OPTIMIZATION OF WORK-IN-PROCESS INVENTORY THROUGH FILLING ACTIVITY IN CHEVRON PACIFIC INDONESIA COMPANY

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By

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DEDICATION PAGE

Alhamdulillah, i dedicated this thesis to:

My lovely Parents and Sisters *who always fill me with a never ending love, care, support and pray*.

My Soulmate, *for his patients.*

My Bestfriends *who always accompany me and my days in joyful and sadness condition with their support, advices and love*.

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Author

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ABSTRACT

Chevron Pacific Indonesia Company (CPI) is one example of industry that implies Vendor Managed Inventory (VMI) technique where the production systems controlling the inventory. In this company, Filling and Loading appears as an operational activity toward Work-in-Process inventory system. Filling deposit the crude oil which came from the oil production field into the storage tank, until it is being shipped through the loading. The loading will follow the 5 days shipping schedule that already being determined before by in charged parties. This research presents an algorithm model under VMI concept to find the best filling strategy to avoid shipment delay. The current condition in the company shows that delay and inconsistency of shipping schedule occurs in some conditions, due to insufficient amount in their storage tank. By using the algorithm model proposed by this research, it will provide the best filling strategy which defines when, where and how much to locate the crude properly so no more shipment delays .

KEYWORDS*:* Vendor Managed Inventory, Filling and loading activity, A lgorithm

Thesis Supervisor: Ir. R. Chairul Saleh, M.Sc., Ph.D

CHAPTER I

INTRODUCTION

1.1 Background

Activities in Oil Company like Chevron Pacific Indonesia (CPI) affect the resources and assets of the company. In current condition, the activities in the company are very complex. So it needs an improvement for the performance.

This research explores the application of Vendor-Managed Inventory (VMI) to optimize Work-in-process (WIP) inventory in replenishment activity through Filling. Optimize the filling system can be perform ed by deciding properly when, how much and where to locate the crude oil.

In reality, the filling applied in the company has caused some delay in several conditions and an inconsistency in fulfill the shipping schedule. The problem occurs because of several reasons. One of the reasons is because of the improper filling decision . The filling activity said to be proper if it can properly determined when, how much and where to locate the crude oil so it will provides the crude oil amount to be loaded which align with the contract with costumers. The improper filling decision is caused by the human habit and the lack of regulation. So, the lack of regulation caused the employee to use their assumptions and experiences in crea ting a filling schedule . And these techniques furthermore become a habit. The problem indicated when the company has to postponed fulfill s the customer demand because of the insufficient amount in the company's storage tank. For example, there was a condition where all tanks cannot provide the crude oil for costumer unless it is being filled before. So, the costumer must wait until the tank had finished being filled and ready to be loaded. Customer waiting will result in inconsistency of shipping schedule. Because the loading starting time is delayed, the finishing time will delayed as well.

The research objective is to scope down the applic ation of VMI in replenishment activities by developing an algorithm to find the best filling strategy to avoid delay shipment. The best filling strategy will define the proper amount of crude oil and storage tank for filling so the loading can meet the contract or shipping schedule as planned before. The algorithm is being developed using the fundamental concept of VMI, which is the integration of information. So, it is how the integration of the information in form of algorithm, can creates a good Filling strategy for improving the loading performance in CPI. When the algorithm is being applied, it will act as the regulation which finally can eliminates the use of assumptions and experiences in determine how much and where to locate the crude oil.

1.2 Problem Statement

This research will conduct to find the proper strategy for replenishment activity in CPI to avoid delay. The problem statement of the research is:

1) How much is the right amount of crude oil to be filled in order to timely fulfill costumer's order?
2) What is the correct Tank selected to be filled by crude oil in order to timely fulfill costumer's order?
3) When to fill the crude oil into the chosen tank in order to timely fulfill costumer's order?

1.3 Objectives of the research

This research will be done by considering the phenomena that appears in this day businesses environment. Companies that can optimally manage their resources and constrain will be able to become the winner in the tight market competition. The objective of this research is to find the best filling strategy using the algorithm which integrating the information under VMI concept. For further, the objective of this research is stated below:

1. To find the right amount of crude oil to be filled in order to timely fulfill costum er's order under VMI concept.
2. To find the correct Tank selected to be filled by crude oil in order to timely fulfill costumer's order under VMI concept.
3. To find when to fill the crude oil into the chosen tank in order to timely fulfill costumer's order under VMI concept.

1.4 Significance

After this research was being done, it will give significance benefit s as stated below:

1. Find the right amount of crude oil to be filled in order to timely fulfill costumer's order under VMI concept.
2. Find the correct Tank selected to be filled by crude oil in order to timely fulfill costumer's order under VMI concept.
3. Find when to fill the crude oil into the chosen tank in order to timely fulfill costumer's order under VMI concept.

1.5 Scope of research

The scope of the research will be stated as follows:

1) The research is carried out at PT. Chevron Pacific Indonesia in Dumai
2) Research is carried out to optimize the crude oil replenishment system (filling system).
3) Tank and equipment support is counted as Ta nk.
4) The research object is focusing only in 1 product, which is Sumatra light crude oil (SLC).
5) Research is solving the case study which based on actual problem defined by the company.
6) Research excluding cost calculation due to restricted data defined by company.
7) Research is conducted in limited time -frame of 6 July 2007 – 10 July 2007 due to the case study defined by company.

1.6 Definition of term

This research explores the application of Vendor-Managed Inventory (VMI) to optimize Work-in-process (WIP) inventory in a form of replenishment activity. The production system representative act as vendor, received the information of replenishment requirement from inventory management representative that act as retailer. Replenishment term in PT. CPI is in form of filling activity which is filled the Crude Oil into chosen tank. Crude oil that being gathering from PT. CPI's production field is Work-in-Process inventory in filling and loading system.

Find the best filling strategy which determines when to fill the right amount into the right tank is an important action to ensure timely delivery of consumer order. But formulating an effective filling activity to ensure the crude oil availability for effective loading activity is not an easy task. Sometimes, if the amount of filling activity is wrong, it will affect loading activity which can result s in delay.

This is why the algorithm is being developed under VMI concept in order to optimize the replenishment activity of work -in-process inventory through filling activity in PT. CPI which indirectly will affect the loading activity to avoid delay.

1.7 Writing Systematic

To make the literature writing of this research study is easier, the writing systematic will be continuing as follows:

CHAPTER II LITERATURE REVIEW

This chapter will explore the basic theory that will be used for solving the problems.

