Feasibility Study of the Location Selection for Oil Distribution Center with Sensitivity Analysis Case Study: A Sample Oil Company

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***Abstract*—Nowadays, electricity is the energy source that is most conveniently and comfortably transferred to the consumer since it can be wired directly from the energy source to the user. It can be easily transformed into other energy types and kept in reserve. Natural gas is the primary fuel produced in Thailand due to its minimum cost and it's also a sustainable alternative. However, due to the annual shutdown of gas pipelines and drilling sites are forced to use Fuel Oil (FO) and High-Speed Diesel (HSD) instead of natural gas to produce electricity. This paper is a study of the oil transportation systems of each alternative, which consists of alternative I being the main oil distribution center, alternative II being the main oil distribution center and the old oil distribution centers A and B, and alternative III being the new oil distribution centers C and D to study the feasibility of the location selection for oil distribution center during this shutdown period. According to the simulation and economic analysis, the Net Present Value (NPV) and Internal Rate of Return (IRR) of each alternative are known, which will be taken into account at the meeting with management. The result was found that alternative III should be chosen because it can satisfy both the quantitative and qualitative. Furthermore, we conducted the sensitivity analysis, it was found that increased investment selections. On the other hand, it will make investment selections.**

***Index Terms*—Sustainable, simulation, economic analysis, sensitivity analysis**

I. Introduction

Electricity is essential for human life as it is the primary energy used in both the industrial and domestic sectors [1]. It takes a lot of fuel to produce enough electricity to meet demand. Therefore, providing a fuel source for electricity generation is crucial. In Thailand, the demand rate for electricity usage is continuously increasing [2], but the domestic energy source has an insufficient production rate. Therefore, electricity generated in Thailand is necessary to look for alternative energy. The use of natural gas as the main fuel is cheap. According to Table I [3], natural gas will be the main fuel used to generate electricity in Thailand because it is the most economical option and has sufficient supply to meet demand. Additionally, there have been investments made in pipelines that connect gas fields in the Gulf of Thailand and Myanmar to Thailand. Therefore, the use of natural gas energy in Thailand's electricity generation is an affordable and sustainable alternative.

TABLE I: The Cost of Generating Electricity [1]

Types of power plants	Cost (baht/unit)
Coal-fired Power Plant	2.67
Combined Cycle Power Plant (Natural gas)	3.09
Biomass Power Plant (> 3 MW)	4.69
Wind Power plant	6.06
Solar Power Plant	5.66

In addition, Fuel oil, diesel, and coal were used to produce enough electricity to meet demand between March to April [4]. It was the annual shutdown to maintain the gas pipeline and drilling sites that transport gas from the gas fields in Myanmar to the Ratchaburi power plant, Thailand, gas pipeline as shown in Fig. 1. At the same time, the demand for electricity in both industrial and domestic sectors in the country cannot be stopped. This is due to the annual shutdown of gas pipelines and drilling rigs that occurs at the peak of the year. Therefore, it is necessary to use Fuel Oil (FO), High-Speed Diesel (HSD), and coal to generate electricity instead of natural gas to provide enough electricity to meet the needs.

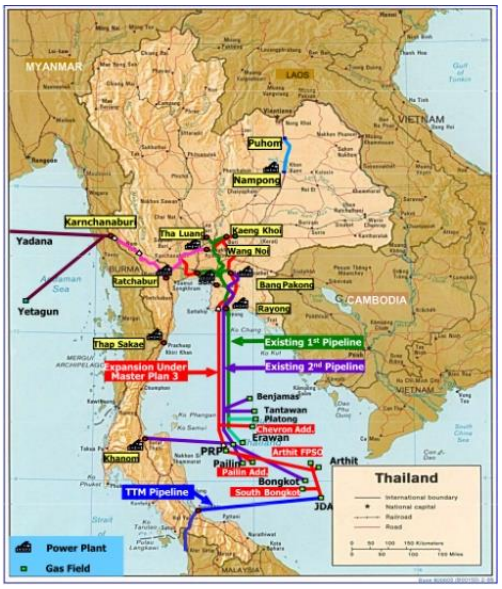

Fig. 1. Thailand's gas pipeline.

