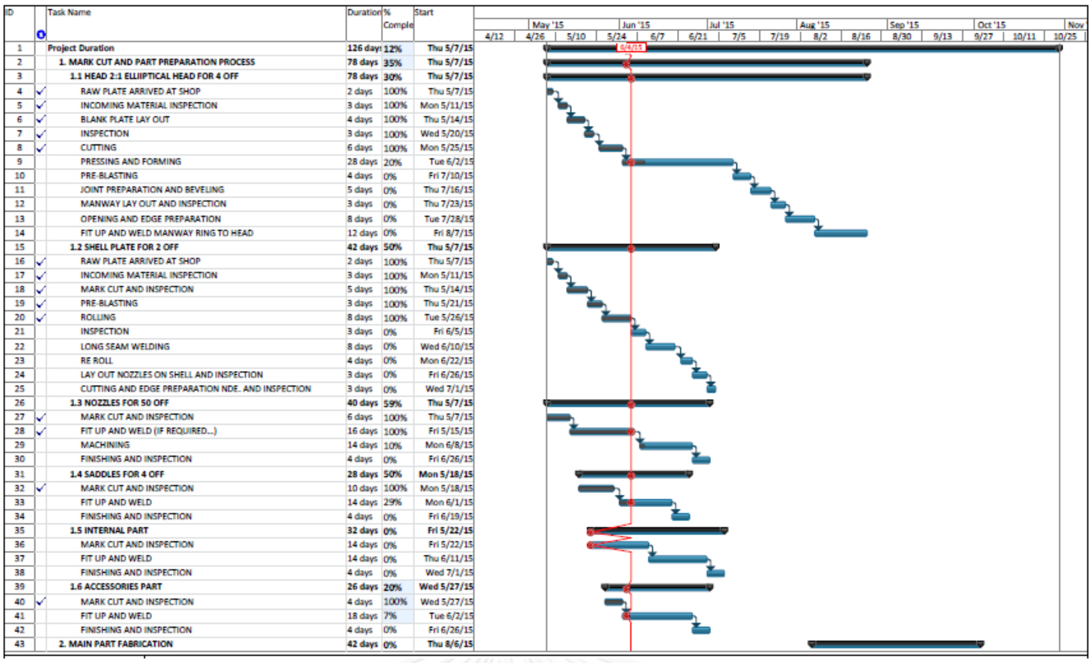


Figure 39: Gantt chart as of 04-June-2015 (1)

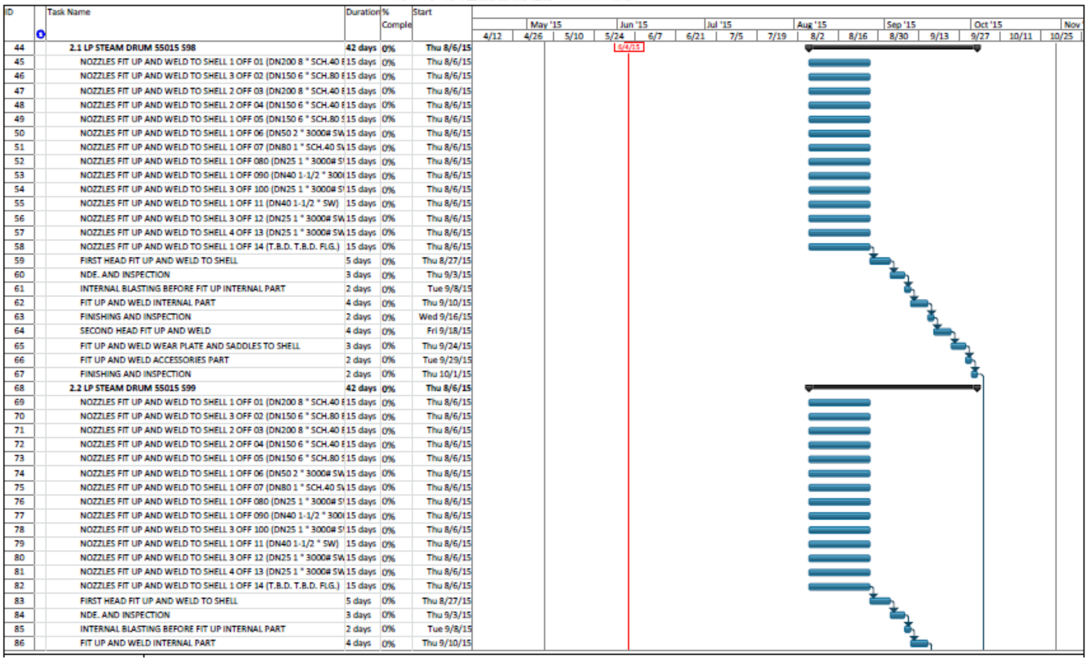
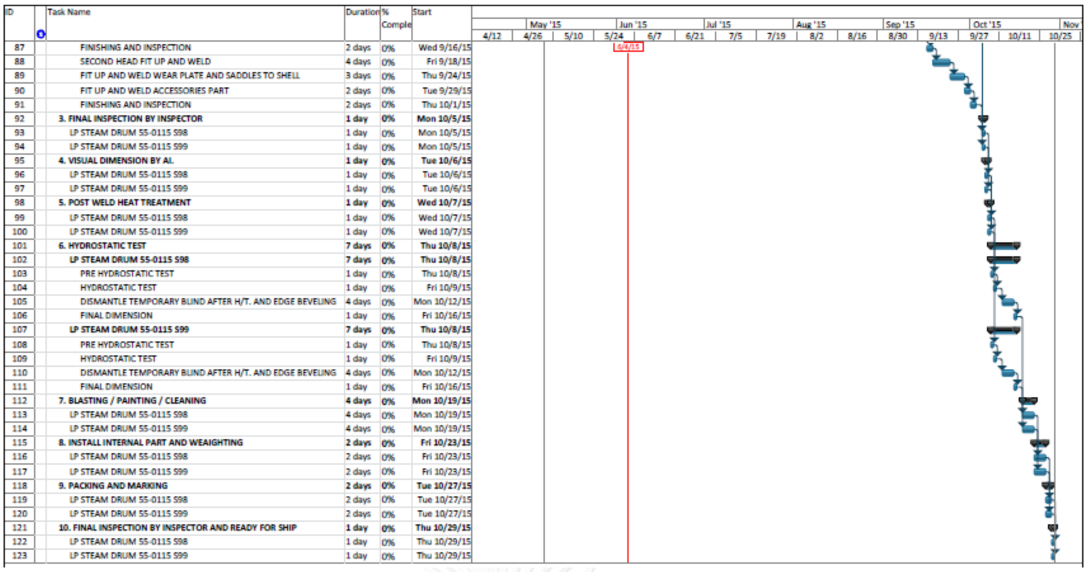


Figure 40: Gantt chart as of 04-June-2015 (2)



ID	Task Name	Duration	% Complete	Start
87	FINISHING AND INSPECTION	2 days	0%	Wed 9/16/15
88	SECOND HEAD FIT UP AND WELD	4 days	0%	Fri 9/18/15
89	FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	3 days	0%	Thu 9/24/15
90	FIT UP AND WELD ACCESSORIES PART	2 days	0%	Tue 9/29/15
91	FINISHING AND INSPECTION	2 days	0%	Thu 10/1/15
92	**3. FINAL INSPECTION BY INSPECTOR**	**1 day**	**0%**	**Mon 10/5/15**
93	LP STEAM DRUM 55-0115 S98	1 day	0%	Mon 10/5/15
94	LP STEAM DRUM 55-0115 S99	1 day	0%	Mon 10/5/15
95	**4. VISUAL DIMENSION BY AI.**	**1 day**	**0%**	**Tue 10/6/15**
96	LP STEAM DRUM 55-0115 S98	1 day	0%	Tue 10/6/15
97	LP STEAM DRUM 55-0115 S99	1 day	0%	Tue 10/6/15
98	**5. POST WELD HEAT TREATMENT**	**1 day**	**0%**	**Wed 10/7/15**
99	LP STEAM DRUM 55-0115 S98	1 day	0%	Wed 10/7/15
100	LP STEAM DRUM 55-0115 S99	1 day	0%	Wed 10/7/15
101	**6. HYDROSTATIC TEST**	**7 days**	**0%**	**Thu 10/8/15**
102	**LP STEAM DRUM 55-0115 S98**	**7 days**	**0%**	**Thu 10/8/15**
103	PRE HYDROSTATIC TEST	1 day	0%	Thu 10/8/15
104	HYDROSTATIC TEST	1 day	0%	Fri 10/9/15
105	DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	4 days	0%	Mon 10/12/15
106	FINAL DIMENSION	1 day	0%	Fri 10/16/15
107	**LP STEAM DRUM 55-0115 S99**	**7 days**	**0%**	**Thu 10/8/15**
108	PRE HYDROSTATIC TEST	1 day	0%	Thu 10/8/15
109	HYDROSTATIC TEST	1 day	0%	Fri 10/9/15
110	DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	4 days	0%	Mon 10/12/15
111	FINAL DIMENSION	1 day	0%	Fri 10/16/15
112	**7. BLASTING / PAINTING / CLEANING**	**4 days**	**0%**	**Mon 10/19/15**
113	LP STEAM DRUM 55-0115 S98	4 days	0%	Mon 10/19/15
114	LP STEAM DRUM 55-0115 S99	4 days	0%	Mon 10/19/15
115	**8. INSTALL INTERNAL PART AND WEAIGHTING**	**2 days**	**0%**	**Fri 10/23/15**
116	LP STEAM DRUM 55-0115 S98	2 days	0%	Fri 10/23/15
117	LP STEAM DRUM 55-0115 S99	2 days	0%	Fri 10/23/15
118	**9. PACKING AND MARKING**	**2 days**	**0%**	**Tue 10/27/15**
119	LP STEAM DRUM 55-0115 S98	2 days	0%	Tue 10/27/15
120	LP STEAM DRUM 55-0115 S99	2 days	0%	Tue 10/27/15
121	**10. FINAL INSPECTION BY INSPECTOR AND READY FOR SHIP**	**1 day**	**0%**	**Thu 10/29/15**
122	LP STEAM DRUM 55-0115 S98	1 day	0%	Thu 10/29/15
123	LP STEAM DRUM 55-0115 S99	1 day	0%	Thu 10/29/15

Figure 41: Gantt chart as of 04-June-2015 (3)

According to Figure 39, 40 and 41, progress line or zigzag curve is also applied for project monitoring which the actual progress of each activity on a specific date is plotted to Gantt chart. This report gives a clear idea of which activity is late currently.

The S-curve presents the performance of project progress which mainly shows current status of the project; ahead, on or behind schedule.

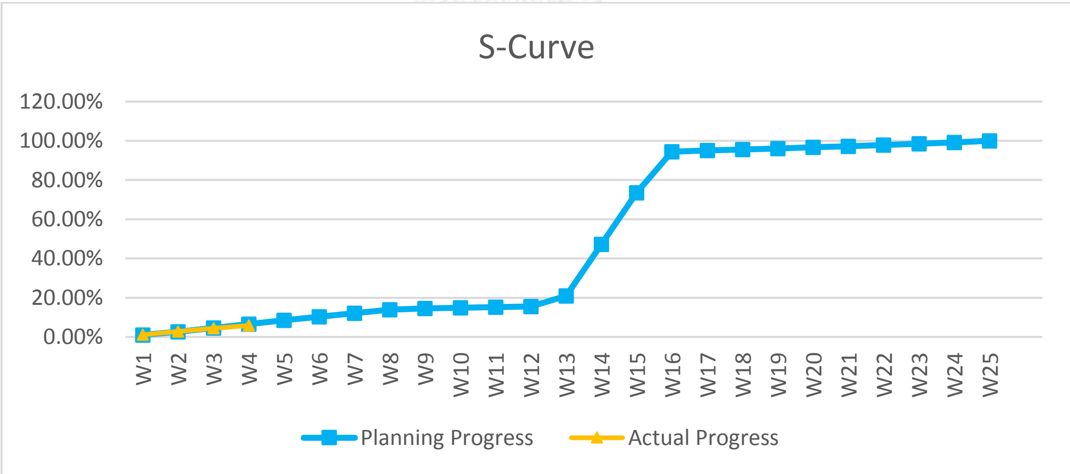


Figure 42: S-Curve at the first month of the project

According to PMI (2013), during project execution, results may require planning updates and re-baselining. This may include changes to expected activity durations, changes in resource productivity and availability, and unanticipated risks. Such variances may affect the project management plan or project documents and may require detailed analysis and development of appropriate project management responses. The results of the analysis can trigger change requests that, if approved, may modify the project management plan or other project documents and possibly require establishing new baselines. A large portion of the project’s budget will be expended in performing the Executing Process Group processes. This is the very important guideline which practical to apply to project base work including project case study.

