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The Asian Journal of Technology Management Vol. 3 No. 1 (2010) 31-43

Improving Inventory Management and Supply Chain of Diesel Fuel in Pertamina 5 Main Depots

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ABSTRACT

Planning Operation subdivision at PT Pertamina has to generate supply decisions including main depot to supply, supply point and transportation mode. However, the variability in planning a supply schedule renders the process of determining a supply decision as ineffective. The last assessment on uncertainties was done at 2006 and has not been considered during decision making process. On the other hand, the result of this research indicates that the uncertainty level is too high to be ignored and the poor information exchange between the regional offices and the head office decreases the Planning Operation's ability to create plans that covers the company condition. This paper proposes an appropriate safety stock to withstand the uncertainties and a supply scheduling process that also considers uncertainties by using Monte-Carlo Simulation with random numbers to simulate the events in the upcoming period.

Key words: inventory management, distribution planning, managing uncertainties, monte-carlo simulation

Introduction

Pertamina state owned company is responsible to provide fuel for entire Indonesia. Especially Supply and Distribution division is established to manage fuel distribution problems. Using hub-spoke logic, many main depots keeping fuel stock spread across Indonesia. Those main depots distributes fuel products directly to selling point or indirectly to remote areas. Under the Supply and Distribution division, Planning Operation subdivision plan distribution shecdule with critical level constraint in every depot. Critical level is minimum inventory level and equal one-day demand without replenishment. Cargo vessels which depends greatly on the weather and sea condition are main transportation mode for cargo vessel's operation, main depot will have shortage risk.Thus distribution shecdule have to minimize this risk. In 2009, 52 times depots occurrences and 22 of them occurred because of SOLAR. The condition is already improved from the year 2006 which has 832 occurrences of critical depots.

The last assessment regarding the inventory model is done in 2006 and changes in the uncertainties from both the supply side and demand side may have changed. Therefore, the safety inventory allocation need to be reassessed to determine whether it is not enough, enough or too excessive given the current conditions. The condition is worsened by the team's distribution planning process which depended to the senior employees without a clear guideline in terms of

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standard decision process in creating the supply decisions.

Therefore, the supply decisions take a long time to be made. As a result, whenever a change happens in the realization of the distribution plan, the team will have to redo the process from the beginning to figure out a new plan to retaliate to the condition and then re-communicate the new plan to related divisions. This continuous routine made the team acknowledges that they often abandon the term *optimal* as long as the conditions that time can be met. From the explanation above, the problem that this paper attempts to solve is the slow decision making process and critical depot occurrences during 2009 by proposing a new level of safety stock as the result of uncertainty assessment and a new simulation that also considers uncertainty as one of the considerations in creating supply decision for SOLAR as the main contributor to Critical Depot occurrences.

> *An effective Supply Chain Management must take into account coordinating all the different pieces of this chain as quickly as possible without losing any of the quality or customer satisfaction, while still keeping the costs down*. (Rockford Consulting, 1999)

The main problems that this research will try to answer are as follows:

1. Does the identified problem reflected in the company's performance as a whole?
2. Is there a significant change in the uncertainty after the last assessment regarding uncertainties in 2006?
3. What are the appropriate inventory policies (Safety Inventory and ROP) for each of the 5 main depots considering the uncertainties?
4. How the current and proposed inventory policy handles the uncertainties?
5. Are there any specific patterns of supply or priorities that can be used as guideline in determining the destination depots?

Literature Review

Pertamina Company Profile

Pertamina's scope of business including upstream and downstream sectors. The upstream sector covers fossil fuel exploration and production in domestic and overseas region. The downstream sector includes processing, marketing, trading and shipping. Pertamina's commodities vary from petroleum product and non-petroleum product. Pertamina has two mission: create profit from energy industry conducting good corporate governance and contribute to Indonesian sociecty's welfare.

Inventory

Inventory is a list of available goods and materials to support business operation. Inventory management is primarily about specifying the size and placement of available goods. Inventory management is required at different locations within a facility or within multiple locations of a supply network to protect the regular and planned course of production against the random disturbance of running out of materials or goods. Inventory management also concerns about lead time, carrying costs, asset management, inventory forecasting, inventory valuation, inventory visibility, future inventory price, physical inventory, physical storage, quality management, replenishment, returned goods, obsolete goods and demand forecasting. (Wikipedia Inventory Management).

