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Front End Engineering (FEE) Application in Baronia Field

Ramli, A. A. S.[1], Zainun, N. Y.[2*],

[1]Department of Building and Construction, Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, MALAYSIA.

[2]Jamilus Research Center (JRC), Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, MALAYSIA.

*Corresponding Author Designation

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Abstract: Front End Engineering (FEE) is simply referred as early project planning phase. It can also be known as Pre Project Planning (PPP), Front End Loading (FEL), Front End Planning (FEP), Front End Engineering Design (FEED), Front End Development (FED) and Front End Decision Making (FEDM). Henceforth, this study is conducted to identify the FEE application and establish effectiveness of the application in Baronia Field which located in Miri, Sarawak. From this study, the data for project scheduling and cost are collected from the project's person in charge. The method of this study is by comparing the result collected. From the project schedule the project completed as planned in 2020. In addition, the cost for the project does not overrun from the estimate cost. From this, it shows that the project performance is execute smoothly. Therefore, it is concluded that FEE application is effective on Baronia Field.

Keywords: Front End Engineering Application, Pre Project Planning, Front End Loading, Baronia Field

1. Introduction

Front End Engineering (FEE) is simply referred as early project planning phase. It can also be known as Pre Project Planning (PPP), Front End Loading (FEL), Front End Planning (FEP), Front End Engineering Design (FEED), Front End Development (FED) and Front End Decision Making (FEDM) [1, 2]. Basically, they all have the same concept despite the different terms used. Moreover, these terms indicate the time and resources available in the pre-project planning and dictate how it goes in the future [3]. The purpose for FEE application in a project is to identify the risks in the early stage and propose solutions to ensure a smooth progress of the project.

Corresponding author: nryasmin@uthm.edu.my

Planning is one of the crucial processes in a project. Planning in a project help to decide on goals or objectives that need to be achieved. However, due to the lack of planning in the pre-project phases, poor leadership and unreliable data can lead to project failure [4]. Besides that, many studies have shown that large infrastructure projects have fail during planning phase or in an execution phase [5, 6, 7]. A project without proper planning will lead to shortages or delays on the project progression. Plus, failures can lead to negative impacts that may arise towards cost, duration and resources of the project [8]. These failures then lead to cost overrun and delay on completion of the project [9]. Hence, decision made early during the early planning phases of projects can be seen as significant on influencing the final project performance [10]. At this stage, it has the highest opportunity to alter the project outcome. In addition, it is also at this stage where the consequences of the decisions are at the highest level while the amount of available information is at the lowest level [11]. Henceforth, it is important that these failures to be identified to minimise negative impacts on the project and at the same time to obtain better project performances.

Although Front End Planning (FEP) have widely studied but its practise is inconsistent and been poorly understand due to lack of effective guidance on FEP [12]. FEE application may has been practise in the construction industry globally but the probability being implement are still small. In Malaysia, the application of FEE in the construction industry is still uncommon and not widely practised. Beside that, a study was done in evaluating capital project based on their scope, cost, schedule and business benefits where only 2.5% of them are defined as successful projects [12]. However, in the oil and gas industry it is different. It was estimated about 30% to 40% of the projects have cost and implementation overruns that exceed 10% [13].

Since FEE application is not widely practice, this study purpose is to determine whether it is effective to be practise in Baronia Field. Thus, the objectives are to identify the FEE application and establish effectiveness of FEE application.

2. Literature Review

2.1 Front End Engineering Phases

All project construction will undergo project life cycle. As for FEE application, it is the preliminary phase of the project [14] and at this phase crucial decision making is carried out. The project outcomes are heavily influences by the decisions made by the owners during this phase. Additionally, FEE application only occur during feasibility, concept and detailed scope phase until just prior to design and construction phase of the project [15] as shown in the Figure 1. In the figure, there are three gate systems: feasibility (Gate 0), Concept (Gate 1) and Detailed scope (Gate 2). These gate systems represent the time which the project should be approved to its next phase and which it may returned to be better defined or be cancelled [12]. These gate systems are a mechanism used by project managers to check the project progress from time to time.