5 Chapter 5: Result Discussion and Evaluation

5.1 Project Monitor and Control

5.1.1 Project progress at the end of 1st month (June 4, 2015)

The project progress as at June 4, 2015 can be seen in Figure 43. At this period there is no critical path activity involve. However, at activity 1.5 - Internal part shows a delay which should have started since May 22, 2015, but still no progress up to this date. It is 8 work days behind the start date.

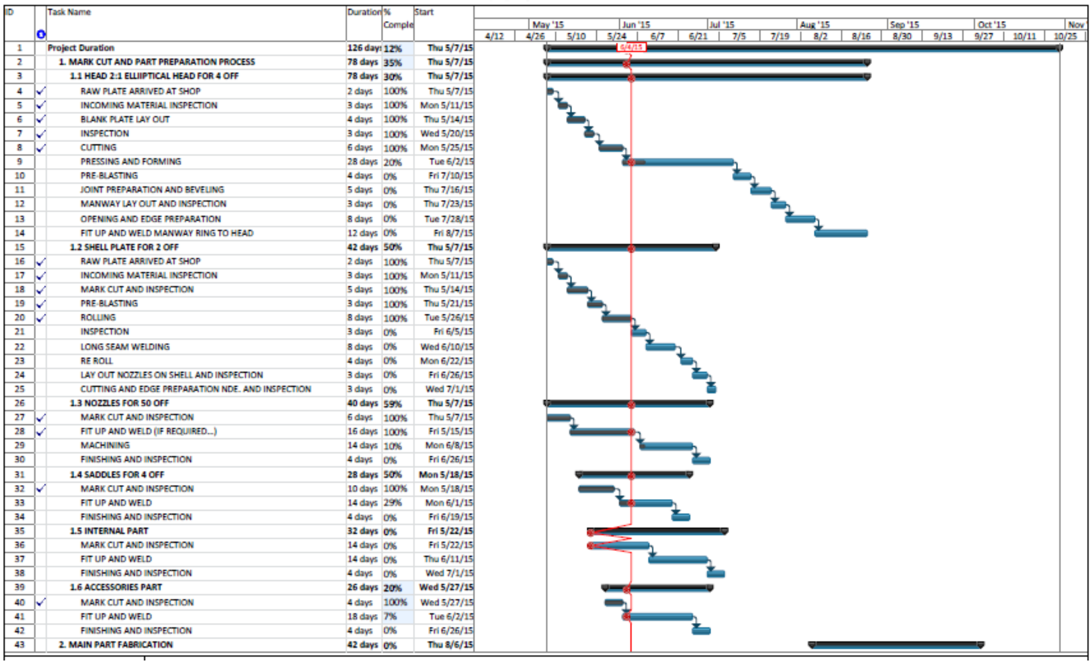


Figure 43: Gantt chart at the first month of project (based on Rev00 schedule)

The S-Curve is shown in Figure 44, the overall project complete is fine but tends to be a little behind schedule that the S-Curve shows that the actual progress is 5.80% at week 4 while the planning progress is 6.54% at week 4.

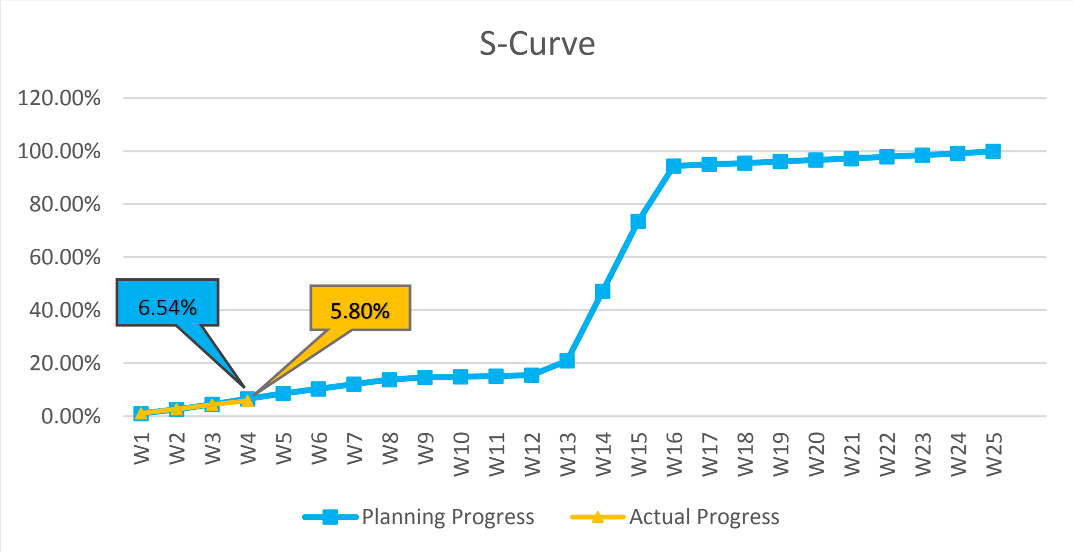


Figure 44: S-Curve at 1st month

According to activity no. 1.5, the reason that caused this task misses the start date is the lateness of material arrival at fabricator. The internal part need to be at the shop beforehand. These materials are free issue material which means they shall be supplied by our side (buyer). The corrective actions are expedited in response to this issue. This is on our end to follow up and have the material deliver at shop as soon as possible. All required of internal parts arrive at June 15, 2015. The inspection need to be performed within 7 days after that. Next, the process can be resumed to the normal project schedule; however, the update is needed for the schedule to reflect the proper date to carry the following tasks. Moreover, in response to this risk in the future, the buyer or supply management team should be aware and get well plan on a delivery date. To be more clearly, the project can proceed after a purchase order (PO) get sent to fabricator. Thus, in ordering the internal parts, this should be performed in parallel when the project PO is being processed. The PO for internal parts should be populated shortly after the PO for this project is issued to fabricator.

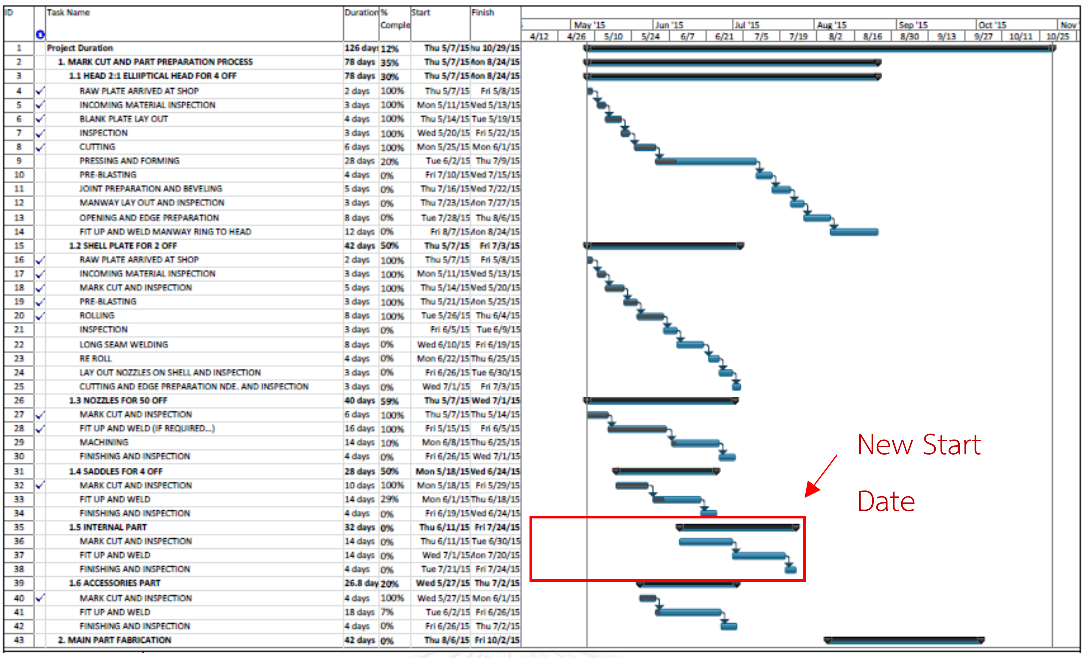


Figure 45: Gantt chart at the first month of project Rev01

Since the start date is passed, the schedule requires re-baselining which the schedule rev.01 then, can be issued (Figure 45). The new start date is June 11, 2015 (from May 22, 2015). This path of activity is able to continue without any delaying the project schedule, not affect the critical path.

5.1.2 Project progress at the end of 2nd month (July 2, 2015)

The work seems to fall behind schedule slightly from the first month. Therefore, the fabricator is notified to work catching up with the schedule at this period, three main activities could be finished up which are 1.2, 1.3 and 1.6. The task 1.5 that has been rescheduled from the previous section could be started on time. The result of the second month end period is quite well as seen from S-curve and progress line.

There are parallel activities at the beginning period of the project which should be monitored closely in order to ensure that those task start as plan. The slippage could cause the other following tasks to get late start as of work need performing in sequence, and it could potentially also delay the overall project; even though, it is not in critical path.