CHAPTER III METHODOLOGY

This chapter dive an explanation about the source and matter of the research, tools and methods of research, data that will be analyses, and flow chart of reserach.

CHAPTER IV DATA COLLECTION AND CALCULATION

This chapter will explore the data collection from the research study and the data calculation using algorithm.

CHAPTER V DISCUSSION

This chapter will present the result of data calculation and discuss the result for producing a conclusion and reccomendation to the current condition.

CHAPTER VI CONCLUSION AND RECOMMENDATION

This chapter will consist about the summary of the reseach study that has been done. In addition, the suggestion for the company and for further research study is stated.

REFERRENCES

APPENDIX A Results of Filling Planning Algorithm

APPENDIX B Actual and Proposed Loading Consolidations

APPENDIX C Actual and Proposed Filling Consolidations

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Stevens (1989) explained that in a traditional supply chain, each "player" is responsible for his own inventory control and production or distribution ordering activities. According to De Toni *et.,al.,* (2005), all players in a traditional supply chain (such as retailers, distributors, manufacturers, must solve a fundamental problem which is "how much to order the production system to make (or the suppliers to supply) to enable a supply chain echelon to satisfy its customers' demands". Each player in th e supply chain basing his production orders or delivery orders solely on his sales to his customer, on his inventory levels and, sometimes, on WIP targets. This condition, makes each echelon in the supply chain only has information about what their custome rs want and not on what the end customer wants. This caused the suppliers hard to gain any insight into what their customers are ordering to cover their own Customer Service Level (CSL), the cost requirements and what the customers are ordering to satisfy immediate customer demand. Finally, this lack of visibility of real demand can and does cause a number of problems in a supply chain.

Facing the problem at the traditional supply chain, several theories propose to re-plan the supply chain. Kurnia *et.al.,(*1998) had explained the re-plan can be applied on the various area such as the area of promotions (efficient promotion), assortments (efficient assortment), development and introduction of new products (efficient new product introduction), and logistics that considers replenishment processes (efficient replenishment).

One concept to re-plan the supply chain is Vendor–Managed Inventory (VMI) concept. According to Archetti *et.al.,* (2005), VMI is a system in which the supplier is responsible to monitors and decides the inventory policy in each retailer. In other words, the supplier will acts as a central decision–maker for all inventory control problem. The application of a VMI policy with respect to the traditional retailer–managed inventory policies raised advantages which rely in a more efficient utilization of the resources. The supplier can reduce and optimize its level of inventories while in line with maintaining the same or even increase the level of service. On the other hand, there is a guarantee that no stock-out will occur in the retailers.

VMI has become more popular in the grocery sector in the last 15 years due to the success of retailers such as Wal-Mart. Disney *et.al.,*(2001) have implemented VMI in a supply chain using data available from a popular ERP system and a spreadsheet based decision support system. Moreover, VMI is not a new strategy. It was discussed by Magee (1958) in a presentation of a conceptual framework for designing a production control system. Magee (1958) explained that one player in the supply chain give information of what the maximum and minimum demands on the stock unit will be; the other has the responsibility of keeping the stock unit replenished but not overloaded as long as demand stays within the specified limits. Cottrill (1997) and Holmstrom (1998) analyze the application of VMI technique in apparel, food and grocery sector. But this technique is potential to be applied in other sector as well. De Toni *et.,al.,* (2005) had studied the VMI which applied in household electrical appliance sector. While in this research, the VMI will be applied in an oil company for optimizing its company replenishment policy.

2.2 Inventory Management

A successful inventory management process translates techniques into daily tactical responses to customer demands and business needs. Inventory management will be proper if it is able to decide properly how and where to locate all inventory items

(Greene, 1997). The strategies for inventory management are efficient store assortment which attempts to optimize the productivity of inventories and store space at the costumer interface, efficient replenishment which attempts to optimize time and cost in the replenishment system, efficient promotion which attempts to maximize the total system efficiency of trade and customer promotion, and efficient product introduction which attempts to maximize the effectiveness of new product development and introduction activities (Silver *et.al.,* 1998).

Tersine defined inventory is a priceless asset that can be r eplaced by the more inexpensive called information. To able replacing it, the information must be correct in time, accurate, and consistent. If this happens, so the inventory will be less, reduce cost, and faster in distributing the product to the consumer.

The objective of the inventory management is to replace the expensive assets that called inventory with a more inexpensive assts that called information. Inventory management answers the question about how much inventory that needs to be stock in case when facing the forecast fluctuation, costumers demand and supplier.

The main reason the needs of inventory management are:

1) To maximize the service to the costumer
2) To maximize the buying efficiency and production
3) To maximize the profit
4) To minimize the inventory stock, but ensure to avoid the stock out

2.2.1 Inventory

The inventory can be categorized into five basic types, which are:

1) Raw material; consist of all elements and direct material that buying for produce the end product.

2) The half-end material; is an inventory from assembling process to the end process.
3) The end material; is an inventory that ready to be distributing to the distribution centre, retailers, distributor, or directly to consumer.
4) Distribution stock; is an inventory that being keep on a point or location where it is as close as possible to the consumer.
5) The maintenance material, improvement and op eration (MRO Supplies); this inventory is including the office writing tools and also other things that need to the operational and service.

As theoretical, the inventory can be divided into 2 kind of inventory component, as stated below:

1) Round inventory consist of the most active components that available in stock (move fastest)
2) Safety stock (finished material, or often called inventory stock support that being used to protect the company from the demand fluctuation)

The inventory was being done because there is a demand, where the demand was divided into two kinds, which are independent demand and dependent demand. Independent demand is a met hod to manage the product which demand was affected by costumer demand or demand from other that out of company control. While the dependent demand is a demand for all components that needed to fulfill the independent demand (Tersine, 1994).

Narasimhan (1995) defines the objective of inventory management is to have the appropriate amounts of materials in the right place, at the right time, and at low cost. Inventory control is a critical aspect of successful management. With high carrying cost, companies ca nnot afford to have any money tied up in excess inventories. The objective of good customer service and efficient production must be met at minimum inventory levels. In order to obtain a good inventory control, a company must match the timing of demand and supply so that the inventory goes on the elf just in time (Narasimhan, 1995).