Inventory model is a mathematical equation to detemine the optimum inventory level in terms of safety stock and replenishment policies.In general there are two replenishment policies: continuous and periodic. (Wikipedia Inventory Model)

Replenishment of stock occurs when the level of inventory drops down to zero. In view of instantaneous replenishment of stock the level of inventory jumps to the original level from zero level. In real situation, it is impossible to get zero lead time. There is always a time lag between date of placing an order and the date on receiving materials. Thus the reorder point must be higher than zero, If the firm places the order when the inventory reaches the reorder point, the ordered goods will arrive before the firm runs out of goods to sell. Efficient replenishment method will reduce lead time. Reorder point need to consinder consumption rate during lead time and safety stock. Safety stock is the minimum level of inventory to avoid shortages due to fluctuation in demand. Safety stock calculation involves a trade-off between shortages risk and carryng cost.

$$Reorder\ Point = (Consumption\ Rate\ \times Lead\ Time) + Safety\ Stock$$

Size of safety stock can dramatically affect business operation and financial. Excessive safety stock lead to high carrying costs. Stored for a long time, inventory will become obsolete, spoiled or broken in the warehouse. Unadequate safety stock lead to lost sales and a higher customer turnover. Optimum safety stock is required. (Wikipedia Safety Stock)

Service Level (Inventory Management)

Service level is used in supply chain management and in inventory management to measure the performance of inventory systems. Under stochastic conditions it is unavoidable that in some periods the inventory on hand is not sufficient to deliver the complete demand and, as a consequence, that part of the demand is filled only after an inventory-related waiting time. In an inventory optimization model, the amount of late deliveries can be influenced through the introduction of penalty costs (backorder costs) into the objective function. In addition to the optimal parameters of the inventory policy under consideration, from the optimal solution of such a model also the optimal size of backorders can be derived.

Unfortunately, this optimization approach requires that the planner know the optimal value of the backorder costs. As these costs are difficult to quantify in practice, the logistical performance of an inventory node in a supply network is measured with the help of technical performance measures. The target values of these measures are set by the decision maker.

Monte Carlo Simulation

Monte Carlo methods are a class of computational algorithms that rely on repeated random sampling to compute their results. Monte Carlo methods are often used in simulating physical and mathematical systems. Because of repeated computation of random numbers, computer is the most suitable to carry out monte carlo simulation.

Monte carlo methods give better solution than deterministic algorithm. Monte Carlo methods are useful for modeling phenomena with significant uncertainty in inputs, such as the calculation of risk in business. It is a widely successful method in risk analysis when compared with alternative methods or human intuition.

There is no single Monte Carlo method, but the term describes a large and widely-used class of approaches. These approaches tend to follow a particular pattern:

1. Define a domain of possible inputs.
2. Generate inputs randomly from the domain using a certain specified probability distribution.
3. Perform a deterministic computation using the inputs.
4. Aggregate the results of the individual computations into the final result.

When a system contains *chance* elements in their behavior, the Monte-Carlo method of simulation can be applied to simulate sytem. The basis of Monte Carlo simulation is experimentation on chance (or probabiliity) elements by mean of random sampling.

The technique breaks down into five simple steps:

1. Setting up a probability distribution for important variables
2. Building a cumulative probability distribution for each variable
3. Establishing an interval of random numbers for each variable
4. Generating random numbers
5. Actually simulating a series of trials

(Heizer & Reinder, 2008)

Methodology

The systemic step of research will start from initial research, problem identification, theoretical foundation, research, data gathering, processing data and analysis, solution, and conclusion and recommendation.

Data Gathering

This step is the gathering of information that is related to this research. The writer uses divides the data into two categories the primary and secondary data.
Primary data is data that were obtained via direct observations and interviews with people who are directly involved in the process in which the research is taking place. In this case, the writer gathered the primary data in the Planning Operation Subdivision of PT PERTAMINA PERSERO main office in Jl. Medan Merdeka Timur No. 1A - Jakarta ***Pusat.***

Secondary data are the data that is already owned by the company as the company's database. These data range from the company's organization structure to the strategy that the company is using and historical data regarding the past performances of the company.