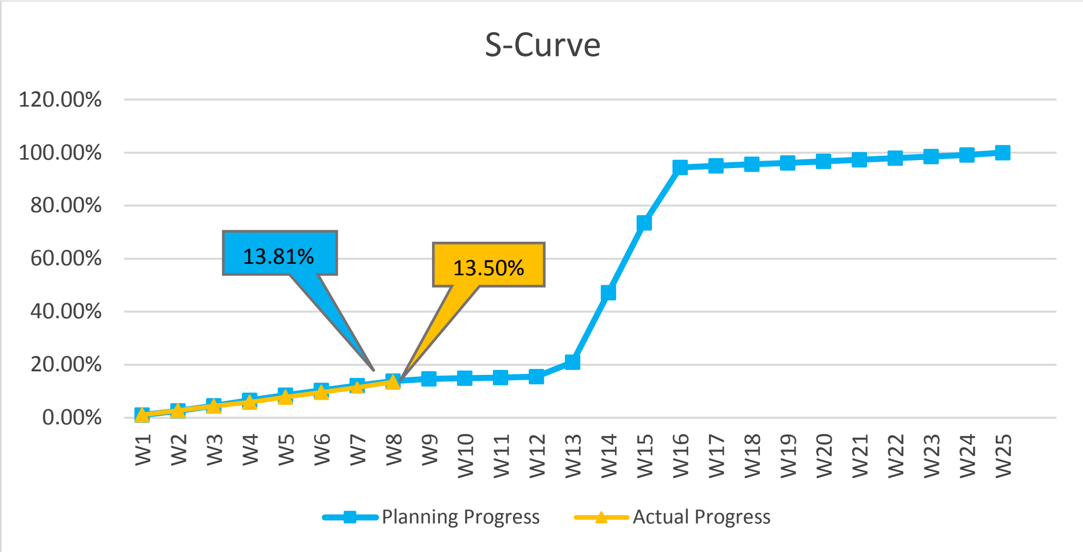
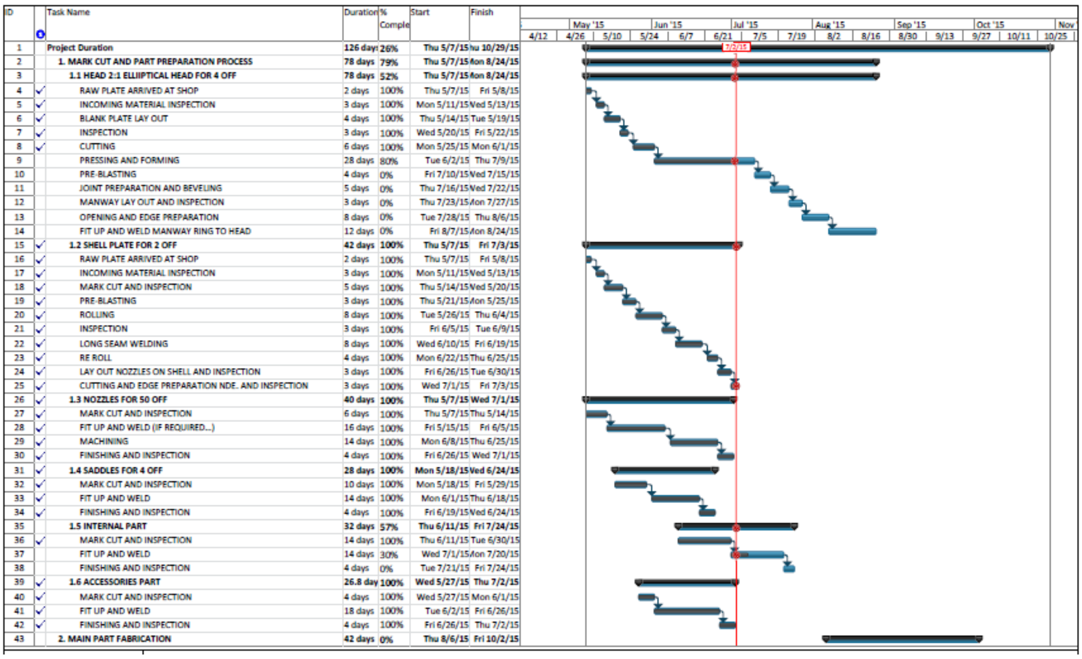


Figure 46: S-Curve at 2nd month

The result is quite well as show by the S-Curve (Figure 46) that the actual progress is 13.50% at week 8 while the planning progress is 13.81% at week 8. Moreover, the Gantt chart below also expose that result at the second month end period is relatively well.



ID		Task Name	Duration	% Comple	Start	Finish
1		Project Duration	126 days	26%	Thu 5/7/15	Thu 10/29/15
2		1. MARK CUT AND PART PREPARATION PROCESS	78 days	79%	Thu 5/7/15	Mon 8/24/15
3		1.1 HEAD 2:1 ELLIPTICAL HEAD FOR 4 OFF	78 days	52%	Thu 5/7/15	Mon 8/24/15
4	✓	RAW PLATE ARRIVED AT SHOP	2 days	100%	Thu 5/7/15	Fri 5/8/15
5	✓	INCOMING MATERIAL INSPECTION	3 days	100%	Mon 5/11/15	Wed 5/13/15
6	✓	BLANK PLATE LAY OUT	4 days	100%	Thu 5/14/15	Tue 5/19/15
7	✓	INSPECTION	3 days	100%	Wed 5/20/15	Fri 5/22/15
8	✓	CUTTING	6 days	100%	Mon 5/25/15	Mon 6/1/15
9		PRESSING AND FORMING	28 days	80%	Tue 6/2/15	Thu 7/9/15
10		PRE-BLASTING	4 days	0%	Fri 7/10/15	Wed 7/15/15
11		JOINT PREPARATION AND BEVELING	5 days	0%	Thu 7/16/15	Wed 7/22/15
12		MANWAY LAY OUT AND INSPECTION	3 days	0%	Thu 7/23/15	Mon 7/27/15
13		OPENING AND EDGE PREPARATION	8 days	0%	Tue 7/28/15	Thu 8/6/15
14		FIT UP AND WELD MANWAY RING TO HEAD	12 days	0%	Fri 8/7/15	Mon 8/24/15
15	✓	1.2 SHELL PLATE FOR 2 OFF	42 days	100%	Thu 5/7/15	Fri 7/3/15
16	✓	RAW PLATE ARRIVED AT SHOP	2 days	100%	Thu 5/7/15	Fri 5/8/15
17	✓	INCOMING MATERIAL INSPECTION	3 days	100%	Mon 5/11/15	Wed 5/13/15
18	✓	MARK CUT AND INSPECTION	5 days	100%	Thu 5/14/15	Wed 5/20/15
19	✓	PRE-BLASTING	3 days	100%	Thu 5/21/15	Mon 5/25/15
20	✓	ROLLING	8 days	100%	Tue 5/26/15	Thu 6/4/15
21	✓	INSPECTION	3 days	100%	Fri 6/5/15	Tue 6/9/15
22	✓	LONG SEAM WELDING	8 days	100%	Wed 6/10/15	Fri 6/19/15
23	✓	RE ROLL	4 days	100%	Mon 6/22/15	Thu 6/25/15
24	✓	LAY OUT NOZZLES ON SHELL AND INSPECTION	3 days	100%	Fri 6/26/15	Tue 6/30/15
25	✓	CUTTING AND EDGE PREPARATION NDE. AND INSPECTION	3 days	100%	Wed 7/1/15	Fri 7/3/15
26	✓	1.3 NOZZLES FOR 50 OFF	40 days	100%	Thu 5/7/15	Wed 7/1/15
27	✓	MARK CUT AND INSPECTION	6 days	100%	Thu 5/7/15	Thu 5/14/15
28	✓	FIT UP AND WELD (IF REQUIRED...)	16 days	100%	Fri 5/15/15	Fri 6/5/15
29	✓	MACHINING	14 days	100%	Mon 6/8/15	Thu 6/25/15
30	✓	FINISHING AND INSPECTION	4 days	100%	Fri 6/26/15	Wed 7/1/15
31	✓	1.4 SADDLES FOR 4 OFF	28 days	100%	Mon 5/18/15	Wed 6/24/15
32	✓	MARK CUT AND INSPECTION	10 days	100%	Mon 5/18/15	Fri 5/29/15
33	✓	FIT UP AND WELD	14 days	100%	Mon 6/1/15	Thu 6/18/15
34	✓	FINISHING AND INSPECTION	4 days	100%	Fri 6/19/15	Wed 6/24/15
35		1.5 INTERNAL PART	32 days	57%	Thu 6/11/15	Fri 7/24/15
36	✓	MARK CUT AND INSPECTION	14 days	100%	Thu 6/11/15	Tue 6/30/15
37		FIT UP AND WELD	14 days	30%	Wed 7/1/15	Mon 7/20/15
38		FINISHING AND INSPECTION	4 days	0%	Tue 7/21/15	Fri 7/24/15
39	✓	1.6 ACCESSORIES PART	26.8 day	100%	Wed 5/27/15	Thu 7/2/15
40	✓	MARK CUT AND INSPECTION	4 days	100%	Wed 5/27/15	Mon 6/1/15
41	✓	FIT UP AND WELD	18 days	100%	Tue 6/2/15	Fri 6/26/15
42	✓	FINISHING AND INSPECTION	4 days	100%	Fri 6/26/15	Thu 7/2/15
43		2. MAIN PART FABRICATION	42 days	0%	Thu 8/6/15	Fri 10/2/15

Figure 47: Gantt chart at the second month of project (based on Rev01 schedule)

5.1.3 Project progress at the end of 3rd month (July 30, 2015)

The activities in the preparation process (item 1) are mostly finished as it should be, and follow the schedule. Fabricator gets started with the item 2 task on some of the very first tasks which is ahead of plan where the actual progress is 18.9% at week 12 while the planning progress is 15.5% at week 12; hence, the actual progress is 3.4% more than plan. None of the work is late at this point.

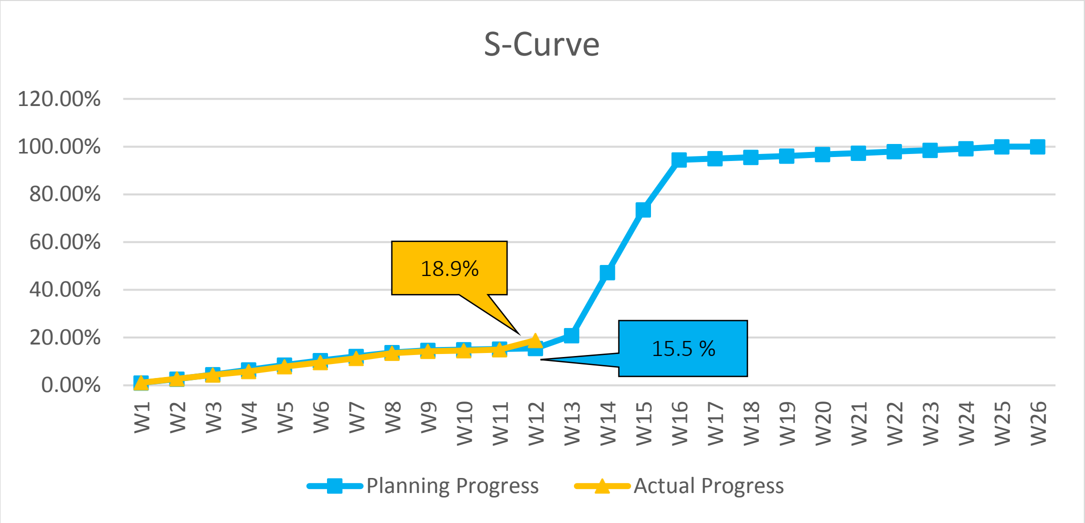


Figure 48: S-Curve at 3rd month

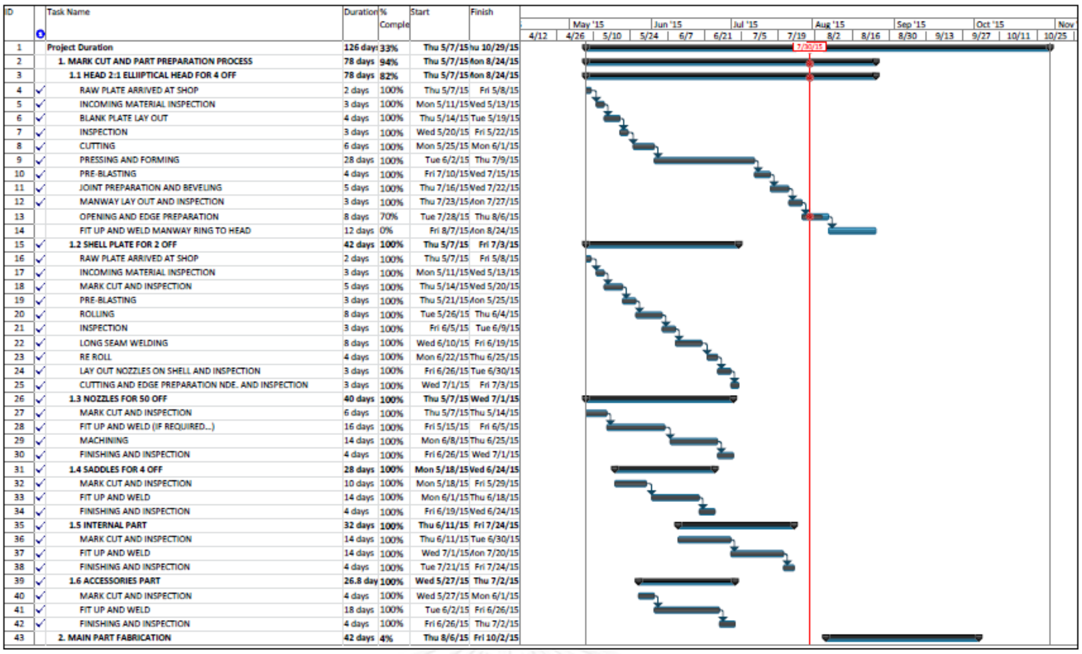


Figure 49: Gantt chart at the third month of project (based on Rev01 schedule)