This paper is a feasibility study of the oil distribution center location analysis project to assist the management in selecting the location of a new distribution center for the transportation of FO and HSD to the power plant group in

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Ratchaburi province to generate electricity. The rest of this paper is organized as follows: Section II describes the research methodology, including data collection, arena simulation, and data analysis. Section III discusses the results, including economic analysis, and sensitivity analysis. Conclusions are finally presented in Section IV.

II. Methodology

This study simulated where the distribution center would be located, which is a lease agreement to serve as a distribution point for fuel oil and diesel fuel to the Ratchaburi Power Plant Group's transport vehicle group for the terminal. The process begins with receiving an order from the district sale manager to planning the vehicle's route. After that, calculating the amount of transportation concerning the inventory reserves, and finally, it is transported to the Ratchaburi power plant group. We will be simulated the entire process with the Arena program to further assess the possibilities, detailed as follows:

A. Data Collection

In this study, we collected the data from actual operational surveys and executive interviews in relevant areas, the data include:

1) Costs and expenses related to the running of the fuel oil and diesel fuel transportation from each distribution center's site.
2) The time it takes to transport fuel oil and diesel fuel from the beginning to the end is based on the volume and plan.

B. ARENA Simulation

The arena is a user-friendly software package that is based on and includes the SIMAN simulation language. Arena provides interchangeable templates of graphical simulation modeling and analysis modules that can be used to build a wide array of simulation models [5, 6]. The modules are typically grouped into panels. By switching panels, you gain access to a different set of modeling constructs and capabilities. In most cases, modules from different panels can be used in the same simulation model.

In this research, the simulation of fuel oil and diesel fuel transport process from each distribution center. The guidelines are based on research by Seyed *et al.* [7], Leise *et al.* [8], Chawis *et al.* [9], and Wilson and Charles [10]. They begin with the internal operating process of the oil distribution center, such as the shipment cost, pipeline transportation cost, operating costs, and safety costs. We put all values parameters in the ARENA simulation, then run the model with a 90-day experimental and repeated it three times.

C. Data Analysis

The analysis uses the results of ARENA simulations to test the hypothesis by the T-test method in combination with economic analysis to assess the value of each alternative using the Net Present Value (NPV), and Internal Rate on Return (IRR), according to Heralova [11]. Deciding on alternatives will use the Focus Group approach from relevant executives to be useful in developing and expanding other commercial projects that can create added value for the organization.

III. Results

From the result of problem analysis and simulation, it is possible to know the transportation time and cost of each oil distribution center with the lowest cost. The alternative is divided into 3 alternatives, including: alternative 1) the main oil distribution center to Ratchaburi Power Plant; alternative 2) the main oil distribution center and A, B distribution centers to Ratchaburi Power Plant; and alternative 3) the main oil distribution center and C, D distribution center to Ratchaburi Power Plant. The placement of the main oil distribution center and distribution centers A, B, C, and Das shown in Fig. 2. Then, the engineering economics analysis was done by determining the Net Present Value (NPV) and the Internal Rate of Return (IRR) of each alternative. It is assumed that the project has a 1-year life and has a floating rate of 5.8% and a discount rate of 11%. The details are as follows:

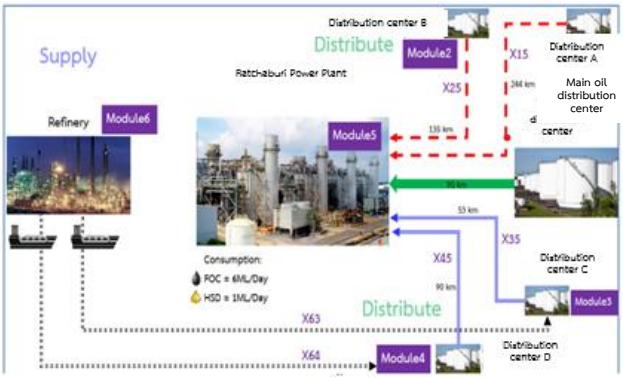

Fig. 2. The main oil distribution center and distribution centers A, B, C, and D.