There are two forms of data, the qualitative data and quantitative data. The qualitative data are the results of observations and interviews while the quantitative data are mostly obtained from the company's database. The qualitative data used in this research are the knowledge regarding the current process of work inside the Planning Operation Subdivision including the process of making supply schedules, priorities of a supply decision, and other information that are not officially recorded in the company's database. The quantitative data used in this research are the historical data regarding the supply occurrences of SOLAR to five main depots in Java and Bali, the inventory model done in 2006, Shipping routes, supply capacity, supply vessel capacity, depot capacity, and many other data that may support the research that are recorded in the company's database.

Data Processing and Analysis

First analysis step after all the data needed are gathered is to analyze whether there are gaps between the KPI and actual performance of the company in order to comprehend the magnitude and root cause of the problem. Then, next is to determine a possible solution to be recommended regarding the company's condition. The last step is to simulate both the company's current policy and the proposed one in order to compare the results.

Data Gathering and Analysis

We only analyze five depots storing diesel fuel, ans those depots are considered as the busiest depot. Particulary, depot located near industrial area has the highest number of activity. Those five depots are as follows:

1. IJG (Jakarta Group which consist of Plumpang and Tanjung Priok)
2. Pengapon (Semarang)
3. ISG (Surabaya)
4. Tanjung Gerem
5. Manggis

In Java and Bali distribution region, there are three supply points: Balongan, Tuban and Cilacap. Each supply points have different capacities and supply the nearest depots. The distribution routes of five depots are described in the picture below.

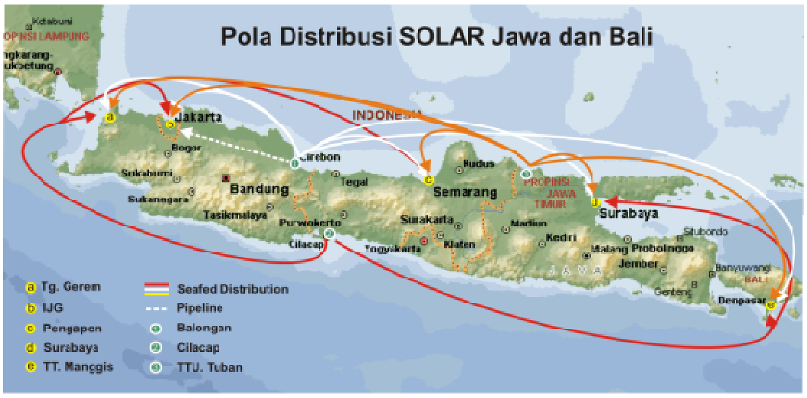

Figure 1. Diesel Fuel Map Route for Java and Bali distribution region

Below here are a figure describing the series of processes related with the scope of work in the Planning Operation subdivision of Pertamina main office.

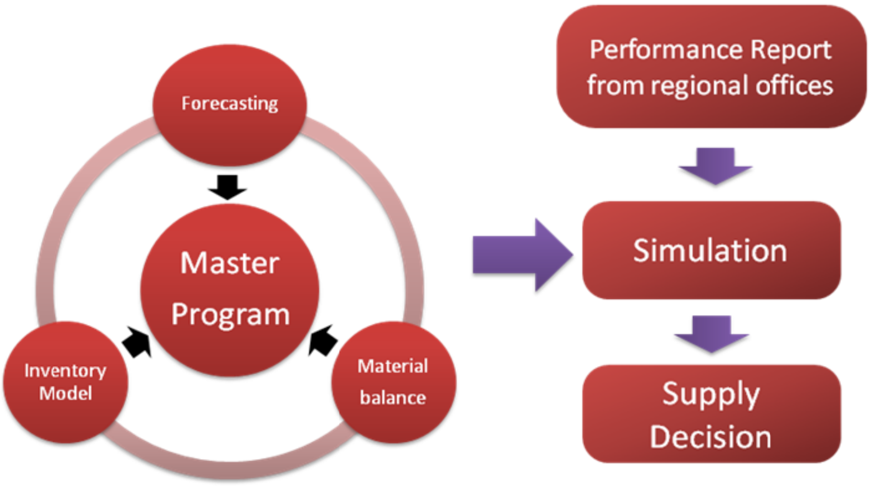

Figure 2. Processess in Supply and Distribution Team

In the last week of each month, Supply and Distribution team, Supply & Decision, Renekon, Tanker Operations collaboratively create a next month master program or distribution planning. The construction of this master program consider the demand of each depot, the production capacity of refineries, arrival of imported diesel fuel and ship availability. Head office is always monitoring depots and supply points regarding the condition of unit. This monitored data is crucial for distribution planning. The regional office make a report about its performance report, so head office can create weekly schedules to supply the depots. If it necessary, head office create revisions on unfullfilled performance report.