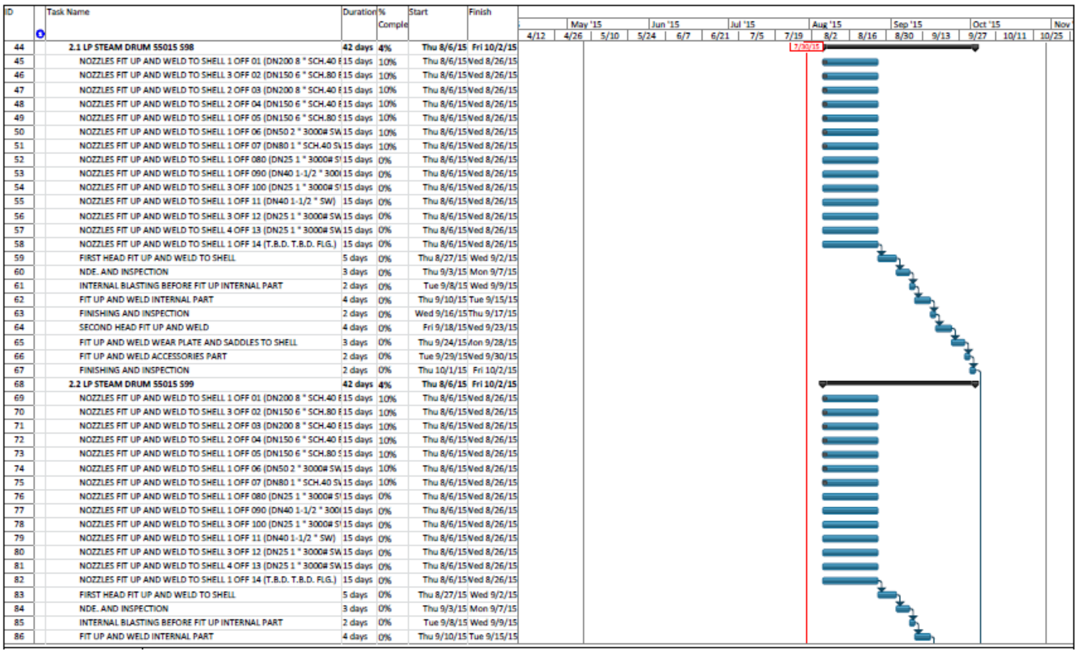


Figure 50: Gantt chart at the third month of project (based on Rev01 schedule) (cont.)

5.1.4 Project progress at the end of 4th month (Aug 27, 2015)

At this period, S-curve shows that the performance is behind the time where the actual progress is 82.80% at week 16 while the planning progress is 84.16% at week 16 (see Figure 51).

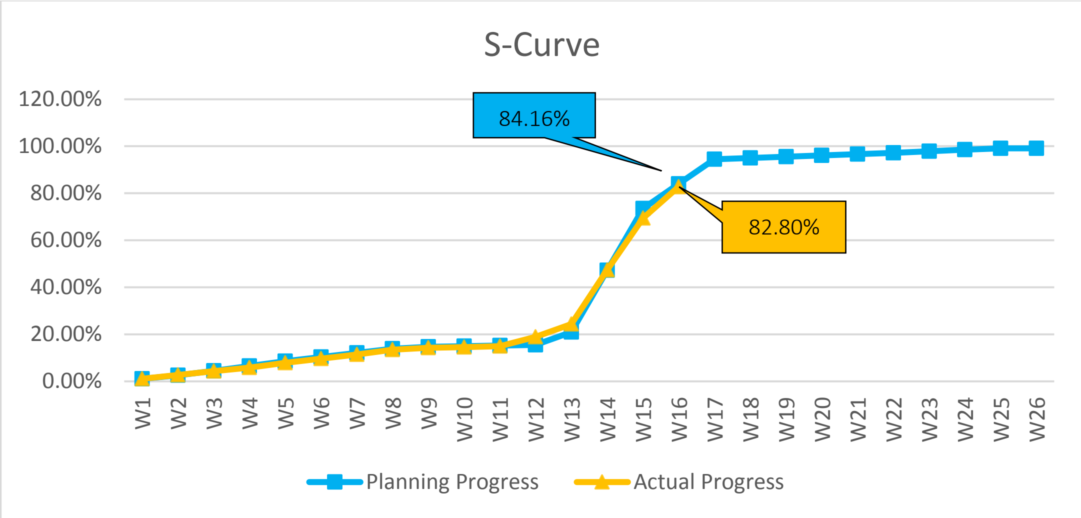


Figure 51: S-Curve at 4th month

As can be seen in Figure 50, part of Nozzle fit up activities could not finish within timeline which is delayed for 4.5 days now. This is because of the labour performance. According to this matter, update to schedule is required in which to have the task continue after 27th of August, 2015. This issue is important as to the change made on project critical path, meaning that the project end date will be impacted.

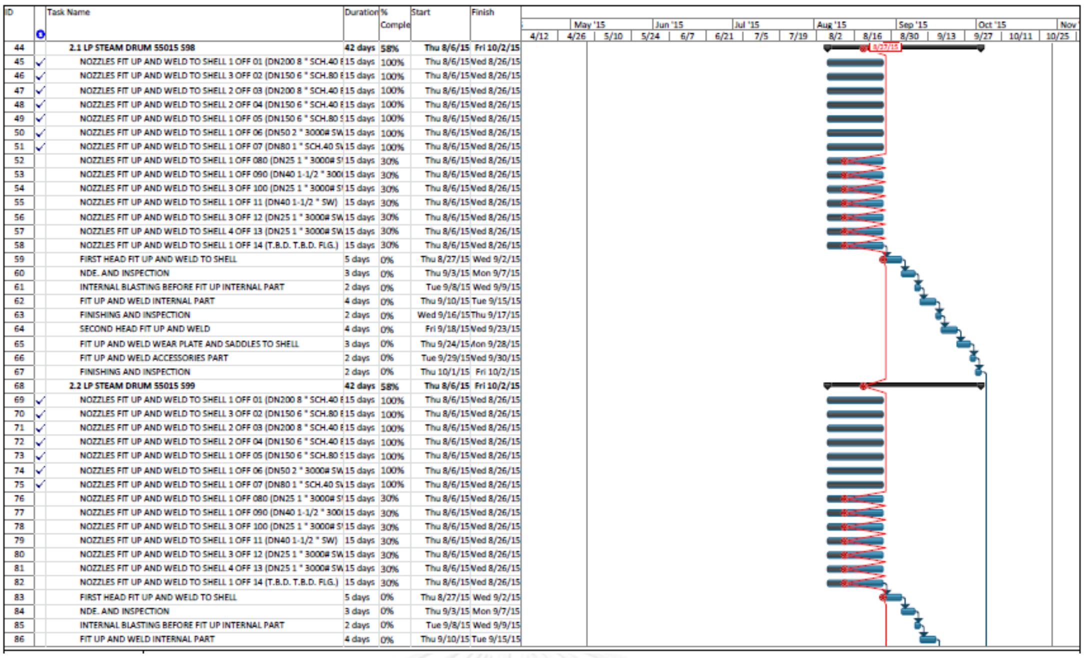


Figure 52: Gantt chart at the forth month of project (based on Rev01 schedule)

The project complete date is extended to Nov 5, 2015 from Oct 29, 2015. However, this is considering acceptable because there are some float available from the previous plan. Crashing activity is not needed. The project manager agrees with seller in making this schedule revision since this is not critical and not effect to delivery date at site. The changes are made by pushing out the ongoing activities by 5 days and the completion date will be at Nov 5, 2015. The schedule revision 2 is issued, see Figure 53. In addition, this issue has also been discussed with focusing on the performance of workers. It also can reference the risk assessment from table 12. Apparently, subcontractor dose not response well to our mitigate plan, the staffs that were put at the job are not enough. To fix this, the more staff will be allocated to perform these jobs.

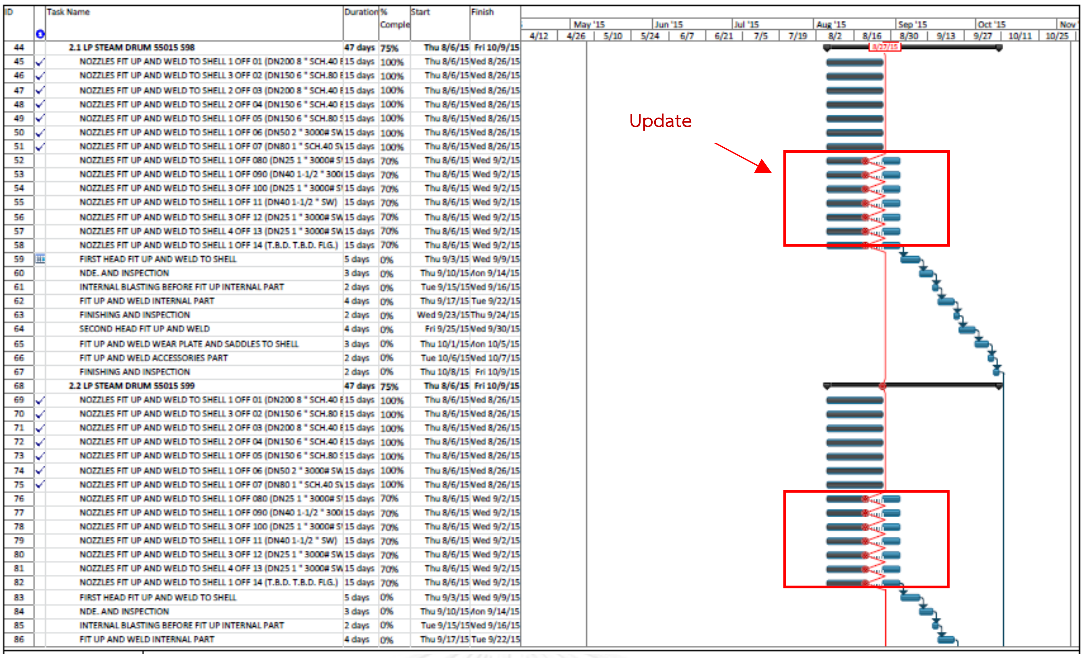


Figure 53: Gantt chart at the forth month of project - Rev02 schedule

Risk Description	Objective	Risk Rating	Preventive Action
Problem with the quality of some parts, or of activities on critical path, rework required.	Time/ Quality	High	Same as above; however, time is critical at these stages. Good workmanship, experienced staff should be allocated to perform these jobs.

5.1.5 Project progress at the end of 5th month

The revision 2 schedule is used regarding what happen from the previous month ending. Due to the prior lagging, the project control team follow up with fabricator to push up the activity forward, trying to recover from delay and reducing the risk of getting worse. Also, during inspection of nozzles and fit up weld, it is found that the work is not in good quality. There are defects on weld seam; consequently, rework is assigned to fix the problem. With these on-going issues, not only the vendor needs to improve work quality, but also the schedule to be kept up. The plan is to focus on workmanship because the experience workers would be able to work faster with quality satisfied. After executing this period, the project schedule is back on track, and tends to be ahead of time.