2.2.2 Properties of inventory

Basically, the properties of inventory are universal. Tersine (1994) classifies the properties of inventory that are the most commonly cited as:

1) Demands are units taken from inventory. It can be categorized according to their size, rate and pattern. Demand size refers to magnitude of demand and has the dimension of quantity. The demand rate is simply the demand size per unit time. Demand patterns refer to how units are withdrawn from the inventory.
2) Replenishment is units put into inventory. It can be categorized according to their size, pattern, and lead time. Replenishment size refers to the quantity or size, pattern and lead time. Replenishment si ze refers to the quantity or size of the order to be received. The replenishment pattern refers to the units are added to inventory. Replenishment lead time is the length of time between the decision to replenish an item and its actual addition to stock an d can be constant or variable.
3) Constraints are limitations placed on the inventory system.

2.2.3 Vendor Managed Inventory

Vendor Managed Inventory (VMI) is a concept in which the buyer of a product provides certain information to a supplier of that product and the supplier takes full responsibility for maintaining an agreed inventory of the material (De Toni *et.al.*, 2005). As a symbiotic relationship, VMI makes it less likely that a business will unintentionally become out of stock of a good and reduces inventory in the supply chain. One of the fundamental element s of VMI concept is the integration of information between each echelon in supply chain to create a good decision.

2.2.4 Inventory Replenishment Policies

A replenishment policies consist of decision regarding when to reorder and how much to reorder (Narasimhan, 1995). There are many different types of replenishment policies, of which below are commonly used: the periodic review, order -up-to policy and the continuous review reorder point, order quantity model. Replenishment policies may take any of several forms. We restrict attention to two types:

1) Continuous review

   Inventory is continuously tracked and an order for a lot size Q is placed when the inventory declines to the reorder point (ROP). So, the size of the order does not change from one order to the next. The time between orders may fluctuate given variable demand.

2) Periodic review:

   Inventory status is checked at regular periodic intervals and an order is placed to raise the inventory level to a specified threshold. So, the time between orders is fixed. The size of each order however can fluctuate given variable demand.

   In periodic review policies, inventory levels are reviewed after a fixed period of time T and an order is placed such that the level of current inventory plus the replenishment lot size equals a pre -specified level called the order-up-to level (OUL). The review interval is the time T between successive orders. Observe that the size of each order may vary, depending on the demand experienced between successive orders and the resulting inventory at the same time of ordering. Periodic review policies are simpler for firms to implement because they do not require that the firm have the capability of monitoring inventory continuously.

2.3 Algorithm

Algorithm is a finite list of well-defined instructions for accomplishing some task that given an initial state and will terminate in a defined end-state. The origin of algorithm is come from the name of Muslim scientist named Abu Ja'far Muhammad bin Musa Al - Khwarizmi (780 – 846 M) that published masterpieces in mathematics, geography and music (Wahid, 2004)

Algorithms are essential to the way it process information, it tells what specific steps to perform and in what specific order in order to carry out a specified task, such as calculating employees' paychecks or printing students' report cards. Typically, when an algorithm is associated with processing information, data are read from an input source or device, written to an output sink or device, and/or stored for further processing. Stored data are regarded as part of the internal state of the entity performing the algorithm. In practice, the state is stored in a data structure, but an algorithm requires the internal data only for specific operation sets called abstract data types.

For any such computational process, the algorithm must be rigorously defined: specified in the way it applies in all possible circumstances that could arise. That is, any conditional steps must be systematically dealt with, case-by-case; the criteria for each case must be clear.

Because an algorithm is a precise list of precise steps, the order of computation will almost always be critical to the functioning of the algorithm. Instructions are usually assumed to be listed explicitly, and are described as starting 'from the top' and going 'down to the bottom', an idea that is described more formally by flow of control.

So far, this discussion of the formalization of an algorithm has assumed the premises of imperative programming. This is the most common conception, and it attempts to describe a task in discrete, 'mechanical' means. Unique to this conception of formalized algorithms is the assignment operation, setting the value of a variable.

2.4 Vendor Managed Inventory in Chevron Pacific Indonesia Company

Vendor-Managed Inventory is a supply chain strategy where the vendor or supplier is given the responsibility to manage the customer's stock. According to De Toni *et.al.,* (2005), VMI comes in many different forms where it depends on sector application, ownership issues and scope of implementation. Familiar names are Quick Response (QR), Synchronized Consumer Response (SCR), Continuous Replenishment (CR), Efficient Consumer Response (ECR), Rapid Replenishment (RR), Collaborative Planning, Forecasting and Replenishment (CPFR) and Centralized Inventory Management (CIM).

In this company, VMI's form that will be applied is Continuous Replenishment (CR). CR reorganizes the traditional system of ordering and replenishment characterized by the transfer of purchase orders from the retailer to the supplier/manufacture/vendor. The supplier himself decides the quantity to be delivered on the basis of information about sales and the stock level in the retail centre, taking into account the orders already acquired by outlets and following a pre-established program of replenishment. The retailer, on the other hand, has to guarantee a continuous flow of information to enable the supplier to formulate realistic order proposals and make reliable provisions.

In this research, the VMI will be applied in an oil company for optimizing its company replenishment policy by using algorithm which based on VMI concept; continuously shared information. The Oil Company is Chevron Pacific Indonesia (CPI) which located in Riau, Sumatera. Their "supplier" term is referring to their oil production field under production system department which produces the constant amount of crude oil continuously in 24 hours. And their “retailer” term is referring to their inventory management area that consist of 16 storage tanks for keeping the crude oil that came from the oil production field continuously also for 24 hours. Vendor that placed in Production System Department will create a replenishment policy for crude oil replenishment in inventory management area. The replenishment policy is the best scheduling of filling system which will decide how much the crude oil to be filled into the correct tank by using the integration of information between vendor, retailer and costumer in order to overcome the stock out while the crude oil must aligned with the shipping schedule.

2.4.1 Production System

Production System in CPI is started from the oil production field where the crude oil is being pumped from the earth continuously for 24 hours. There are two type of crude oil that being pumped, which is Sumatera Light Crude Oil and Duri Crude Oil. After being pumped, the crude oil directly being sent to the inventory management area where the storage tank is located (Department of Hydrocarbon Transportation CPI, 2002).

2.4.2 Filling and Loading System

The process of inventory management in CPI is started at the filling system. The filling system is similar to the replenishment activity in inventory term. Crude oil that had gathered from the production field is WIP inventory in filling and loading system. While the loading activity is the activity that taking the crude oil from the storage tank to meet the demand.