Performance Gaps

From the data, Tabel 1, Planning Operation subdivision was unsuccesfully to reach target during 2009. Next, we discuss why they fail to reach four KPI in greater detail.

Table 1. Key Performance Indicator and actual performance gap

Key Performance Indicator	Target 2009	Actual 2009	Description
Critical Depots (Average of occurrence/month)	2	4,33 (52 occurrences at 2009)	Below target
Master Program Compliance (%)	90	81,38	Below target
Timely Performance report (Rating 1 – 4)	4	2,8	Below target
Performance management Accuracy (%)	100	87	Below Target

Critical depot has inventory level below one day consumption rate and no reserve inventory. Critical depot is prioritized for replenishment. Even no vessels are available to replenish, container trucks are used from other depots. If diesel fuel was out of stock, economic activities depend to depot supply are disturbed. This economic activity disturbance is very complex to measure.

Other stockout risk are lost sales and contract penalty which is equal to two time of agreed price. The diesel fuel is consumed both by retail customers and industry. If Pertamina cannot fulfill industry demand for diesel fuel, then Pertamina have to pay at twice of the agreed price which is written in contract. If Pertamina is unable to supply diesel fuel to retail sector, it disturb economic activities such as: fishery and distribution trucks. This will affect the economy of the entire region. The critical depot occurs because allotted inventory is unable to dampen fluctuation of demand.

Since 2006 Planning Operation never take a counter measure to deal with fluctuation of demand problem. Planning Operation solve distribution problem with linear programming approach which is regarded inappropriate to deal with uncertainty. Planning Operation create master program based on daily performance report. Therefore, the timeliness of daily report is crucial but regional offices often delivers the report very late. This report lateness push Planning Operation to revise master program with incomplete information. From interview investigation, the report is prepared at the morning when it should have already sent. Checking depot inventory level is time consuming so this report finished at noon. It is obvioud why Timely Performance Report is below target.

Performance Management Accuracy measures the ability of the company to create plans that reflects the entire company's condition. This is measured by a plan's degree of executability which goes for the Master Program and the daily supply decisions. This KPI did not reach the target because the Planning Operation subdivision do not have enough information in generating a plan. Regional offices often does not provide crucial information like a vessel condition or purchase contract status in advance. Regional office give this crucial information when head office ask them.

Master Program Compliance measures the extent of the Master Program's accuracy in one month. Put it simple, we measure how many times master program is revised. More revision means more inaccurate master program, in contrast less revision means more accurate master program. Planning Operation Subdivision do not consider uncertainty as one of the factors that influences a decision. As demand deviation occured, Planning Operation create master program revision. This condition is worsened by the poor performance report timeliness and the availability of current condition.

Root Cause Analysis

We need to find out the root causes why below target KPI problems arise. Root causes summary is written on the Table 2.

Table 2. Problems, Root Cause and Solution

Problems	Reasons	Root Cause	Solution
Critical Depot	The amount of inventory allocated were not able to withstand the uncertainties The information regarding the depot inventory did not reach the Planning Operation Subdivision at the time it is needed	There are no study on uncertainties faced by the company since 2006 Poor performance report timeliness	Create new assessments regarding the uncertainties faced by the company using historical data Improve the timeliness of performance report updating by moving the checking process at regional offices to night time
Master Program Compliance	The original plan of distribution is often revised to comply with the conditions related with unanticipated deviations from supply and demand. The planning process relies on the senior employees comprehension without clear guidelines	Uncertainty is not a factor that affects the decision making process. There are no clear guidelines on creating a distribution plan. Purchase order status is not communicated	Create a clear process guideline on deciding a supply shipment which also considers the uncertainty factor in the implementation of the plan
Timely Performance report	The checking process in the regions are often done in the morning while it should have been done at night	Lack of performance control in the regional offices in terms of daily routine output timeliness	Timely Performance report
Performance Management Accuracy	The planning that is done by the Planning Operations Subdivision sometime fails to cover some details in distribution	The daily report from the regions did not include crucial detailed information such as vessel condition that will affect the implementation of distribution plan and thus become one reason of the decrease in master program compliance and critical depot	Performance Management Accuracy