S-Curve in Figure 54 shows that the actual progress is 96.50% at week 20 while the planning progress is 96.13% at week 20; therefore, the actual progress is ahead planning progress which none of the work is late at this point.

The Figure 55 and 56, Gantt charts show that there are some works are done ahead of schedule. This should be carefully controlled, and it will results in ending the project on time.

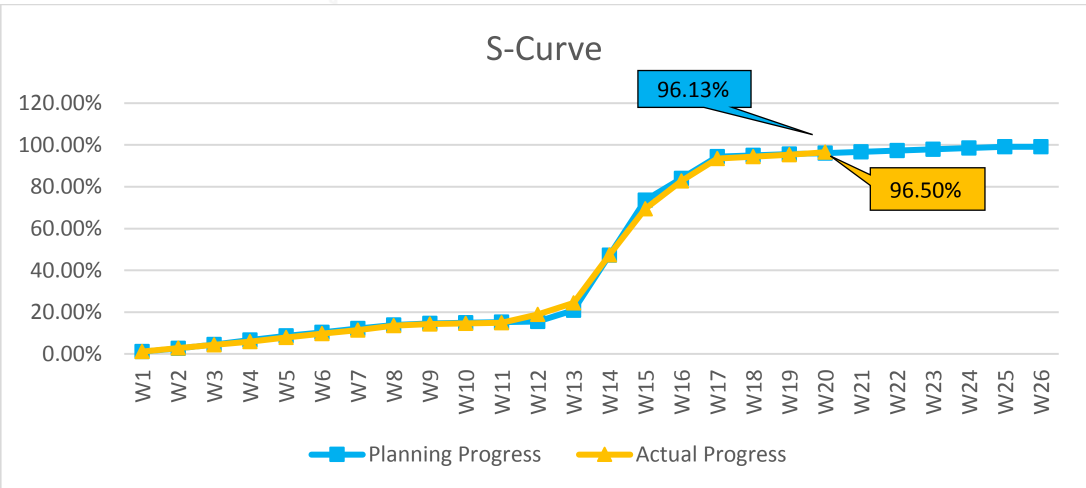


Figure 54: S-Curve at 5th month

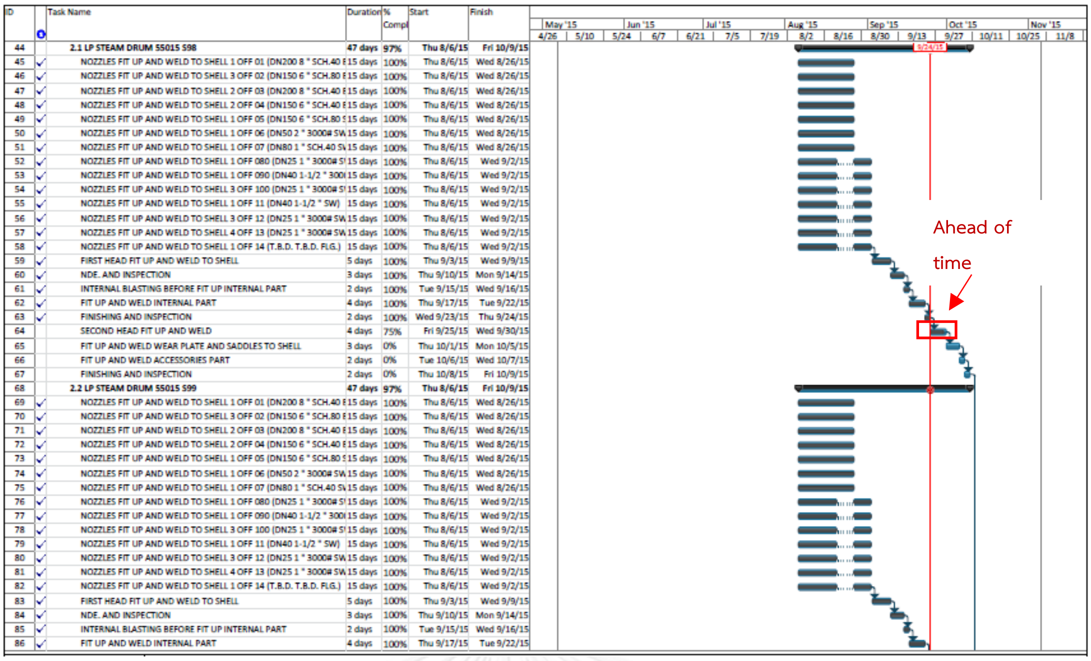


Figure 55: Gantt chart at the fifth month of project - Rev02 schedule

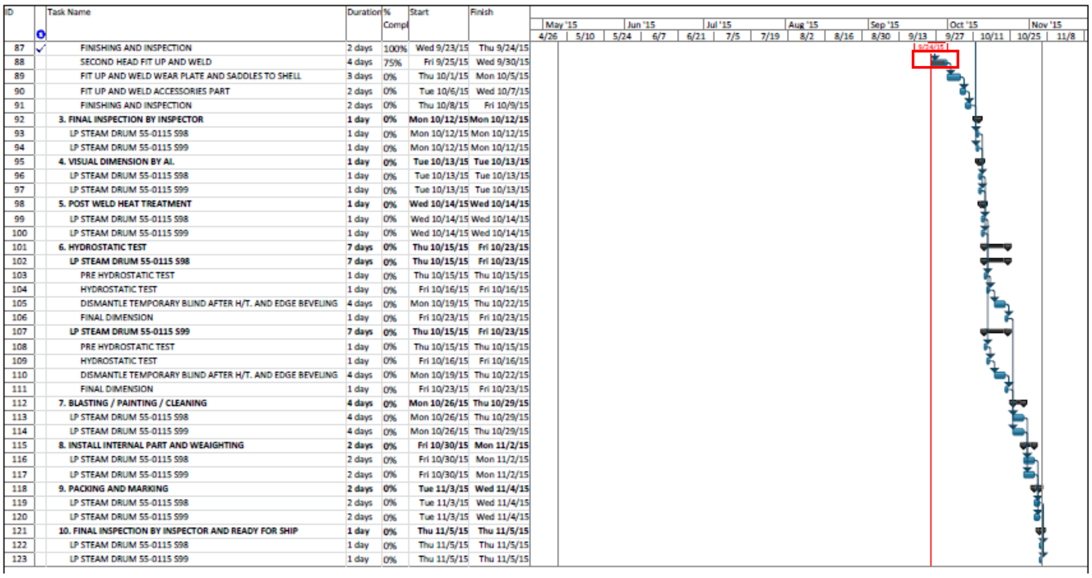


Figure 56: Gantt chart at the fifth month of project - Rev02 schedule (cont.)

5.1.6 Result at the end of the project

After the end of fifth month, it comes to the last period where the main activities in building up the product (drum) are completed. The remaining works are mainly about quality and inspection which include final inspection, post weld heat treatment (PWHT), hydro test, painting, and so on. Each activity could be usually done in a short period of time; one or two days. There is very low chance of delay occurred at this stage. The project can be carried on within a time frame, and finish align with schedule. The S-curve shown in Figure 57 is the project performance at the end which finish at week 26th. The actual result of project finish later than the old baseline for one week. If plotting the actual result compare with the baseline from the revision 0 schedule, which project duration was 25 weeks regards the initial plan, and it should be illustrated as Figure 58. Moreover, the project plan (Figure 59, 60 and 61) presents that all activities are complete on planned date.

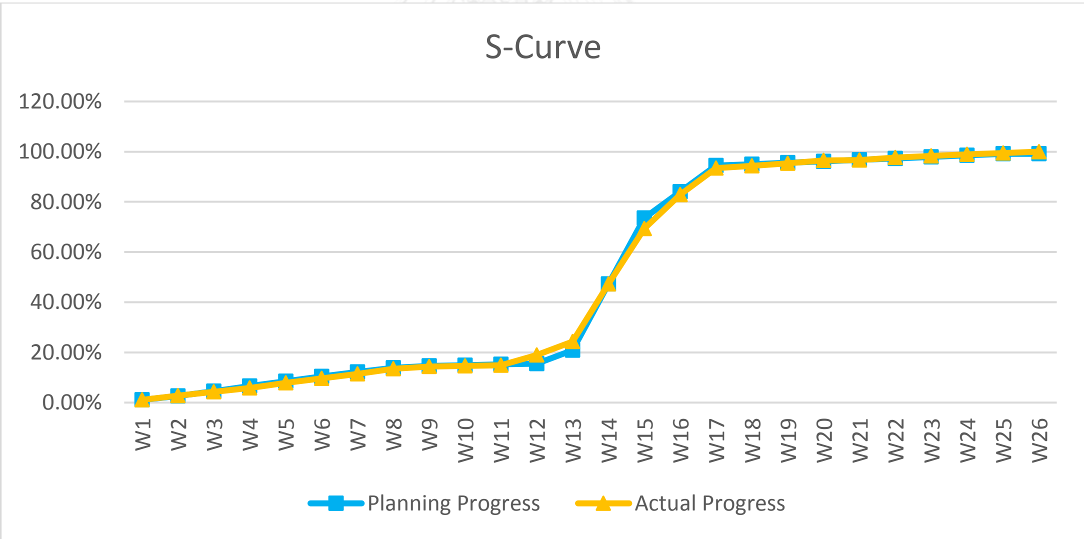


Figure 57: S-Curve until the end of project (base on rev.02 schedule)

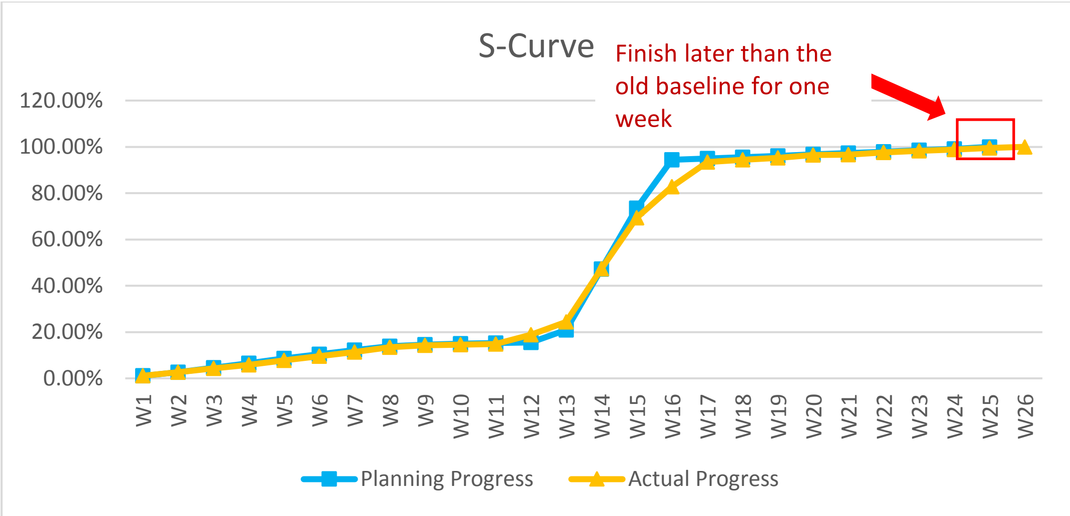
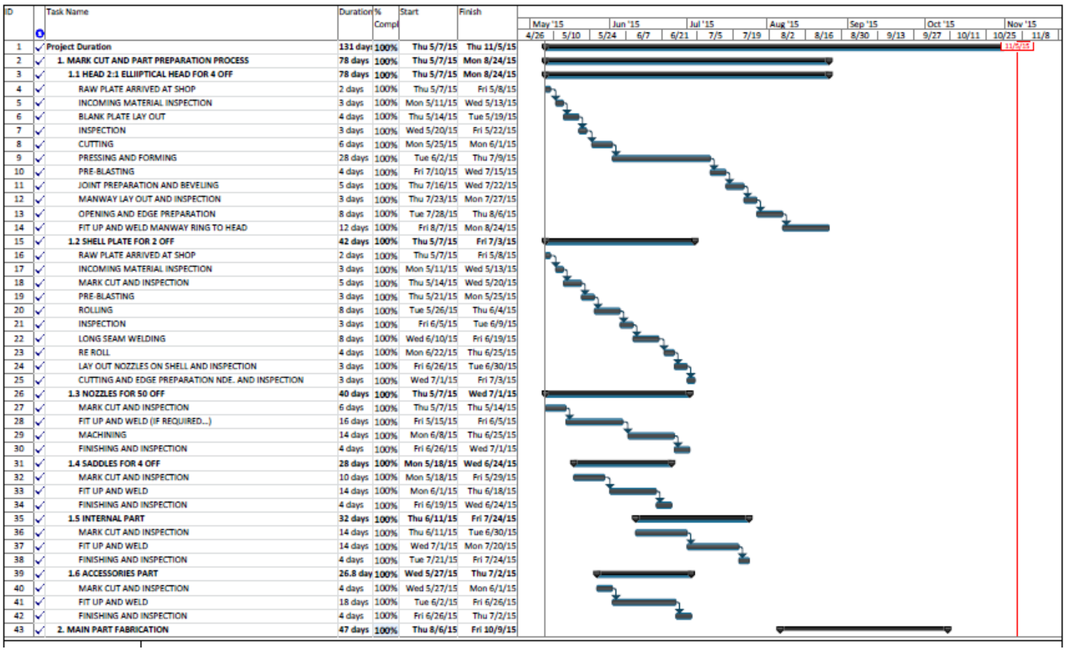