In create a filling planning, it is needed to have a loading or shipping plan. Because the unfulfilled largest loading or shipping plan at current day (XL_m) will become an input in developing the filling planning in order to cover all shipping schedule at current day.

The loading plan to develop the filling planning is start with determine the tank which can cover the current day loading. To select the tank, it is need a consideration based on the tank's condition. The integration of information about the tank condition is needed here. The tank/s which available and operable is the tank/s which is not in maintenanc e schedule, performs loading activity, and performs filling activity. After that, Tank which has the fixed Pumpable amount that can cover the $XL_{\mathbf{m}}$ will be selected for being loaded. Formula (1) below will determine the fixed amount of oil inside the storag e tank which can be load because each tank has its own unpumpable amount. The oil will not be able to be loaded if it is reach the unpumpable amount limit, which is determined by the company.

$$Fp_{\mathbf{x}} = Cs_x - Up_x \qquad \dots (1)$$

Where;

$Fp_{\mathbf{x}}$ = Fixed Pumpable s tock on **x** tank; **x** = 1,2,…**y**

$Cs_{\mathbf{x}}$ = Current stock on **x** tank; **x** = 1,2,…**y**

$Up_{\mathbf{x}}$ = Unpumpable stock on **x** tank; **x** = 1,2,…**y**

$XL_{\mathbf{m}}$ = The largest loading or shipping plan at **m** day that unfulfilled ; **m**=1,2,…n

In developing filling planning, it is need to rank the priority of which tank to be filled first by finding the difference amount between $XL_{\mathbf{m}}$ that need to be fulfilled, Cs_x and Up_x using formula (2) below:

$$\Delta F_{\mathbf{x}} = XL_m - Cs_x + Up_x \qquad \dots (2)$$

Where;

ΔF_x = Filling amount of **x** tank in cover XL_m

The tank chosen to become the first priority to be filled (P_i) is the tank which has the lowest ΔF_x. Because, the lowest ΔF_x means need less filling time in achieving the target (XL_m), and can soon perform loading activity.

In defining the require amount of oil to be filled in to the chosen tank (R_{ix}), use the formula (3) below.

$$R_{ix} = (20\% * XL_m) + P_i \qquad \ldots (3)$$

Where;

R_{ix} = Required amount of **i** priority of **x** tank based on ΔF_x value; **i** = 1, 2, ..**j**

P_i = Filling amount of **i** priority tank based on ΔF_x value; **i** = 1, 2, ..**j**

Based on formula above, the required amount to be filled into the chosen tank is covering the XL_m with additional 20% to prevent any unpredictable things during loading activity.

After it gets the required amount, the integration information about the estimation of crude oil received in current day is being considered in developing the filling planning. Because the total required amount will be equivalent or less than the estimation crude oil received, as present in formula (4) below:

$$\leq E_{OIL}; \mathbf{i} = 1, 2, ..\mathbf{j} \qquad \ldots (4)$$

Where;

E_{OIL}= Estimation of oil will be received at current day

From formula (4), the filling amount based on the availability of oil estimation will be as formula (5) below:

$F_i =$; **i** = 1, 2, ..**j** … (5)

Where;

E_{OILi} = Estimation of oil will be received at current day which available to provide Filling **i**.

Then, the duration of each activity is determined by the amount over the rate, as formula (6)

$\overline{}$ + Preparation time … (6)

In loading activity, require amount will be used as long as it is not bigger than the maximum capacity of rate that the company can handles and the minimum capacity of rate that the company can tolerates. While the preparation time is the time needs for setup and other pre loading activity. There is a strong relationship between fillings with loadings activity. If the filling is improper, the loading will be interrupt caused by the insufficient amount of crude oil stock.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Introduction

The steps of this research are as follow.

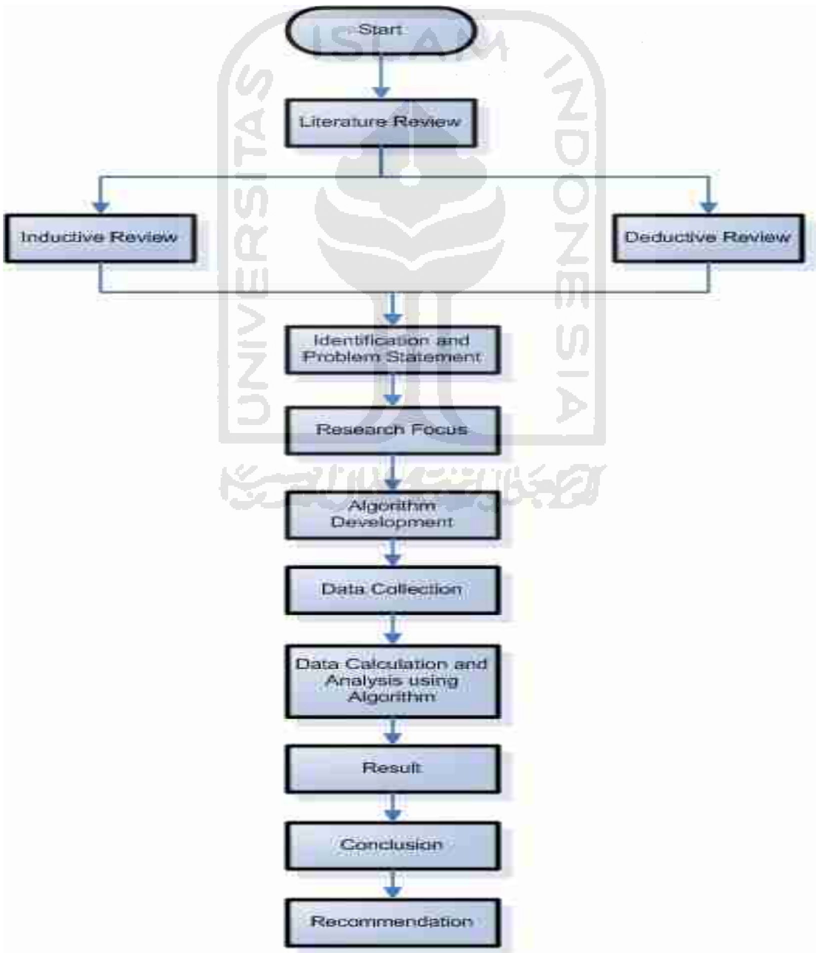

Figure 3.1 Research Methodology Flowchart

The research starts at literature review activities which are Inductive review and deductive review. Inductive review is a literature reviews to decide the current topic research. After that, the research study will continue to the identification and problem statement that finally will lead to research focus. By understanding the problem, the algorithm is being developed to solve the problem. After that, the data needed is being collected. The research study will calculate the data using the algorithm under the concept of literature that being chosen. Then, the result is being analyzed and discussed. At last, the conclusion is being got and the suggestion for the company and further research are raised.