A. Economic Analysis

1) Alternative I: The main oil distribution center

The transportation of alternative I gives the total cost of the main distribution center to distribute oil to power plants in Ratchaburi. As shown in Table II, they are divided into two periods, which are from March to May and from August to October. All the cost data for alternative II, in the case of additional oil distribution center openings, can be used for alternative II and alternative III analysis.

TABLE II: Total Cost of Alternative I

Costs	Products	
	FO	HSD
Shipment cost	900	1350
Inventory cost	–	–
Price/Build stock	330,000	600,000
Operations cost/Floating Rate/Safety	–	–
Idle cost (Vehicle)	1020	1020
Road transportation cost	12,000	9300
Pipeline cost/service	1500	1500

The results obtained from the test in the scenario model of alternative I were that all activities cost 502,607 monetary units, divided into shipment costs of 499,044 monetary units, unemployment transportation costs of 3563 monetary units, and the resource cost of 469,818 monetary units. Furthermore, 146 trips, or 95.7%, were not delivered on time. It can be concluded that the use of the main oil distribution centers is not sufficient to meet the daily

demand. Therefore, further testing to determine the finish time that the oil distribution center will be able to deliver the oil as needed was found to take 254 days without adding any resources.

2) Alternative II: The main oil distribution center with A and B distribution center

The transportation of alternative II gives the total cost of the main distribution center. The A and B oil distribution centers are used to distribute oil to power plants in Ratchaburi. As shown in Table III, they are divided into two periods, as well as alternative I. All the cost data for alternative II, in the case of additional oil distribution center openings, can be used for further engineering economics analysis.

TABLE III: TOTAL COST OF ALTERNATIVE II

Costs	Original oil depot		An old oil depot (A)		An old oil depot (B)
	FO	HSD	FO	HSD	HSD
Shipment cost & Pipeline cost	900	1350	-	-	750
Inventory cost	-	-	-	-	150
Price/Build stock	330,000	600,000	330,000	600,000	600,000
Operations cost/Floating Rate/Safety	-	-	3600	4500	4500
Idle cost (Vehicle)	1020	1020	1020	1020	1020
Road transportation cost	12,000	9300	36,000	27,900	18,600
Pipeline cost/ service	1500	1500	7500	8400	8400

The results obtained from the test in the scenario model of alternative II were that all activities cost 1,235,309 monetary units, divided into shipments and pipeline costs of 946,960 monetary units, unemployment transportation costs of 288,349 monetary units, and the resource cost of 902,677 monetary units. It found that 11 trips were not delivered on time, which was 20% from oil distribution center A and 80% from oil distribution center B. It can be concluded that the use of the main oil distribution centers, A and B, is insufficient to meet the daily demand. Further testing to determine the finish time at which the distribution center would be able to deliver the full demand of oil required a total of 185 days, which is just 1 day more than the plan, with no additional resources added.

3) Alternative III: The main oil distribution center with C and D distribution center

The transportation of alternative III gives the total cost of the main distribution center. The C and D oil distribution centers are used to distribute oil to power plants in Ratchaburi. As shown in Table IV, they are divided into two periods, as well as alternative 1 and alternative II. All the cost data for alternative III, in the case of additional oil distribution center openings, can be used for further engineering economics analysis.

The results obtained from the test in the scenario model of alternative III were that all activities cost 579,068 monetary units, there was no transportation, and daily transport was completed 1.20 hours per day before the scheduled time, or there were three transport vehicles. It can be concluded that the use of the main oil distribution centers C and D is sufficient for daily demand.