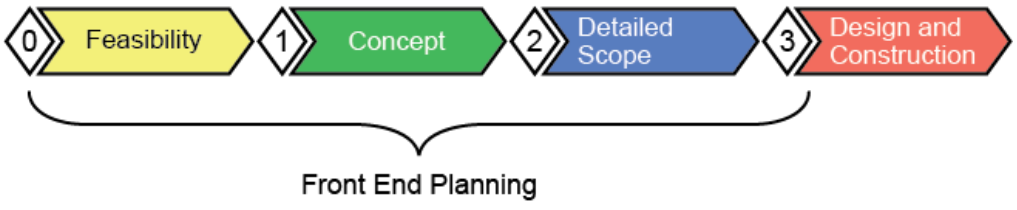

Figure 1: FEE Application in Life Cycle [15]

2.2 Front End Engineering Application Tools

FEE practise required involvement of various human interaction, information's and process that not many companies often execute it especially in capital projects. Thus, tools were developed in order to enhance FEE process. Many researchers have developed tools to support FEE process in achieving a better performance. There are various planning tools that have been developed to help organize and

execute project planning. These tools are designated to manage execution, monitoring and control all work activities concerning planning to ensure that all the deliverables are completed efficiently. These tools can be divided into two categories: modern tools and traditional tools.

The modern technologies consist of computer planning software like scheduling, estimating and controlling software. These types of tools will keep on developed to satisfy the industry needs. Despite that, the traditional tools also have been used by many project teams before the arrival of the modern tools. Examples of these tools are bar charts, check lists, work breakdown structures and simple workflow diagrams. The example of traditional tool is Project Definition Rating Index (PDRI) and modern tool is Front End Planning Tool (FEPT).

2.2.1 Project Definition Rating Index (PDRI)

Project Definition Rating Index played a role as a tool for scope definition check lists. Scope definition is the method by which the projects are defined and ready for execution [16]. The aim of PDRI developed is to measures the present status of front-end engineering (FEE) application during a project and pointed out the areas where inadequate planning is done. At the same time, it is keeping a check on the probability of project success. PDRI is first developed by CII in 1994. The first PDRI was developed with the purpose of exploitation it on industrial projects. The CII researchers created this tool intended to address the distinctive circumstances that surround the infrastructure projects. The researchers have developed more of this tool accordingly to its specific industry needs. Since then, there have been five PDRI tools existed. They are RT-314A intended for small infrastructure projects, RT-268 used for infrastructure projects, RT-314 for small industrial projects, RT-113 designed for industrial projects and RT-155 aimed for general projects [17].

2.2.2 Front End Planning Tool (FEPT)

Front End Planning Tool (FEPT) is a practical tool to provide a widely applicable and comprehensive electric process management system [18]. It is designated with the goal of applying software technology to address the unique characteristics of the planning process and to provide the construction industry with an adequate process management tool to support FEE application. FEPT is applied to manage three phases of FEE application: feasibilities, concept and detailed scope. It comprises a set of services, processes and access methods for managing planning activities and deliverables. Moreover, it will enable more efficient assembly of information handover packages in either hard copy or soft copy format. The reason the details have been archived electronically during the first phase of FEE application.

2.3 Baronia Rejuvenation

In Baronia Field, there are 69 wells that been drilled from 5 platforms with 11 sidetracks. There are 16 platforms that consists of 2 bridged link complexes (A & B) with a remote vent (tripod) each, 4 wellhead tripod jackets and a network of infield submarine flow lines and gas lift supply pipelines, together with oil/gas trunk lines. The following figure shows the schematic of Baronia Platforms:

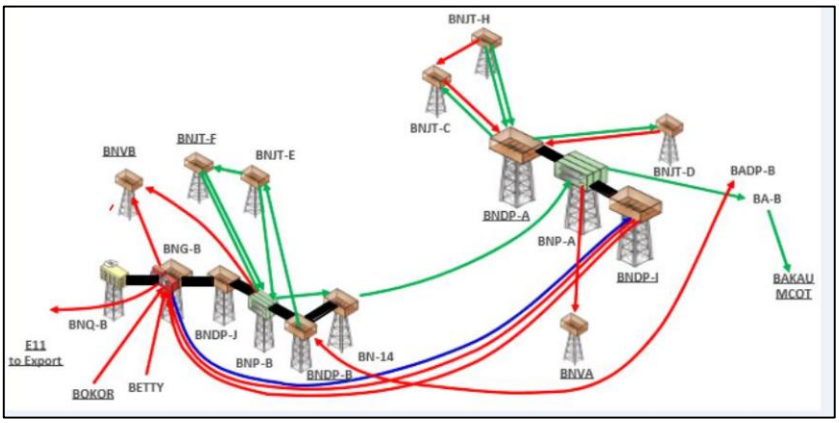

Figure 2: Baronia Platforms

The figure above shows the position of the 16 platforms which connected by complex A and B respectively. Furthermore, the below table presents a list of existing platforms in Baronia Field.

Table 1: Existing platforms in Baronia Field

No.	Platform	Type of Platform	Structure	Well	Age
1	BNDP-A	Tender Assisted Drilling Platform	8 legs	12 slots	40
2	BNP-A	Production Platform	4 legs	-	43
3	BNDP-I	Drilling Platform	6 legs	15 slots	23
4	BNV-A	Vent Jacket	3 legs	-	41
5	BNJT-C	Satellite Jacket	3 legs	3 slots	38
6	BNJT-D	Satellite Jacket	3 legs	3 slots	37
7	BNJT-H	Satellite Jacket	3 legs	3 slots	35
8	BNDP-B	Tender Assisted Drilling Platform	8 legs	12 slots	37
9	BNP-B	Production Platform	4 legs	-	37
10	BNDP-J	Drilling Platform	4 legs	15 slots	23
11	BNG-B	Gas Compression Platform	8 legs	-	22
12	BNV-B	Vent Jacket	3 legs	-	37
13	BNJT-E	Cluster Drilling Platform	3 legs	3 slots	37
14	BNJT-F	Cluster Drilling Platform	3 legs	3 slots	36
15	BN-14	Single Well Jacket	3 legs	1 slot	39
16	BNQ-B	Living Quarters	4 legs	-	22

2.5 Importance of Front End Engineering (FEE) Application

The basis for effective project execution emphasized is Front End Engineering (FEE) application [19]. Its function to identify and mitigates overall project risks and with adequate FEE application, project team will identify risks as soon as possible [20] thus promoting better performances by lowering cost and reducing time completion. Research was done on the impact of FEE application to overall project performance. It was found that a project will have better prosecution with sufficient planning [21]. Furthermore, with well performed FEE application, both design and construction, and total design cost and schedule have been reduced by 20% and 39% [22]. At the same time, it has increased the chance of fulfilling the project's environment and socials goals. In addition, projects with rigorous FEE application performed more than 10% better in terms of cost, 7% better with respect to schedule performance and 5% better relative to change orders than project with little FEE application [6].

FEE application is conducted after the completion of the concept and feasibility study where all options will be assessed form an economic and safety perspective. Simultaneously, project values are developed in FEE phase [23]. (12) Without proper planning, there will be economic, social and environment losses. Consequently, it can be concluded that FEE application is essential in projects.

2.6 Challenges of Front End Engineering (FEE) Application

A study has been carried out in finding the challenges of FEE application in the construction industry. In reference of the study, the author has pointed out five highest challenges accordingly. These challenges are ranked based on professionals' perspectives. The first challenge referred to is the incompetence in identifying the importance of process. Second is the result of uncertainty information at the initiation phase project. Next issue is time constriction in performing FEE process. Besides that,

it is due to the client's insufficient knowledge. Lastly, it is the disorder between the team management at early stage of project [24].

Apart from that, it was found that not all owners are interested on FEE application and decide to move to the next phase with inadequate planning [25]. Furthermore, some even considered project planning as trivial matter [26]. Thus, the consequence made by the decision makers in failing to acknowledge the uncertainty and complexity of FEE phase has cause project failure [27].

The above statements represent the challenges of FEE application in the construction industry. If these challenges are not solved, it will be the factor in resulting project failure. Therefore, the entire project team should be responsible in making sure FEE application is effective and efficient in the project execution

3. Methodology

3.1 Data Collection and Data Analysis

In this study, the data have been collected from Baronia Rejuvenation Project. These data were collected from the project life cycle phases starting from the project planning stage consists of feasibility, concept and detailed scope up until the project closed.