3.2 Research Object

This research is being conducted in CHEVRON PACIFIC INDONESIA COMPANY (PT. CPI) in Sumatera Operation, Dumai with Sumatera Light Crude Oil (SLC) as the object that being analyzed.

3.3 Identification and Problem Statement

This process is being done to formulate the problems which already being explained and stated in the background of the pr oblem.

3.4 Vendor Managed Inventory in Chevron Pacific Indonesia Company

In Oil Company such as Chevron Pacific Indonesia (CPI), their "vendor" term is referring to their oil production field under production system department which produces the constant amount of crude oil continuously in 24 hours. And their "retailer" term is refer to their inventory management area that consist of 16 storage tanks for keeping the crude oil that came from oil production. Vendor that placed in Production System Department will create a replenishment policy by integrating the information for crude oil replenishment system. The replenishment policy is the best filling strategy which will decide when and how much the crude oil to be filled into the correct tank to overcome the stock out while the crude oil must fulfill consumer demand

3.5 Filling and loading System in Chevron Pacific Indonesia Company

The process of inventory management in CPI is started at the filling system. The filling system is similar to the replenishment ac tivity in inventory term. Crude oil gathered from the production field is WIP inventory in filling and loading system. CPI has an oil production fields which produces the constant amount of crude oil continuously in 24 hours. While the loading activity is the activity that taking the crude oil from the storage tank to meet the demand.

3.6 Algorithm Development

The algorithm is being developed under VMI concept in order to find the best filling strategy for filling system in PT. CPI based on Windi Winasti and Chairul Saleh (2007), the steps are stated as follow:

Step 1: Select x tank/s which is/are available and operable to be filled.

Step 2: Define XL_m that will become an input for filling planning.

Step 3: Select tank/s which is/are available for loading by calculate the fixed pumpable amount of each tank using formula (1), then choose tank/s which can cover XL_m

that previously defined in step 2. The remaining of tank/s will become the candidate of filling tank selected.

$Fp_{\mathbf{x}} = Cs_x - Up_x$ … (1)

Where;

$Fp_{\mathbf{x}}$ = Fixed Pumpable stock on **x** tank; **x** = 1, 2,…**y**

$Cs_{\mathbf{x}}$ = Current stock on **x** tank; **x** = 1, 2,…**y**

$Up_{\mathbf{x}}$ = Unpumpable stock on **x** tank; **x** = 1, 2,…**y**

$XL_{\mathbf{m}}$= The largest loading or shipping plan at **m** day that unfulfilled; **m**=1, 2,…**n**

Step 4:

a. If XL_m at m day can be fulfilled, calculate Step 5 until Step 8 using XL_m at m+1, and respectively.
b. If XL_m at current day cannot be fulfilled, skip Step 4.

Step 5: From tank/s selected, calculate each Filling Amount (ΔF_x) with each Current Stock (Cs_x) and Unpumpable Stock (Up_x) using formula (2).

$\Delta F_{\mathbf{x}} = XL_m - Cs_x + Up_x$ ... (2)

Where;

$\Delta F_{\mathbf{x}}$ = Filling amount of **x** tank in cover $XL_{\mathbf{m}}$

Step 6: Determine filling **i** priority based on $\Delta F_{\mathbf{x}}$ value (P_i) by ranking the lowest value of $\Delta F_{\mathbf{x}}$ as the highest priority to be filled and respectively.

Step 7: Determine the require Amount to be filled of the priority chosen (Ri_x) using formula (3).

$$R_{ix} = (20\%* XL_m) + P_i \qquad \dots (3)$$

Where;

$R_{\mathbf{ix}}$ = Required amount of **i** priority of **x** tank based on $\Delta F_{\mathbf{x}}$ value; **i** = 1, 2, ..**j**

$P_{\mathbf{i}}$ = Filling amount of **i** priority tank based on $\Delta F_{\mathbf{x}}$ value; **i** = 1, 2, ..**j**

Step 8: Determine the Filling amount based on the availability of E_{OIL} using formula (4), and (5).

$\leq E_{OIL}$; **i** = 1, 2, ..**j** … (4)

$F_i =$; **i** = 1, 2, ..**j** … (5)

Where;

$E_{\mathbf{OIL}}$ = Estimation of oil will be received at current day

$E_{\mathbf{OILi}}$ = Estimation of oil will be received at current day which available to provide Filling **i**.

Step 9: Get the result offilling amount decision and tank selection .

3.7 Data Collection

The Data Gathering was done in three ways:

1. Field Study by doing direct observation toward filling and loading activity.

2. Get statistical and primary data from company, such as 5 days shipping schedule, tank status, filling and loading records, etc.
3. Free interviews with the employees that undocumented well and unstructured. For example, the interview with head of department, general leader of department, head of filling and loading operator, filling and loading operator staff, etc.

3.8 Data Calculation

All data that had gathered related to filling activity will be processed using the algorithm development under VMI concept (Windi Winasti and Chairul Saleh, 2007).

3.9 Result

The result from data calculation will be analyzed and discussed in order to achieve the research objective.

3.10 Conclusion and Recommendation

From the discussion of results, the conclusion is being got. Based on the conclusion, the suggestion that will benefit the research and company will be recommended.

CHAPTER IV

DATA COLLECTION AND CALCULATION

4.1 Data Collection

Research was done in CHEVRON PACIFIC INDONESIA COMPANY (PT. CPI) of Sumatera Operation, in Dumai, Riau. The working hours in PT. CPI for each worker is up to 8 hours for 5 days in 1 week, which the detail stated as follows:

Start : 07.00 AM – 04.00 PM (In WIB)

Break : 12.00 AM – 01.00 PM (In WIB)

For workers in Chevron Terminal Operation and Maintenance which handle filling and loading activity will divide the working hours into shift schedule. The detail stated as follows:

Shift 1: 07.00 AM - 03.00 PM (In WIB)

Shift 2: 03.00 PM - 11.00 PM (In WIB)

Shift 3: 11.00 PM - 07.00 AM (In WIB)

The kinds of crude oil produced by PT. CPI are Duri Crude Oil and Sumatera Light Crude Oil. There are 16 storage tanks in Dumai that available for manage all crude oil that came from the oil production area in Duri. But this research focused on Sumatera Light Crude Oil, which has 6 Storage Tanks in Dumai.