Figure 58: S-Curve until the end of project (base on rev.00 schedule – Initial baseline plan)



ID	Task Name	Duration	% Compl	Start	Finish
1	**Project Duration**	**131 days**	**100%**	**Thu 5/7/15**	**Thu 11/5/15**
2	**1. MARK CUT AND PART PREPARATION PROCESS**	**78 days**	**100%**	**Thu 5/7/15**	**Mon 8/24/15**
3	**1.1 HEAD 2:1 ELLIIPTICAL HEAD FOR 4 OFF**	**78 days**	**100%**	**Thu 5/7/15**	**Mon 8/24/15**
4	RAW PLATE ARRIVED AT SHOP	2 days	100%	Thu 5/7/15	Fri 5/8/15
5	INCOMING MATERIAL INSPECTION	3 days	100%	Mon 5/11/15	Wed 5/13/15
6	BLANK PLATE LAY OUT	4 days	100%	Thu 5/14/15	Tue 5/19/15
7	INSPECTION	3 days	100%	Wed 5/20/15	Fri 5/22/15
8	CUTTING	6 days	100%	Mon 5/25/15	Mon 6/1/15
9	PRESSING AND FORMING	28 days	100%	Tue 6/2/15	Thu 7/9/15
10	PRE-BLASTING	4 days	100%	Fri 7/10/15	Wed 7/15/15
11	JOINT PREPARATION AND BEVELING	5 days	100%	Thu 7/16/15	Wed 7/22/15
12	MANWAY LAY OUT AND INSPECTION	3 days	100%	Thu 7/23/15	Mon 7/27/15
13	OPENING AND EDGE PREPARATION	8 days	100%	Tue 7/28/15	Thu 8/6/15
14	FIT UP AND WELD MANWAY RING TO HEAD	12 days	100%	Fri 8/7/15	Mon 8/24/15
15	**1.2 SHELL PLATE FOR 2 OFF**	**42 days**	**100%**	**Thu 5/7/15**	**Fri 7/3/15**
16	RAW PLATE ARRIVED AT SHOP	2 days	100%	Thu 5/7/15	Fri 5/8/15
17	INCOMING MATERIAL INSPECTION	3 days	100%	Mon 5/11/15	Wed 5/13/15
18	MARK CUT AND INSPECTION	5 days	100%	Thu 5/14/15	Wed 5/20/15
19	PRE-BLASTING	3 days	100%	Thu 5/21/15	Mon 5/25/15
20	ROLLING	8 days	100%	Tue 5/26/15	Thu 6/4/15
21	INSPECTION	3 days	100%	Fri 6/5/15	Tue 6/9/15
22	LONG SEAM WELDING	8 days	100%	Wed 6/10/15	Fri 6/19/15
23	RE ROLL	4 days	100%	Mon 6/22/15	Thu 6/25/15
24	LAY OUT NOZZLES ON SHELL AND INSPECTION	3 days	100%	Fri 6/26/15	Tue 6/30/15
25	CUTTING AND EDGE PREPARATION NDE. AND INSPECTION	3 days	100%	Wed 7/1/15	Fri 7/3/15
26	**1.3 NOZZLES FOR 50 OFF**	**40 days**	**100%**	**Thu 5/7/15**	**Wed 7/1/15**
27	MARK CUT AND INSPECTION	6 days	100%	Thu 5/7/15	Thu 5/14/15
28	FIT UP AND WELD (IF REQUIRED...)	16 days	100%	Fri 5/15/15	Fri 6/5/15
29	MACHINING	14 days	100%	Mon 6/8/15	Thu 6/25/15
30	FINISHING AND INSPECTION	4 days	100%	Fri 6/26/15	Wed 7/1/15
31	**1.4 SADDLES FOR 4 OFF**	**28 days**	**100%**	**Mon 5/18/15**	**Wed 6/24/15**
32	MARK CUT AND INSPECTION	10 days	100%	Mon 5/18/15	Fri 5/29/15
33	FIT UP AND WELD	14 days	100%	Mon 6/1/15	Thu 6/18/15
34	FINISHING AND INSPECTION	4 days	100%	Fri 6/19/15	Wed 6/24/15
35	**1.5 INTERNAL PART**	**32 days**	**100%**	**Thu 6/11/15**	**Fri 7/24/15**
36	MARK CUT AND INSPECTION	14 days	100%	Thu 6/11/15	Tue 6/30/15
37	FIT UP AND WELD	14 days	100%	Wed 7/1/15	Mon 7/20/15
38	FINISHING AND INSPECTION	4 days	100%	Tue 7/21/15	Fri 7/24/15
39	**1.6 ACCESSORIES PART**	**26.8 day**	**100%**	**Wed 5/27/15**	**Thu 7/2/15**
40	MARK CUT AND INSPECTION	4 days	100%	Wed 5/27/15	Mon 6/1/15
41	FIT UP AND WELD	18 days	100%	Tue 6/2/15	Fri 6/26/15
42	FINISHING AND INSPECTION	4 days	100%	Fri 6/26/15	Thu 7/2/15
43	**2. MAIN PART FABRICATION**	**47 days**	**100%**	**Thu 8/6/15**	**Fri 10/9/15**

Figure 59: Gantt chart at the end of project - Rev02 schedule

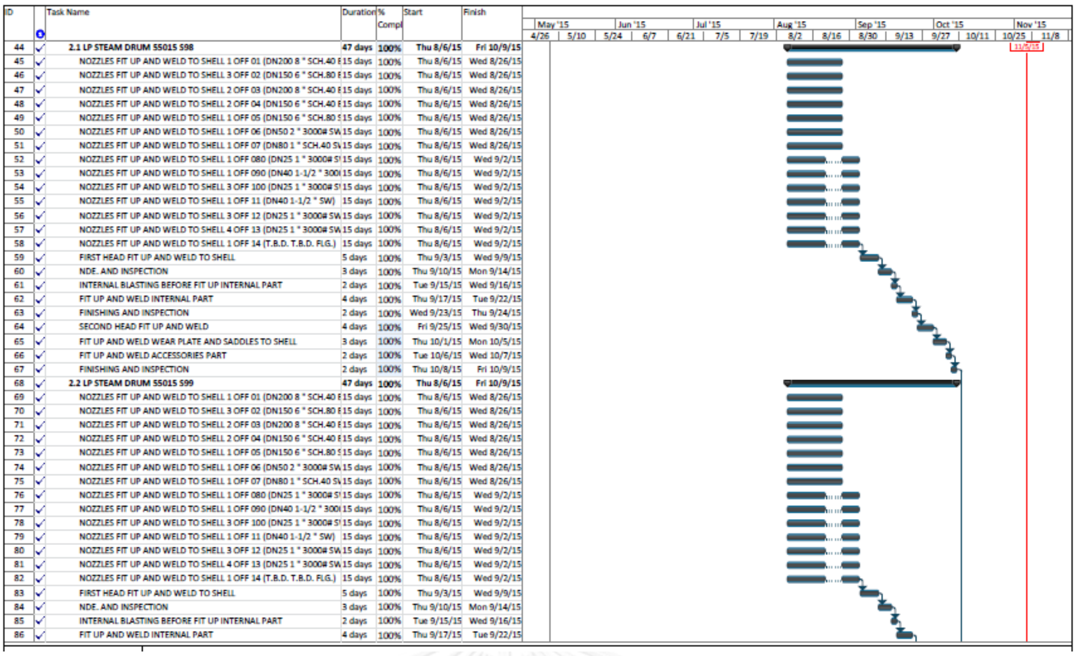


Figure 60: Gantt chart at the end of project - Rev02 schedule (cont.)

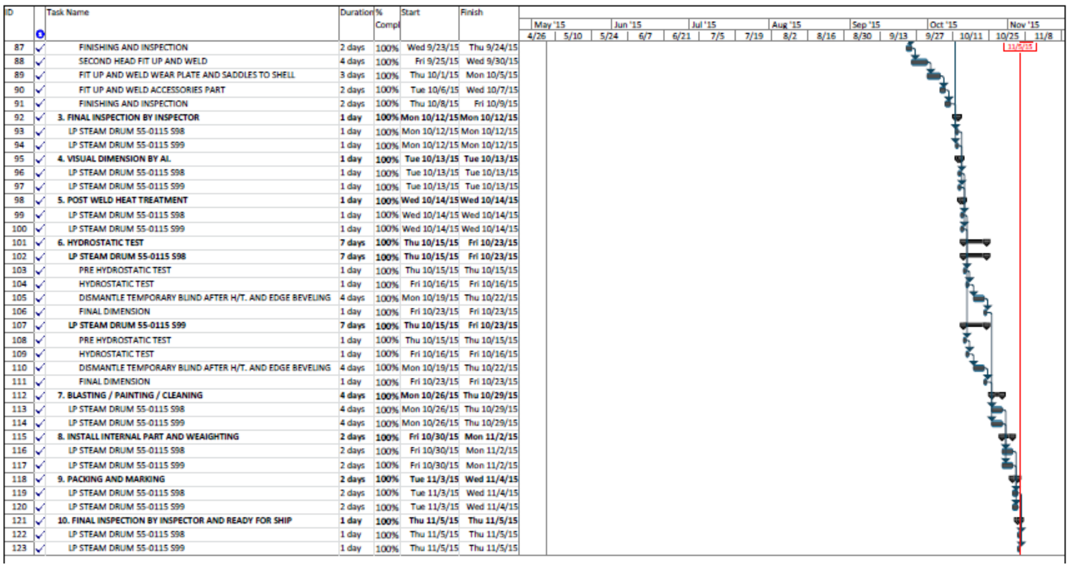


Figure 61: Gantt chart at the end of project - Rev02 schedule (cont.)

6 Chapter 6: Conclusion and Recommendations

6.1 Conclusion

The company historically has problems of project delays. The major components failed to deliver as committed date to customer. The causes of delay are identified, and the current project control practice are studied and evaluated. In this regard, the problems are taken to consideration which to develop on-time project delivery of the company.

The objective of this research project is to improve the framework for project control by following the guideline of project time management of PMBOK. Therefore, a framework has been formulated as a base for the project control practice and to be suitable for case study company project.