In this study, there are two types of data to analyse which were project time completion and cost. The analysis for time completion was based on the project scheduling planned beforehand. The analysis for cost will be referred to cost breakdown which include cost for all work scope such as FEED design, insurance, installation and more. Last but not least, comparison was made between Baronia Field with other construction project to determine the effectiveness of FEE application.

4. Results and Discussion

The schedule data from the project were analysed from the beginning (planned stage) until the execution stage (operation and maintenance). Meanwhile the data for cost were taken from both the consultant cost and EOR cost. From these results, both schedule and cost become the benchmark for FEE application effectiveness.

4.1 Baronia Field

Baronia Field is in Sarawak water on Baram Delta Province which is a tertiary basin located in the northern part of Sarawak and extends north-eastward through Brunei into the southern part of Sabah. It is 40 km away from offshore Miri and was first discovery in the 1972 while the first oil production is at the year of 1972. The area is estimated in around 9km x 4km approximately. Figure 2 shows an illustration of the overview of Baronia Field. Baram Delta Gas Gathering Project 2 or known as BARDEGG2 and Baronia EOR project will be undertaken as a single integrated development project operated by Petronas Carigali Sdn Bhd [28]. Additionally, it also stated that BARDEGG2 is the second phase of Baram Delta gas gathering project on Baronia Field. It also aims to collect and compress the associated gas that was previously burned to improve oil recovery. Furthermore, Petronas has team up with Shell in preparing Baram Delta Operations in Enhanced Oil Recovery program to extract all-natural gas and carbon dioxide resources to accelerate the maturation of crude oil fields.

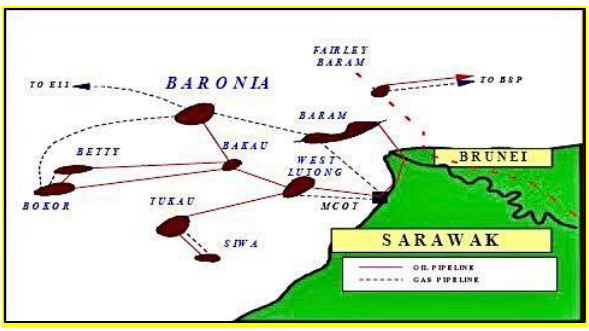

Figure 4: Baronia Field Overview [29]

4.1.1 Front End Engineering Application in Baronia Field

For BARDEGG2 project, Front End Engineering Design (FEED) work is performed, and Petronas has selected a local engineering services provider - RNZ Integrated to perform the FEED work. FEED activities consist of eight categories including an account of initial trigger, design characteristics, team management, market assessment and benchmarking, user needs assessment, product exploration, development plan and target specifications [30]. However, it can be modified according to the views of the person who adopt it.

FEE application is important for oil and gas megaprojects and comprises [31]. Additionally, the government does aware of the significant of FEE application and applied it in their project. However, the result for FEE application's effectiveness is difficult to predict as there is not full publication regarding the project.

4.2 Schedule

The planning stage for the project began in 2014, started constructing on 2016 and finished on 2020. From the data collected, project schedule of Baronia Field can be seen in the figure below.