The data collection related to Sumatera Light Crude Oil for filling and loading activity was being got from observation, interview and company's statistic data. The company's statistic data that will be calculated is the data of Sumatera Light Crude Oil in 1 period of "5 Days Shipping Schedule", which is from 6 July 2007 to 10 July 2007.

4.1.1 Storage Tank's Capacity

The capacity of storage tank that can handle the SLC will be as follows:

Table 4.1 Storage Tank Capacity

Tank	Capacity
1	212
2	165
3	212
4	212
5	674
6	674

4.1.2 Consolidation of Supply and Demand

The consolidation of supply and demand in CPI will be as follows:

Table 4.2 Consolidation of Supply and Demand

Date	Vessel Name	Demand	Supply from Oil Field
6-Jul-07	PP7 No.1	90	250
6-Jul-07	PP7 No.2	90	250
7-Jul-07	Venus	269	250
7-Jul-07	Earth	200	250
7-Jul-07	PP7 No.4	90	250
7-Jul-07	Mars	120	250
8-Jul-07	PP7 No.5	50	250
8-Jul-07	PP7 No.6	90	250
9-Jul-07	Jupiter	120	250
9-Jul-07	PP7 No.8	90	250
10-Jul-07	Neptune	120	250
10-Jul-07	PP7 No.9	90	250
10-Jul-07	PP7 No.10	50	250
11-Jul-07	Anjani	180	250

4.1.3 Company Actual Activity

4.1.3.1 Current Stock of Tank at 6 July 2007 – 10 July 2007

The current stock of the company if following their current system will be stated in tables below.

Table 4.3 Current Stock at 6 July 2007

Storage Tank	Amount
1	73
2	133
3	207
4	24
5	80
6	291

Table 4.4 Current Stock at 7 July 2007

Storage Tank	Amount
1	104
2	133
3	207
4	144
5	80
6	305

Table 4.5 Current Stock at 8 July 2007

Storage Tank	Amount
1	66
2	23
3	42
4	92
5	267
6	122

Table 4.6 Current Stock at 9 July 2007

Storage Tank	Amount
1	116
2	23
3	43
4	21
5	244
6	122

Table 4.7 Current Stock at 10 July 2007

Storage Tank	Amount
1	84
2	153
3	208
4	21
5	120
6	122

4.1.3.2 Current Filling Activity

The current filling activities were done by the company during 6 July 2007 until 10 July 2007 are stated as follows:

Table 4.8 Filling Activity at 6 July 2007

Time	Tank	Stock	
		Before	After
0.00- 4.30	1	73	113
4.30- 17.10	4	24	144
17.10- 22.30	1	30	117
22.30- 24.00	6	291	305

Table 4.9 Filling Activity at 7 July 2007

Time	Tank	Stock	
		Before	After
0.00 - 4.00	6	305	341
3.00 - 3. 10	3	207	207
4.00 - 21.40	5	80	267
21.40 - 24.00	1	30	66

Table 4.10 Filling Activity at 8 July 2007

Time	Tank	Stock	
		Before	After
0.00 - 10.30	1	66	161
10.30 - 15.00	5	178	244
15.00 - 24.00	3	41	133

Table 4.11 Filling Activity at 9 July 2007

Time	Tank	Stock	
		Before	After
0.00 - 8.35	3	43	118
8.35 - 20.40	2	23	153
20.40 - 24.00	1	29	84

Table 4.12 Filling Activity at 10 July 2007

Time	Tank	Stock	
		Before	After
0.00 - 7.45	1	84	159
7.45 - 24.00	4	21	204

4.1.3.3 Current Loading Activity

The current loading activities were done by the company during 6 July 2007 until 10 July 2007 are stated as follow:

Table 4.13 Consolidation of Current Loading Activity

Date	Time	Storage Tank Used	Amount	Demand	Vessel
6-Jul-07	05.00 – 12.00	1	90	90	PP7 No. 1
6-Jul-07	23.00 – 24.00	1	13	90	PP7 No. 2
7-Jul-07	00.00 - 06.00	1	77	90	PP7 No. 2
7-Jul-07	01.00 – 09.41, 10.00 – 18.00	3, 2	109, 160	269	Venus
7-Jul-07	05.00 – 21.40	6	200	200	Earth
7-Jul-07	13.00 – 24.00	4	105	120	Mars
7-Jul-07	22.00 – 24.00	5	48	90	PP7 No.4
8-Jul-07	00.00 – 02.00	4	15	120	Mars
8-Jul-07	00.00 – 3.37	5	42	90	PP7 No.4
8-Jul-07	06.00 – 11.10	1	50	50	PP7 No.5
9-Jul-07	01.00 – 13.12	5	120	120	Jupiter
9-Jul-07	03.00 – 10.00	1	90	90	PP7 No.6
10-Jul-07	01.00 – 08.00	3	77	90	PP7 No.8
10-Jul-07	20.00 – 24.00	1	51	90	PP7 No.9
10-Jul-07	21.00 – 24.00	3	91	200	Neptune
11-Jul-07	00.00 – 03.00	1	39	90	PP7 No.9
11-Jul-07	00.00 - 07.50	2	109	200	Neptune
11-Jul-07	06.00 – 10.50	1	50	50	PP7 No.10

4.1.4 Input for Algorithm

4.1.4.1 Storage Tank's Condition

One of the inputs for filling and loading activity will be the condition of storage tank attached to the operational activity. At the observation period, started at 6 July 2007, all of storage tanks attached are in operable condition. The status of each storage tanks is measured every day at 00.00 AM.

Table 4.14 Tank Status

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Operable
5	Operable
6	Operable

4.1.4.2 The 5 Days Shipping Schedule

This research study will analyze the Five Days Shipping Schedule of Sumatera Light Crude Oil (SLC) PT. CPI from July 6th 2007 until July 10th 2007. All amount of oil relate to this research is in thousand barrels. In CPI, the maximum rate is 25000 barrel/hour and the minimum is 15000 barrel/hour. The estimation of preparation time every loading activity is approximately 1 hour. In filling activity, the rate used is approximately 10000 barrel/hour.