There are indications of a few similar root causes for problems which are as follows:

a) Uncertainty factor omission in making decision of supply
b) Incomplete and late report from regional offices
c) Poor communication among divisions
d) No guidelines in making a decision of supply

The calculation of supply uncertainties involves calculating the average lead time and its standard deviation. The lead time consist vessel's loading time and voyage time needed to reach destination depots. The data used in this calculation is compiled from the three supply point at Java Island during 2009. Lead time do not consist discharge time because the ship's cargo anchored in depot already considered as depot's inventory.

Table 3. Supply Lead Time Uncertainty Calculation Summary

Depot	Average Lead Time (Loading & Voyage in days)	σL	Coefficient Variation (Average lead time/ σL)
Tj. Gerem	4	1.8	0.45
IJG	4	1.6	0.4
Pengapon	4	1.6	0.4
Surabaya	4	1.3	0.33
TT. Manggis	4	1.4	0.35

Based on the calculation results above, the coefficient variation of supply to all the depots are more than 0.1 which indicates that the supply lead time is probabilistic so that it should not be treated as a static number both in further calculation nor in distribution planning. Unfortunately, due to the company's discretion policy, the information regarding the actual throughput or demand of the depots cannot be released to a third party so that the writer does not have the access to the actual demand needed to calculate the demand uncertainty moreover to analyze the changes from the last assessment. Hence, the demand data used in this research is still considered static at the DOT level for April and thus this research is limited in generating an appropriate safety inventory level, reorder point and an optimum distribution model that fulfills the daily demand (DOT) in April and contracted Industrial Demand.

The DOT are as follows: Tg. Gerem 1278 KL, Jakarta 7989 KL, Semarang 1670 KL, Surabaya 4179 KL, TT. Manggis 2905 KL. The level of Safety Stock and Reorder Point is calculated using the formula as explained below. The calculation results of this section will be used as comparison to the result from the inventory model 2006 and serves as a basis in creating the distribution simulation later on.

$$\textbf{Safety Stock} = \mathbf{Z} \times \sqrt{(\mathbf{D}^2 \times \sigma_L^2) + (\mathbf{L} \times \sigma_D^2)}$$
$$\textbf{ROP} = (\mathbf{D} \times \mathbf{L}) + \textbf{Safety Stock}$$

Note:

Z	=	Probability of desired service level
D	=	Demand (DOT)
σ_L	=	Standard deviation of lead time
L	=	Average supply lead time
σ_D	=	Standard deviation of demand

Table 4. Safety Stock and Reorder Point

Target Service Level	98%
Z	2,053748911

Depot	DOT (KL)*	Average Lead Time**	σL	Safety Stock (KL)	CD	ROP (KL)	ROP (Days)
Tg. Gerem	1100	4	1,8	4.066	4	8.466	8
IJG	7200	4	1,6	23.659	3	52.459	7
Semarang	1621	4	1,6	5.327	3	11.811	7
Surabaya	4243	4	1,3	11.328	3	28.300	7
TT. Manggis	1623	4	1,4	4.667	3	11.159	7

* DOT in April ** From the supply uncertainty calculation

The calculation results indicates that the shipment must be planned from a week before the inventory in the main depots reaches zero if the team wants to avoid the risk of critical depot. The result of the calculation also indicates that the five days barrier currently used by the team is too short so that if a deviation occurs, there is a chance that the critical depot will happen.

Table 5. Comparison with Inventory Model 2006

Depot	Safety Stock (KL)	Safety Stock (2006)*	Releasable Inventory (KL)	Additional Inventory Needed (KL)	Holding Cost (Rp/L perday)	Holding Cost Liberated*	Holding Cost Needed*
Tg. Gerem	4.066	6.041	1.975		Rp19	Rp1.099.445	
IJG	23.659	21.206		2.453	Rp9		Rp667.512
Semarang	5.327	4.492		835	Rp13		Rp333.758
Surabaya	11.328	11.756	428		Rp9	Rp112.920	
TT. Manggis	4.667	13.682	9.015		Rp10	Rp2.747.916	