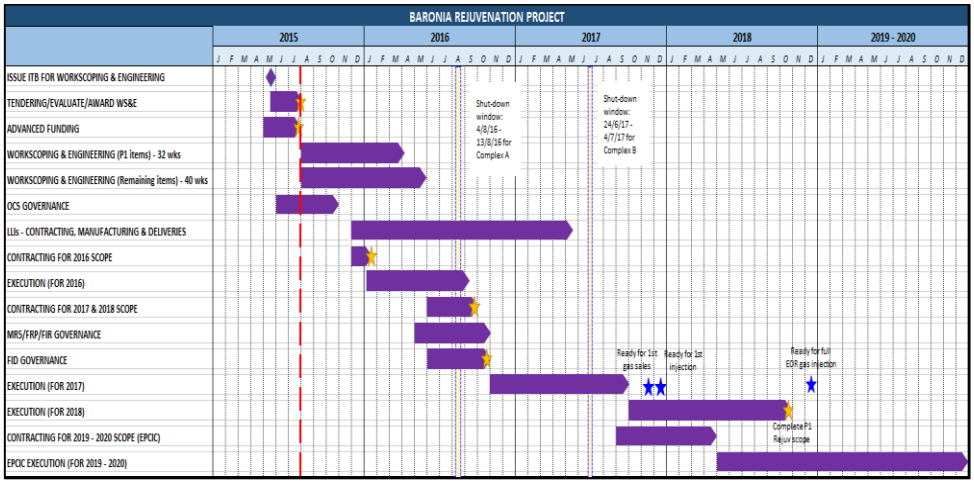

Figure 5: Overall Project Schedule

From the figure above, the project has started at 2014 for the planning stage and commenced its execution at 2016. The applied Front End Engineering Application in this study is Front End Loading (FEL). The reason for this is to ensure the project can be carefully executed in the next stages without necessary casualties. From the above schedule, the execution and start-up operation stage for the project started in 2016 up until 2020. It can be seen that the execution stage has four phases namely execution for 2016, 2017, 2018, 2019 and 2020. The first execution (for 2016) commenced in the early month of 2016 while the second (for 2017) in early November of 2016. Next, the execution (for 2018) started in early October of 2017. Finally for the execution (2019 and 2020), it began at the early of May 2018 up until end of 2020. The start-up operation occurred in 2020 where the project is called for closure. In addition, referring to the figure above, the first gas injection is on the end of 2017 and full gas injection is also on the end of 2018. Lastly, the project does not overrun from its original schedule as the project finished in 2020 as planned.

4.3 Cost

From the data collection, the cost for the project were accordingly by the consultant and Enhanced Oil Recovery Cost (EORC). Compared to consultant cost, EORC has include the owner's cost. The level of accuracy is +/- 20% plus the currency used are in USD. The currency exchange rate

is USD 1 is equal to MYR 3.13. The table below shows cost breakdown for both consultant cost and EORC.

Item	Description
1	Front End
2	Design
3	Jacket
4	Topsides
5	Offshore Installation
6	Pipelines
7	Hook Up and Commissioning
8	Host Tie-In
9	Platform Certification & Insurances
10	Platform Management
11	Base Cost
12	Project Contingency (+/- 20%)

Table 4: Cost breakdown

For the consultant cost the final total was calculated with the cost of USD 371,966.00 which equivalent to MYR 1,164,254. Meanwhile for Enhanced Recovery Cost is calculated with the cost of USD 260,578.85 which is equivalent to MYR 1,076,607.60. The cost made by the consultant has higher cost compared to EORC. The reason for this is the difference in cost for offshore installation, host tie-in, platform certification and insurances and platform management. The consultant cost has higher cost in these categories than in EORC.

From the result, it can be concluded that the project first started at 2014 and finally finished at 2020. The time completion for the project based on the planned scheduling. Beside that, the cost consumed for the project is much smaller than the cost estimate. The cost for the project is RM 1,076,607.60 where the project is assumed to consume a budget of RM 1.2 million. Hence, the project shows its effect in ensuring the project runs smoothly while keeping the cost and schedule in control.

5. Conclusion

At the end of this study, all the objectives were achieved. According to the data analysed, Front End Engineering (FEE) is applied in the project. The term used for FEE application in the project is Front End Loading (FEL) which are not uncommon in the oil and gas industry. Referring to the project, FEL stage is divided into three phases FEL1, FEL2 and FEL3. In addition, the effectiveness of FEE application in Baronia Field depends on two factors which are the cost and schedule of the projects. From the result, both the cost and schedule are not overrun. Therefore, it shows that the project is a success and proved that FEE application is effective.

The practise of FEE application is relatively small both in and out of Malaysia. Thus, there were some recommendations which could be used a guideline in increasing the understanding on FEE application and increase the practise of FEE application in the future. At the same time, it will help to provide a better performance for future projects. These recommendation are as following:

a. Planning stage take longer which simultaneously increase cost the longer time period of the project. The recommendation that can be done is use detailed framework for scheduling such as software for easier management.

b. The detail reports on the planning (FEL) stages in Baronia Field's project for more understanding on FEE application could be added for future research.

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