No	Vessel which has ETA	Berth	6-Jul SLC	6-Jul DC	7-Jul SLC	7-Jul DC	8-Jul SLC	8-Jul DC	9-Jul SLC	9-Jul DC	10-Jul SLC	10-Jul DC	Req Rate	DWT
1	Mercury	15.00 06		170									68	115
2	Venus	23.00 06			269								69	90
3	Earth	4.00 06		375		25							53	106
	Earth	4.00 06			200								53	106
4	Mars	8.00 07			120								8	18
5	Jupiter	14.00 08							120				7	18
6	Neptune	23.00 09									200		55	87
7	Pluto	18.00 10										300	50	114
	PP7 No. 1		90										15	
	PP7 No. 2		90										15	
	PP7 No. 3					50							15	
	PP7 No. 4				90								15	
	PP7 No. 5						50						15	
	PP7 No. 6						90						15	
	PP7 No. 7									50			15	
	PP7 No. 8								90				15	
	PP7 No. 9										90			
	PP7 No. 10										50			
	Total Lifting		180	545	679	75	140	0	210	50	340	300		
	Prod estimation		254	191	254	191	254	191	254	191	254	191		

* in thousand barrels

Figure 4.1 The 5 Days Shipping Schedule

4.1.4.3 Storage Tank's Current Stock

From previous filling planning, stock in each storage tank is measured every day at 00.00 AM. For first day of The Five Days Sipping Schedule which is 6 July 2007, the amount of current stock for each storage tank.

Table 4.15 Tank's Current Stock

Storage Tank	Amount
1	73
2	133
3	207
4	24
5	80
6	291

4.2 Data Calculation

Based on the algorithm under VMI concept that being explained in the literature review and methodology, "The Five Days Shipping Schedule" and all data related will be calculate as follow.

4.2.1 Day 1 (6 July 2007)

From previous filling planning, stock in storage tank for today is:

Table 4.16 Tank's Current Stock at 6 July 2007

Storage Tank	Amount
1	73
2	133
3	207
4	24
5	80
6	291

Step 1 Select x tank/s which is/are available and operable to be processed using algorithm

Table 4.17 Tank Status at 6 July 2007

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Operable
5	Operable
6	Operable

Step 2 Define XL_m that will become an input for filling planning.

$XL_1 = 90$

Step 3 Select tank/s which is/are available for loading and the remaining of tank/s will become the candidate of filling tank selected.

Table 4.18 Fixed Pumpable Amount (Fp_x) at 6 July 2007

Notation	Formula	Amount
Fp_1	= 73 – 17	56
Fp_2	= 133 – 14	119
Fp_3	= 207 – 19	188
Fp_4	= 24 – 18	6
Fp_5	= 80 – 50	30
Fp_6	= 291 – 50	241

From Table 4.18, it can be seen that Fp_x at Tank 2 and 3 can cover $XL_1 = 90$. So, the Tank statuses changed are as below:

Table 4.19 Tank Status Update at 6 July 2007

Storage Tank	Status
1	Operable
2	Loading
3	Loading
4	Operable
5	Operable
6	Operable

Step 4 Use XL_2 = 269 in step 5 until step 8 calculation, because XL_1 = 90 is fulfilled. So, it will develop a planning for fulfilling the 2 nd day of the largest shipping planning.

Step 5 From x tank/s selected; calculate each ΔF_x with each Cs_x.

Table 4.20 Filing Amount at 6 July 2007

Notation	Formula	Amount
ΔF_1	= 269 – 73 +17	213
ΔF_4	= 269 – 24 +18	263
ΔF_5	= 269 – 80 +50	239
ΔF_6	= 269 – 291 + 50	28

Step 6 Determine (P_i) by ranking the lowest value of ΔF_x as the highest priority to be filled and respectively.

Table 4.21 Priority based on filling amount at 6 July 2007

Notation	Formula	Amount	Priority	New Notation
ΔF_1	= 269 – 73 +17	213	2^{nd}	P_2
ΔF_4	= 269 – 24 +18	263		
ΔF_5	= 269 – 80 +50	239	3^{rd}	P_3
ΔF_6	= 269 – 291 + 50	28	1^{st}	P_1

Step 7 Determine the R_{ix} of the priority chosen.

Table 4.22 Require amount based on priority at 6 July 2007

Notation	Formula	Amount
$R1_6$	=(20% * 269) + 28	81.8
$R2_1$	=(20% * 269) + 213	266.8
$R3_5$	=(20% * 269) + 239	292.8

Step 8 Determine the F_i based on the availability of E_{OIL}

≤ 250 so:

Table 4.23 Result Filling Day 1 (6 July 2007)

Notation	Formula	Amount
F1 at 6	$=R1_6$, because $R1_n \leq E_{oil1}$ = 81.8, because $81.8 \leq 250$	81.8
F2 at 1	$= E_{oil2}$, because $R2_n \geq E_{oil2}$ = 168.2, because $266.8 \geq (250-81.8)$	168.2

Step 9 The Result of this algorithm can be seen in attachment .

4.2.2 Day 2 (7 July 2007)

From previous filling planning, stock in storage tank for today is:

Table 4.24 Tank's Current Stock at 7 July 2007

Storage Tank	Amount
1	241
2	43
3	117
4	24
5	80
6	373

Step 1 Select x tank/s which is/are available and operable to be processed using algorithm

Table 4.25 Tank Status at 7 July 2007

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Operable
5	Operable
6	Operable

Step 2 Define XL_m that will become an input for filling planning.

Since $XL_2 = 120$.

Step 3 Select tank/s which is/are available for loading and the remaining of tank/s will become the candidate of filling tank selected. Note that the current day of shipping plan are 269, 200, 90, and 120.

Table 4.26 Fixed Pumpable Amount (Fp_x) at 7 July 2007

Notation	Formula	Amount
Fp_1	= 241 – 17	230
Fp_2	= 43 – 14	29
Fp_3	= 117 – 19	98
Fp_4	= 24 – 18	6
Fp_5	= 80 – 50	30
Fp_6	= 373 – 50	323

From Table 4.26, it can be seen that Fp_x at Tank 1, 3 and 6 can cover current day of shipping plan which are 200, 90 , and 269. So, the Tank statuses changed are as below:

Table 4.27 Tank Status Update at 7 July 2007

Storage Tank	Status
1	Loading
2	Operable
3	Loading
4	Operable
5	Operable
6	Loading

Step 4 Use XL_2 = 120 in step 5 until step 8 calculation, because XL_2 = 120 is not fulfilled. So, it will develop a planning for fulfilling the 2 nd day of the shipping planning that unfulfilled.