* From the consolidated inventory data in 2006

Proposed Solution

Based on (Rowe, Understanding Uncertainty, 2006) and (Rowe, Managing Uncertainty, 2005), Rowe suggest to analyze and manage uncertainties. Rowe proposed several means to address directly uncertainties. Rowe suggestion is implemented to overcome uncertainties in critical depot. The writer proposes to treat the destination depots as independent entities with different characteristics The proposed safety stock of diesel fuel for each depot are 4,066 KL for Tg. Gerem, 23,659 KL for Jakarta, 5,327 KL for Semarang, 11,328 KL for Surabaya and 4,667 KL for TT. Manggis. Appropriate Reorder Point level for this quarter are 8,466 KL (8 days of DOT) for Tg. Gerem, 52,459 KL (7 days of DOT) for Jakarta, 11,811 KL (7 days of DOT) for Semarang, 28,300 KL (7 days of DOT) for Surabaya, and 11,159 KL (7 days of DOT) for TT. Manggis. Based on interview results, regional offices deliver inventory report late because they checked depot inventory in the morning time. Therefore, the checking process should be done at afternoon so that report can be delivered early for next morning. The writer proposes that the daily performance report delivered by the regional offices must cover inventory level, anchored vessels, demand, purchase contract, vessel's condition (capability to set sail) and status of purchase contracts. This proposal will increase Performance Management Accuracy.

Uncertainty plays a significant role and affects the planning decision. Uncertainty factors must be simulated in master program creation. It is anappropriate to solve this problem using linear programming. The writer proposes a flowchart below as guideline in deciding a supply schedule. Flowchart below are accomodating plan revision when it is needed. Master program simulation can forecast critical depot. This simulation result are informed to the nearest depot in critical depot region so that nearest depot can prepare reserve supply for critical depot. The purpose for creating this simulation is to further discuss about the proposed policy by comparing it with the current policies of Planning Operation Subdivision in creating a supply decision and compare the result between the two as the answer for the fourth research question.

The interview results stated that the main objective of PT PERTAMINA PERSERO distribution is to fulfill the demands of the depots. The priority of creating a supply decision is to avoid the possibility of critical depots even if it incurs more costs. This priority will be the basis of deciding which is better to keep using the current policy or to use the writer's proposed policy.

The problems faced by the Supply and Distribution team in the day to day operations are too complicated to be captured entirely. Therefore, limitations are made in the creation of this distribution model. This distribution model will only capture the distribution process around Java and Bali from three supply points located in Java Island using four available vessels. The capacity of supply point's data used in this model is the average of shipment the supply points received or produced for each month and it is assumed that it is available at the beginning of the period. In addition, the four available vessels are assumed to be standing by at the designated supply points. MR-1 at Balongan, MR-2 at Tuban, MR-3 and GP at Cilacap. Once a vessel has finished discharging its cargo at a destination depot, it is assumed that the vessel immediately go back to the nearest supply point unless planned otherwise. Below here are the capacity and costs related with utilizing the vessels.

Table 6. Vessel Capacity and Costs

Vessel	Capacity (KL)	Transportation Cost **)
MR – 1	34.000	IDR 130/KL
MR – 2	34.000	IDR 130/KL
MR – 3	34.000	IDR 130/KL
GP – 4	17.000	IDR 150/KL
Pipeline	18.000*)	IDR 100/KL

*) Available once every three days
**) Based on the average of the costs incurred for each shipment in Region II and III the cost details remain as the company's confidential information.

The supply lead time in this problem has a probabilistic nature so that the problem could not be treated as a linear problem because the lead time has the capability to change over time. This distribution model will be created by using Monte-Carlo Simulation with random numbers that reflects the variability of the supply. There are a total of three random numbers that reflects the variability of Vessel Loading Time, Voyage Time and Unloading Time. These random numbers are made according to the occurrences in supply during 2009 and generated using the table of random numbers. In this simulation, if the vessel is on standby when a supply is planned then the vessel can begin loading immediately. After a random number is generated and it defines 2 days as loading time then the vessel can depart at the end of the next day.

The same logic goes with the unloading time, after a random number is generated and it defines 1 day as unloading time then the vessel will finish unloading its cargo by the end of the day and departs immediately. As for the voyage time, 1 day of voyage time means that the vessel will arrive at the destination at the next day. This simulation is done twice using the current policy regarding the decision of supply and the proposed policy to compare and analyze in order to improve the condition.