TABLE IV: TOTAL COST OF ALTERNATIVE III

Costs	Original oil depot		An old oil depot (C)		An old oil depot (D)
	FO	HSD	FO	HSD	HSD
Shipment cost & Pipeline cost	900	1350	1350	1650	-
Inventory cost	-	-	150	150	-
Price/Build stock	330,000	600,000	330,000	600,000	720,000
Operations cost/Floating Rate/Safety	-	-	-	-	-
Idle cost (Vehicle)	1020	1020	1020	1020	1020
Road transportation cost	12,000	9,300	7059	5471	9300
Pipeline cost/ service	1500	1500	3000	4200	4800

From the 3 alternatives, it was found that alternative III was suitable transporting fuel oil and diesel fuel to the Ratchaburi Power Plant. It can transport enough oil to meet the demand for daily power generation and is a lower-cost alternative to the currently used alternative II of the annual shutdowns. It can also be completed before the scheduled time as well. This will help maintain the stability of Thailand's energy.

B. Sensitivity Analysis

In the analysis, four factors of each alternative are adjusted, which may affect the decision. Factors include the cost of water transportation, oil price, unemployed truck cost, and the cost of road transportation. The cost adjustment details for each factor are shown in Table V.

TABLE V: THE COST ADJUSMENT

Factors	An increase	Decrease
The cost of water transportation	+10%	−10%
Oil price	+1%	−1%
Unemployed truck cost	+5%	−5%
The cost of road transportation	+5%	−5%

1) Alternative I: The main oil distribution center

According to a sensitivity analysis of the factors expected to affect the decision found that adjusted: the cost of water transportation by +10%, oil price by +1%, unemployed truck cost by +5%, and the cost of road transportation by +5%, the result in a negative Net Present Value (NPV), making the alternative inappropriate as an investment. On the other hand, it makes the NPV value positive, making alternative I suitable for investment. Alternative I had the minimum overall activity cost of 8,537 monetary units, but it was not appropriate for investment during the annual shutdown period since it couldn't transport enough oil to meet demand.

2) Alternative II: The main oil distribution center with A and B distribution center

According to a sensitivity analysis of the factors expected to affect the decision found that adjusted: the cost of water transportation by ±10%, oil price by ±1%, unemployed truck cost by ±5%, and the cost of road transportation by ±5%, the result in a negative Net Present Value (NPV), both

adjusted by increase or decrease, making the alternative inappropriate as an investment. In addition, alternative II had the maximum overall activity cost of 17,514 monetary units and because it could not transport oil to its destination for a specific amount of time, it was deemed unsuitable for investment during the annual shutdown period.

3) Alternative III: The main oil distribution center with C and D distribution center

According to a sensitivity analysis of the factors expected to affect the decision found that adjusted: the cost of water transportation by +10%, oil price by +1%, unemployed truck cost by +5%, and the cost of road transportation by +5%, the result in a negative Net Present Value (NPV), making the alternative inappropriate as an investment. On the other hand, it makes the NPV value positive, making alternative III suitable for investment. Alternative III had the minimum overall activity cost of 15,224 monetary units and it was found that alternative III had a lower cost than alternative II. Furthermore, alternative III can be transport oil to its destination early.

IV. Conclusion

According to a simulation of each oil distribution center's operational and economic analysis, alternative I should be selected under the normal circumstance, non-urgent, and the daily demand volume is under 2,500,000 liters to be the most effective. Alternative III should be selected during the annual shutdown of gas drilling sites and pipelines to be the most suitable alternative. It can be transported ahead of time and is efficient both quantitative and qualitatively. When sensitivity analysis is discovered that alternative III, which the same result: if factors affect how the outcome changed an increased outcome, it will not make investment selections. On the other hand, if factors affect how the outcome changes in a decrease, it will make investment selections.

Additionally, there won't be much of an effect on environmental issues if alternative I or alternative III are selected. The impact of environmental of alternative 1 is not considered in this model because it is already being used resources and alternative III is the shortest-distance conveyance.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

C. P. and P. P. conducted the research; N. S. and P. J. analyzed the data; A. S., C. I., and A. J. wrote the paper; all authors had approved the final version.

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