There are three main sections in this research. First section studies the existing project control system of the case study company. Brainstorming of involved project team members are performed to find the reasons of delay. By identifying all of the top delay causes, these lead the project team to the right direction of where to focus in improving project delivery time. The project schedule was not present detail for each activity, the progress tracking control was not properly shown, and the follow up activity seemed to be not frequent enough. Then, the area of improvement could be identified results from those problems. All of current issues are to be addressed base on project time control management.

The next chapter is to implement the proper project control system to an ongoing project. Project time control management guideline is followed step by step. The schedule is created using Microsoft project which showing critical path as well. The critical path is enable the team to be aware if there are anything that can harm the project completion date.

The planned schedule has been set up which to be used as a baseline compare with the actual result during project execution. As the project developed, work progress is monitored in which the performance of the project could be presented through S-

Curve. According to this, whether the current progress is ahead or behind schedule could be realised. In the meantime, the progress trend line is utilised in Microsoft project which provide a clear result on which activity is falling behind the planned date. Moreover, the weekly meeting is held which tends to be a good practice for follow up activity. Related circumstances are to be discussed with mainly concern on project progress. Standard report template is issued, with the same format, it enables relevant project team to review and catch errors easily.

After the implementation phase, it is followed by the result evaluation and discussion. Since the project time management system is applied to the project. The project schedule gets improved to present proper detail activities, each important schedule aspects are drawn such as critical path, network activity, and duration time. Progress of works are reported weekly hence should anything tend to go wrong or delay appear to the project, it could be aware, and correct since the early stage. The delay issues are minimized and also, the cost of crashing activity to keep up with schedule is eliminated. The weekly meeting with subcontractors is very crucial element for the successful implementation.

In conclusion, the study summarises the main causes of delay from analysing of current project control practice. Therefore, the project time management principle from PMBOK is adapted to Case Study Company in order to overcome those delays, gaining effectively control over project execution. Conclusions can be drawn from the results of analysis of the implementation phase. There are schedule deviations during project execution, delay at some activities; however, the corrective actions could be generated to recover plan promptly. The update to the current schedule is also decided to make as necessary. So, the project could run according to appropriate set of plan. The results show that progress of the project tend to be on schedule since the very beginning of the project and it is complete on time at the end. The project time management framework from this research may also be applicable for similar projects in the company.

According to proposed planning and control framework presented in chapter three, the final framework can be drawn after accomplished this research project as following.

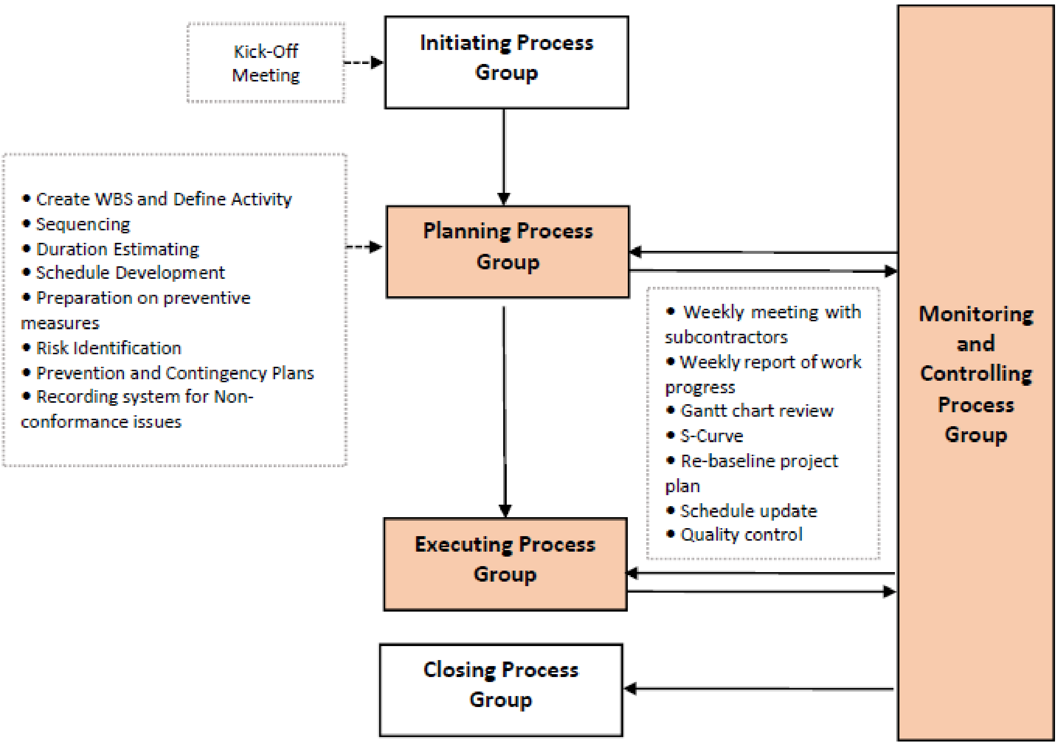


Figure 62: Final planning and control framework

6.2 Recommendations

To minimise the delay in case study project, the additional practices of project management are also can be developed in greater detail.

Recording system for Non-conformance issues – this is in order to organise and store information of any deviations in project which could be potentially benefit the future project; facilitate the decision making, reducing time in dealing with the issue that was previously happened before. This system will be useful to the less experienced and people new to the project management profession.

Project cost control should be incorporated in order to improve the effectiveness of project and prevent the project cost overruns. In this study, the risk assessment had been carried out by considering the effect to the key three aspects; time, quality and cost. Therefore, there can be improvements by incorporating these issues and focusing on them in future work.

Subcontractor performance is one of the important factors leading to the project success. The performance evaluation should be considered. If the existing subcontractor is underperformed, finding alternative subcontractors seem to be the solution.

From the implementation phase, the preventive action in response to this risk was not well managed by practitioner who is responsible to that risk, result in plan deviation. If this is could put in place. The better project performance can be expected.

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Appendix A – Minute of meeting template

Weekly Report

Job No.:	Project Name:	Date:
Inspector:	PO Number:	Report No:
Vendor:	Location:	Week End:

* =O (open), C (closed)
**=C (critical) - must be addressed ASAP to avoid project impact
I (important) – needs to be addressed to avoid moderate project impact
N (non critical) – general comment for information/review

Item	Engineering Issues	Responsible	Date	Status (O,C, critical, I, N)
1				
2				
3				

Item	Material Issues	Responsible	Date	Status (O,C, critical, I, N)
1	Raw material status – receive yes/no			
2				
3				

Item	Quality Issues	Responsible	Date	Status (O,C, critical, I, N)
1				
2				
3				

Item	Schedule Issues	Responsible	Date	Status (O,C, critical, I, N)
1				
2				
3				

Weekly Report

Item	Risk Registers	Responsible	Date	Status (O,C, critical, I, N)
1				
2				
3				

1. Engineering
   - Drawing and specification status of receive
   - Clarifications require on design

2. Material

Pending material

ID	Description	ETA	Status	Actual Receive	Remark
1					
2					
3					
4					

3. Inspection & Quality
   - Detail of inspection work. (Photo to be attached)
   - Manpower Assign (if applicable)

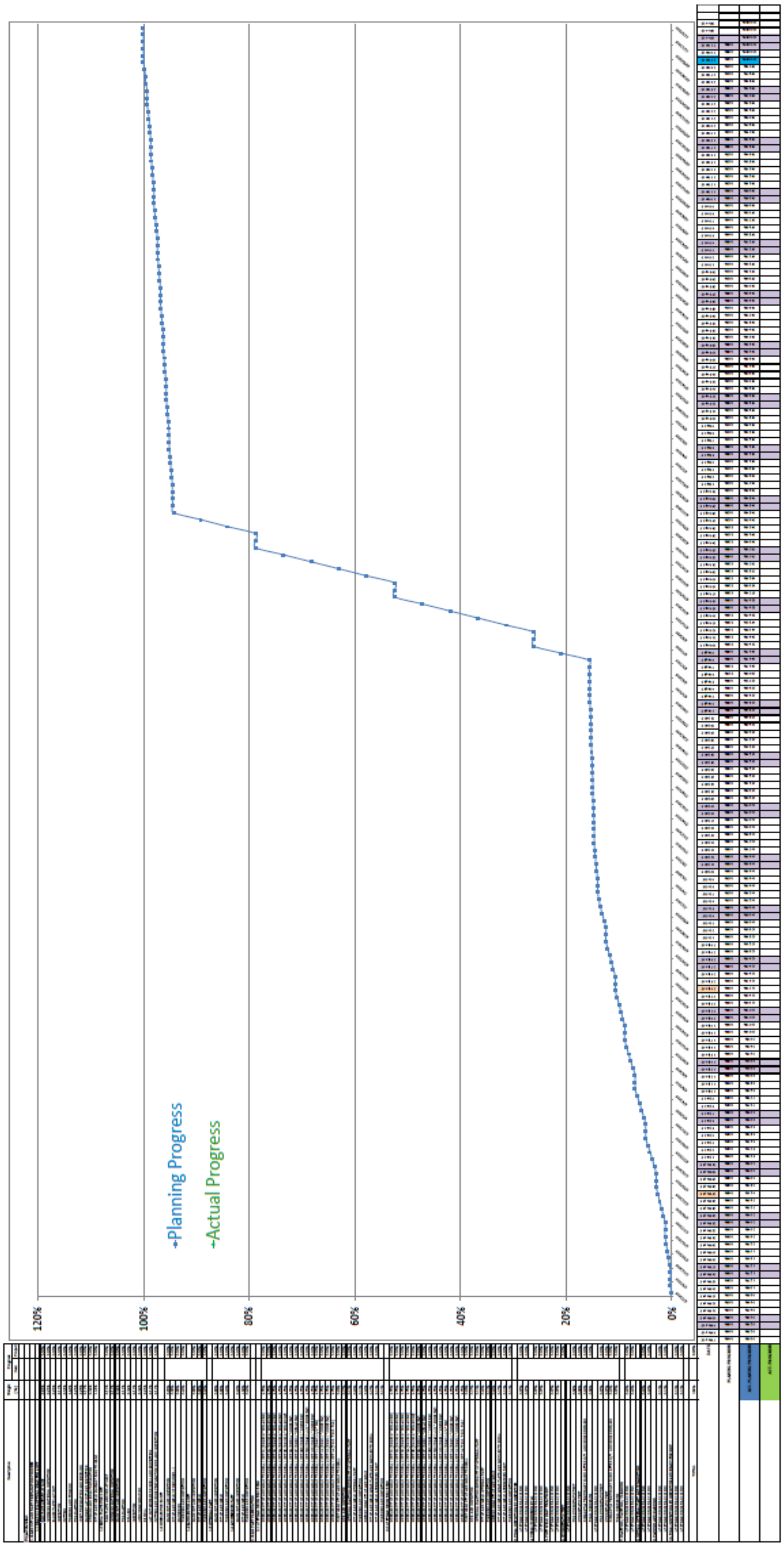
Welder		Fitter/ Helper		QC		Total	
Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual

4. Schedule
   - Gantt chart review
   - Critical path review
   - Milestone achievement (Start - finish – delivery date)
   - S-Curve review

Overall Progress Summary

Unit	Progress (%)		Diff (%)	Schedule			Remark
	Plan	Actual		Start	Finish	Expected Delivery	
Drum Unit 11						1st Shipment (dd/mm/year)	
Drum Unit 12						2nd Shipment (dd/mm/year)	

Appendix B – S-curve development based on daily basis



The daily progress will be recorded; hence, the actual progress can be tracked and plotted as S-curve to evaluate the result compare with the plan.

Appendix C – Weighting Table

The percent weight are given to each activity so that when the task is done, the percent complete can be realised and used to create S-curve consequently.