The parameters of the supply decision are as follows:

a. Capacity of the Supply Points
b. Capacity of the destination depot's tank
c. Capacity of the supply vessels
d. Vessel location

Limited by the parameters above, the decision variables in deciding a supply schedule are as follows:

a. Which vessel to send? (in the case of Jakarta Pipeline is one of the choice)
b. Where the vessels should go? One destination or use ROB (Remain on Board)?

The proposed policy governs over the performance report timeliness and completeness, and a standardized decision process. However, in this simulation the author emphasize on simulating the core of distribution planning which are the reorder point and the transportation mode. Table 7 presents the difference between policies.

Table 7. Difference Between Policies in Simulation

Current Policy	Proposed Policy
Use 5 days barrier as Reorder Point for every depot	Use different reorder points and treats each depot independently
Use any available vessel	Use distance priority to schedule supply

Table 8. Distances from Supply Points to Destination Depots (Ranked)

	Tg. Gerem	Jakarta	Semarang	Surabaya	TT. Manggis
Cilacap	1	2	3	4	2
Balongan	3	1	2	4	5
Tuban	5	4	2	1	3

From the table above, the decision applies in a sequential order based on the ranks. For example, if Jakarta needs to be supplied then the supply has to come from Balongan, if Balongan is unable to supply because there is no supply vessel available then Cilacap is the second choice and so forth. This is created to minimize the bunker cost (Fuel Cost) of the vessel that delivers the inventory. From the comparison Table 9, the proposed policy outperform the current policy in vessel utilization, critical depot and total cost.The proposed policy incurs more cost in transportation and carring cost due to higher reorder point but it avoid lost sales or critical depot. It is recommended that Pertamina use proposed policy.

Table 9. Comparison of simulation results

Categories	Number of ship-ments	Critical Depot (occurr-ence)	Demur-rage (days)	Ship Anchor-ed (idle days)	Total Holding Cost (IDR 1000s)	Total Transport-ation Cost (IDR 1000s)	Total Cost
Current Policy	15	2	0	35	40,237,820	64,150,000	183,998,820 *
Proposed Policy	20	0	2	33	51,498,940	68,270,000	119,768,940

*Lost sales and Purchase Contract fine of twice the contract price is included

Conclusion and Recommendation

The conclusion that can be taken from the Initial Research. Literature Study, and Data Gathering and Analysis is that Critical Depot occured because of the change in uncertainties and the poor performance report by the regional offices that affects the decision making process at Planning Operation Subdivision. The answer to five research questions are as follows:

Company Performance

Critical depot, Master Program Compliance, Performance Report Timeliness and Performance Management Accuracy are still below the target. Not only Planning Operation but also regional offices contribute to below target KPI. The Poor Performance Report Timeliness created the domino effect into decreasing the Performance Management Accuracy.

Eventually Master Program Compliance and Critical Depot got below target. As frequency of critical depot exceed, almost twice target tolerance, Pertamina was unable to keep the mission commitment of supply. Pertamina had mission to ensure the welfare of the society.

Uncertainty and Safety Stock

Analyzing the uncertainty level, the data indicates that the safety stock level can be changed at every depot. Each depot has its own DOT and ROP of each depot is also changed. The proposed safety stock of diesel fuel for each depot are 4,066 KL for Tg. Gerem, 23,659 KL for Jakarta, 5,327 KL for Semarang, 11,328 KL for Surabaya and 4,667 KL for TT. Manggis. Appropriate Reorder Point level for this quarter are 8,466 KL (8 days of DOT) for Tg. Gerem, 52,459 KL (7 days of DOT) for Jakarta, 11,811 KL (7 days of DOT) for Semarang, 28,300 KL (7 days of DOT) for Surabaya, and 11,159 KL (7 days of DOT) for TT. Manggis. By changing the safety stock level into calculated reorder point above, Pertamina can reduce carrying cost up to 2,9 Billion rupiah. Current five day safety stock policies is proven to be unable to dampen fluctuation of demand.

Current and Proposed Policies Simulation

The company's current policy is to treat the depots as the same and make the reorder point for every depot flat at five days of demand and ignores the variabilities that may happen during the implementation of supply plan. The writer proposes to treat the depots as independent entities which has their own characteristics and considers the uncertainty during decision making. By simulating the current policy and the proposed policy using Monte-Carlo Simulation with Random Number, the result indicates that the current policy generates two critical depots while the proposed policy did not generate any.

The proposed policy's holding and transportation costs tend to be more expensive because there are more shipments sent during the period due to the higher ROP. However, this trade off is deemed necessary due to the costs and effect of one critical depot may cause. In addition, by using the Monte Carlo Simulation, the points where there are possibilities for critical depot to happen can be identified beforehand. Therefore, appropriate countermeasure can be taken to prevent it either by informing the nearby installations to be ready provide backup via landline distribution or by building stock resilience earlier.

The writer recommends the use of the new reorder point instead of the five days barrier for Jakarta, Tg. Gerem, Semarang, Surabaya and Manggis. The five days barrier that is currently used by the subdivision is too risky to be used to avoid critical depot as proven in the simulation. In addition, the use of Monte Carlo Simulation is highly recommended to simulate the events in one month of operations after a Master Program is created to identify possibilities of critical depots and generate vessel routes to ease the daily process which to come.The writer recommends Planning Operation Subdivision to emphasize this important factor to the regional offices so that the regional offices can provide a better performance report at the right time. The information regarding vessel conditions and purchase contract with industry are the two type of information that are often not communicated and result in the decrease of Master Program Compliance and Performance Management Accuracy. One way to improve the performance report timeliness is to move the inventory check schedule to night time when the daily operations of the depot is finished.

For more accurate model, here are some suggestions for future research:

a) Add damage probability of vessel.
b) Investigate possible communication line and technology that enhance information exchange between headqueater and main depot.
c) Facilitates more distribution area for example: Sumatra, Kalimantan, Sulawesi, Maluku, Nusa Tenggara and Papua.
d) Study about centralization and decentralization authority that give substantial improvement in diesel fuel supply chain.

References

Chopra, S., & Meindl, P. (2007). *Supply Chain Management Strategy. Planning & Operation 3rd edition*. New Jersey: Pearson Education Inc.

Growth of Fuel Consumption. (t.thn.). Dipetik February 2010, dari Untukku: http://www.untukku.com/berita-untukku/berita-otomotif/nopol-mobil-jakarta-jadi-tiga-huruf-untukku.html

Heizer, J., & Reinder, B. (2008). *Operations Management Ninth Edition*. New Jersey: Pearson Education Inc.

Number of Cars Growth in Jakarta. (t.thn.). Dipetik March 2010, dari Pertamina: http://fajar.site88.net/pemasaran.php

Pertamina Company Profile. (t.thn.). Dipetik February 2010, dari PT Pertamina Persero: http://www.pertamina.com

Pertamina Market Share. (2007, October 6). Dipetik February 2010, dari Waspada: http://www.waspada.co.id/index2.php?option=com_content&do_pdf=1&id=5088

Rockford Consulting. (1999). *Effective Supply Chain*. Dipetik March 2010, dari Rockford Consulting: http://rockfordconsulting.com/

Rowe, W. D. (2005). *Managing Uncertainty*. Dipetik July 2010, dari Rowe Research & Engineering Associates, Inc: http://www.rowe-res.com/Managing%20Uncertainty.pdf

Rowe, W. D. (2006). *Understanding Uncertainty. Dipetik* July 2010, dari Rowe Research & Engineering Associates, Inc: http://www.rowe-res.com/Understandin%20Uncertainty.pdf

Wikipedia Inventory. (t.thn.). Dipetik March 2010, dari Wikipedia: http://www.en.wikipedia.org/wiki/inventory

Wikipedia Inventory Management. (t.thn.). Dipetik March 2010, dari Wikipedia: http://en.wikipedia.org/wiki/Service_level#Service_level_.28inventory_management.29

Wikipedia Inventory Model. (t.thn.). Dipetik March 2010, dari Wikipedia: http://en.wikipedia.org/wiki/Inventory_model

Wikipedia Monte Carlo Simulation. (t.thn.). Dipetik March 2010, dari Wikipedia: http://en.wikipedia.org/wiki/Monte_carlo_simulation

Wikipedia Safety Stock. (t.thn.). Dipetik March 2010, dari Wikipedia: http://www.en.wikipedia.org/wiki/safety_stock