Table 25: project activity with percent weight

Description	Start	Finish	Weight (%)
Entire Project	Thu 5/7/15	Thu 10/29/15	
1. MARK CUT AND PART PREPARATION PROCESS	Thu 5/7/15	Mon 8/24/15	
1.1 HEAD 2:1 ELLIIPTICAL HEAD FOR 4 OFF	Thu 5/7/15	Mon 8/24/15	
RAW PLATE ARRIVED AT SHOP	Thu 5/7/15	Fri 5/8/15	0.05%
INCOMING MATERIAL INSPECTION	Mon 5/11/15	Wed 5/13/15	0.23%
BLANK PLATE LAY OUT	Thu 5/14/15	Tue 5/19/15	0.23%
INSPECTION	Wed 5/20/15	Fri 5/22/15	0.17%
CUTTING	Mon 5/25/15	Mon 6/1/15	0.34%
PRESSING AND FORMING	Tue 6/2/15	Thu 7/9/15	1.70%
PRE-BLASTING	Fri 7/10/15	Wed 7/15/15	0.23%
JOINT PREPARATION AND BEVELING	Thu 7/16/15	Wed 7/22/15	0.29%
MANWAY LAY OUT AND INSPECTION	Thu 7/23/15	Mon 7/27/15	0.17%
OPENING AND EDGE PREPARATION	Tue 7/28/15	Thu 8/6/15	0.46%
FIT UP AND WELD MANWAY RING TO HEAD	Fri 8/7/15	Mon 8/24/15	0.68%
1.2 SHELL PLATE FOR 2 OFF	Thu 5/7/15	Fri 7/3/15	
RAW PLATE ARRIVED AT SHOP	Thu 5/7/15	Fri 5/8/15	0.11%
INCOMING MATERIAL INSPECTION	Mon 5/11/15	Wed 5/13/15	0.17%
MARK CUT AND INSPECTION	Thu 5/14/15	Wed 5/20/15	0.46%
PRE-BLASTING	Thu 5/21/15	Mon 5/25/15	0.17%
ROLLING	Tue 5/26/15	Thu 6/4/15	0.46%
INSPECTION	Fri 6/5/15	Tue 6/9/15	0.17%
LONG SEAM WELDING	Wed 6/10/15	Fri 6/19/15	0.46%

Description	Start	Finish	Weight (%)
RE ROLL	Mon 6/22/15	Thu 6/25/15	0.23%
LAY OUT NOZZLES ON SHELL AND INSPECTION	Fri 6/26/15	Tue 6/30/15	0.17%
CUTTING AND EDGE PREPARATION NDE. AND INSPECTION	Wed 7/1/15	Fri 7/3/15	0.17%
1.3 NOZZLES FOR 50 OFF	**Thu 5/7/15**	**Wed 7/1/15**	
MARK CUT AND INSPECTION	Thu 5/7/15	Thu 5/14/15	0.35%
FIT UP AND WELD (IF REQUIRED...)	Fri 5/15/15	Fri 6/5/15	0.90%
MACHINING	Mon 6/8/15	Thu 6/25/15	0.80%
FINISHING AND INSPECTION	Fri 6/26/15	Wed 7/1/15	0.23%
1.4 SADDLES FOR 4 OFF	**Mon 5/18/15**	**Wed 6/24/15**	
MARK CUT AND INSPECTION	Mon 5/18/15	Fri 5/29/15	0.80%
FIT UP AND WELD	Mon 5/18/15	Thu 6/4/15	0.80%
FINISHING AND INSPECTION	Fri 6/5/15	Wed 6/10/15	0.23%
1.5 INTERNAL PART	**Fri 5/22/15**	**Mon 7/6/15**	
MARK CUT AND INSPECTION	Fri 5/22/15	Wed 6/10/15	0.80%
FIT UP AND WELD	Thu 6/11/15	Tue 6/30/15	0.80%
FINISHING AND INSPECTION	Wed 7/1/15	Mon 7/6/15	0.23%
1.6 ACCESSORIES PART	**Wed 5/27/15**	**Wed 7/1/15**	
MARK CUT AND INSPECTION	Wed 5/27/15	Mon 6/1/15	0.23%
FIT UP AND WELD	Tue 6/2/15	Thu 6/25/15	1.03%
FINISHING AND INSPECTION	Fri 6/26/15	Wed 7/1/15	0.23%
2. MAIN PART FABRICATION	**Thu 8/6/15**	**Fri 10/2/15**	
2.1 LP STEAM DRUM 55015 S98	**Thu 8/6/15**	**Fri 10/2/15**	
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8 " SCH.40 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6 " SCH.80 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8 " SCH.40 BW)	Thu 8/6/15	Wed 8/26/15	2.85%

Description	Start	Finish	Weight (%)
NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6 " SCH.40 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6 " SCH.80 SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1 " SCH.40 SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2 " SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)	Thu 8/6/15	Wed 8/26/15	2.85%
FIRST HEAD FIT UP AND WELD TO SHELL	Thu 8/27/15	Wed 9/2/15	0.29%
NDE. AND INSPECTION	Thu 9/3/15	Mon 9/7/15	0.17%
INTERNAL BLASTING BEFORE FIT UP INTERNAL PART	Tue 9/8/15	Wed 9/9/15	0.11%
FIT UP AND WELD INTERNAL PART	Thu 9/10/15	Tue 9/15/15	0.23%
FINISHING AND INSPECTION	Wed 9/16/15	Thu 9/17/15	0.11%
SECOND HEAD FIT UP AND WELD	Fri 9/18/15	Wed 9/23/15	0.23%
FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	Thu 9/24/15	Mon 9/28/15	0.17%
FIT UP AND WELD ACCESSORIES PART	Tue 9/29/15	Wed 9/30/15	0.11%
FINISHING AND INSPECTION	Thu 10/1/15	Fri 10/2/15	0.11%
2.2 LP STEAM DRUM 55015 S99	**Thu 8/6/15**	**Fri 10/2/15**	
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 01 (DN200 8 " SCH.40 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 3 OFF 02 (DN150 6 " SCH.80 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 2 OFF 03 (DN200 8 " SCH.40 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 2 OFF 04 (DN150 6 " SCH.40 BW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 05 (DN150 6 " SCH.80 SW)	Thu 8/6/15	Wed 8/26/15	2.85%

Description	Start	Finish	Weight (%)
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 06 (DN50 2 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 07 (DN80 1 " SCH.40 SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 080 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 090 (DN40 1-1/2 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 3 OFF 100 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 11 (DN40 1-1/2 " SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 3 OFF 12 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 4 OFF 13 (DN25 1 " 3000# SW)	Thu 8/6/15	Wed 8/26/15	2.85%
NOZZLES FIT UP AND WELD TO SHELL 1 OFF 14 (T.B.D. T.B.D. FLG.)	Thu 8/6/15	Wed 8/26/15	2.85%
FIRST HEAD FIT UP AND WELD TO SHELL	Thu 8/27/15	Wed 9/2/15	0.29%
NDE. AND INSPECTION	Thu 9/3/15	Mon 9/7/15	0.17%
INTERNAL BLASTING BEFORE FIT UP INTERNAL PART	Tue 9/8/15	Wed 9/9/15	0.11%
FIT UP AND WELD INTERNAL PART	Thu 9/10/15	Tue 9/15/15	0.23%
FINISHING AND INSPECTION	Wed 9/16/15	Thu 9/17/15	0.11%
SECOND HEAD FIT UP AND WELD	Fri 9/18/15	Wed 9/23/15	0.23%
FIT UP AND WELD WEAR PLATE AND SADDLES TO SHELL	Thu 9/24/15	Mon 9/28/15	0.17%
FIT UP AND WELD ACCESSORIES PART	Tue 9/29/15	Wed 9/30/15	0.11%
FINISHING AND INSPECTION	Thu 10/1/15	Fri 10/2/15	0.11%
3. FINAL INSPECTION BY INSPECTOR	**Mon 10/5/15**	**Mon 10/5/15**	
LP STEAM DRUM 55-0115 S98	Mon 10/5/15	Mon 10/5/15	0.07%
LP STEAM DRUM 55-0115 S99	Mon 10/5/15	Mon 10/5/15	0.07%
4. VISUAL DIMENSION BY AI.	**Tue 10/6/15**	**Tue 10/6/15**	
LP STEAM DRUM 55-0115 S98	Tue 10/6/15	Tue 10/6/15	0.07%
LP STEAM DRUM 55-0115 S99	Tue 10/6/15	Tue 10/6/15	0.07%
5. POST WELD HEAT TREATMENT	**Wed 10/7/15**	**Wed 10/7/15**	
LP STEAM DRUM 55-0115 S98	Wed 10/7/15	Wed 10/7/15	0.07%

Description	Start	Finish	Weight (%)
LP STEAM DRUM 55-0115 S99	Wed 10/7/15	Wed 10/7/15	0.07%
6. HYDROSTATIC TEST	**Thu 10/8/15**	**Fri 10/16/15**	
LP STEAM DRUM 55-0115 S98	**Thu 10/8/15**	**Fri 10/16/15**	
PRE HYDROSTATIC TEST	Thu 10/8/15	Thu 10/8/15	0.06%
HYDROSTATIC TEST	Fri 10/9/15	Fri 10/9/15	0.06%
DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	Mon 10/12/15	Thu 10/15/15	0.23%
FINAL DIMENSION	Fri 10/16/15	Fri 10/16/15	0.06%
LP STEAM DRUM 55-0115 S99	**Thu 10/8/15**	**Fri 10/16/15**	
PRE HYDROSTATIC TEST	Thu 10/8/15	Thu 10/8/15	0.07%
HYDROSTATIC TEST	Fri 10/9/15	Fri 10/9/15	0.07%
DISMANTLE TEMPORARY BLIND AFTER H/T. AND EDGE BEVELING	Mon 10/12/15	Thu 10/15/15	0.23%
FINAL DIMENSION	Fri 10/16/15	Fri 10/16/15	0.07%
7. BLASTING / PAINTING / CLEANING	**Mon 10/19/15**	**Thu 10/22/15**	
LP STEAM DRUM 55-0115 S98	Mon 10/19/15	Thu 10/22/15	0.23%
LP STEAM DRUM 55-0115 S99	Mon 10/19/15	Thu 10/22/15	0.23%
8. INSTALL INTERNAL PART AND WEAIGHTING	**Fri 10/23/15**	**Mon 10/26/15**	
LP STEAM DRUM 55-0115 S98	Fri 10/23/15	Mon 10/26/15	0.23%
LP STEAM DRUM 55-0115 S99	Fri 10/23/15	Mon 10/26/15	0.23%
9. PACKING AND MARKING	**Tue 10/27/15**	**Wed 10/28/15**	
LP STEAM DRUM 55-0115 S98	Tue 10/27/15	Wed 10/28/15	0.11%
LP STEAM DRUM 55-0115 S99	Tue 10/27/15	Wed 10/28/15	0.11%
10. FINAL INSPECTION BY INSPECTOR AND READY FOR SHIP	**Thu 10/29/15**	**Thu 10/29/15**	
LP STEAM DRUM 55-0115 S98	Thu 10/29/15	Thu 10/29/15	0.11%
LP STEAM DRUM 55-0115 S99	Thu 10/29/15	Thu 10/29/15	0.11%
TOTAL			100.00%

VITA

Rattiya Pimchaichon was born on November 18th, 1987 in Chonburi, Thailand. She graduated the Bachelor Degree in Chemical Engineering from Thammasat University in year 2010. She worked for Praxair (Thailand) Co., Ltd. as a purchasing engineer in 2011. Later in year 2012, she decided to study in the dual master's degree program at Regional Centre for Manufacturing Systems Engineering (RCMSE), Chulalongkorn University in cooperation with University of Warwick in United Kingdom. During the course of studies she accepted her current position as a product engineer in power generation industry.