Step 5 From x tank/s selected; calculate each ΔF_x with each Cs_x.

Table 4.28 Filing Amount at 7 July 2007

Notation	Formula	Amount
ΔF_2	= 120 – 43 +14	91
ΔF_4	= 120 – 24 +18	114
ΔF_5	= 120 – 80 + 50	90

Step 6 Determine (P_i) by ranking the lowest value of ΔF_x as the highest priority to be filled and respectively.

Table 4.29 Priority based on filling amount at 7 July 2007

Notation	Formula	Amount	Priority	New Notation
ΔF_2	= 120 – 43 +14	91	2nd	P_2
ΔF_4	= 120 – 24 +18	114	3rd	P_3
ΔF_5	= 120 – 80 + 50	90	1st	P_1

Step 7 Determine the R_{ix} of the priority chosen.

Table 4.30 Require amount based on priority at 7 July 2007

Notation	Formula	Amount
$R1_5$	=(20% * 120) + 90	114
$R2_2$	=(20% * 120) + 91	115
$R3_4$	=(20% * 120) + 114	138

Step 8 Determine the F_i based on the availability of E_{OIL} ≤ 250 so:

Table 4.31 Result Filling Day 2 (7 July 2007)

Notation	Formula	Amount
F1 at 5	$=R1_5$, because $R1_n \leq E_{oil1}$ = 114, because 114 ≤ 250	114
F2 at 2	$= R2_2$, because $R2_n \leq E_{oil2}$ = 115, because 115 ≤ (250-114)	115
F2 at 4	$= E_{oil3}$, because $R3_n \geq E_{oil3}$ = 21, because 138 ≥ (250-114-115)	21

Step 9 The Result of this algorithm can be seen in attachment.

4.2.3 Day 3 (8 July 2007)

From previous filling planning, stock in storage tank for today is:

Table 4.32 Tank's Current Stock at 8 July 2007

Storage Tank	Amount
1	41
2	158
3	27
4	45
5	74
6	104

Step 1 Select x tank/s which is/are available and operable to be processed using algorithm

Table 4.33 Tank Status at 8 July 2007

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Operable
5	Operable
6	Operable

Step 2 Define XL_m that will become an input for filling planning.

Since $XL_3 = 90$.

Step 3 Select tank/s which is/are available for loading and the remaining of tank/s will become the candidate of filling tank selected. Note that the current day of shipping plans are 90, and 50.

Table 4.34 Fixed Pumpable Amount (Fp_x) at 8 July 2007

Notation	Formula	Amount
Fp_1	= 41 – 17	24
Fp_2	= 158 – 14	144
Fp_3	= 27 – 19	8
Fp_4	= 45 – 18	27
Fp_5	= 74 – 50	34
Fp_6	= 104 – 50	54

From Table 4.34, it can be seen that Fp_x at Tank 2 and 6 can cover current day of shipping plan which are 90 and 50. So, the Tank statuses changed are as below:

Table 4.35 Tank Status Update at 8 July 2007

Storage Tank	Status
1	Operable
2	Loading
3	Operable
4	Operable
5	Operable
6	Loading

Step 4 Use XL_4 = 120 in step 5 until step 8 calculation, because XL_3 = 90 and other current day of shipping plan are fulfilled. So, it will develop a planning for fulfilling the 4th day of the shipping planning that unfulfilled.

Step 5 From x tank/s selected; calculate each ΔF_x with each Cs_x.

Table 4.36 Filing Amount at 8 July 2007

Notation	Formula	Amount
ΔF_1	= 120 – 41 +17	96
ΔF_3	= 120 – 27 +19	112
ΔF_4	= 120 – 45+18	93
ΔF_5	= 120 – 74 + 50	96

Step 6 Determine (P_i) by ranking the lowest value of ΔF_x as the highest priority to be filled and respectively.

Table 4.37 Priority based on filling amount at 8 July 2007

Notation	Formula	Amount	Priority	New Notation
ΔF_1	= 120 – 41 +17	96	3rd	P_3
ΔF_3	= 120 – 27 +19	112		
ΔF_4	= 120 – 45+18	93	1st	P_1
ΔF_5	= 120 – 74 + 50	96	2nd	P_2

Step 7 Determine the R_{ix} of the priority chosen.

Table 4.38 Require amount based on priority at 8 July 2007

Notation	Formula	Amount
$R1_4$	=(20% * 120) + 93	117
$R2_5$	=(20% * 120) + 96	120
$R3_1$	=(20% * 120) + 96	120

Step 8 Determine the F_i based on the availability of E_{OIL} ≤ 250 so:

Table 4.39 Result Filling Day 3 (8 July 2007)

Notation	Formula	Amount
F1 at 4	$=R1_4$, because $R1_n \leq E_{oil1}$ = 114, because $114 \leq 250$	117
F2 at 5	= $R2_5$, because $R2_n \leq E_{oil2}$ = 115, because $115 \leq (250-117)$	120
F2 at 1	= E_{oil3}, because $R3_n \geq E_{oil3}$ = 13, because $120 \geq (250-117-120)$	13

Step 9 The Result of this algorithm can be seen in attachment.

4.2.4 Day 4 (9 July 2007)

From previous filling planning, stock in storage tank for today is:

Table 4.40 Tank's current stock at 9 July 2007

Storage Tank	Amount
1	54
2	68
3	27
4	162
5	194
6	54

Step 1 Select x tank/s which is/are available and operable to be processed using algorithm

Table 4.41 Tank Status at 9 July 2007

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Operable
5	Operable
6	Operable

Step 2 Define XL_m that will become an input for filling planning.

Since $XL_4 = 120$.

Step 3 Select tank/s which is/are available for loading and the remaining of tank/s will become the candidate of filling tank selected. Note that the current day of shipping plans are 120, and 90.

Table 4.42 Fixed Pumpable Amount (Fp_x) at 9 July 2007

Notation	Formula	Amount
Fp_1	= 54 – 17	37
Fp_2	= 68 – 14	54
Fp_3	= 27 – 19	8
Fp_4	= 162 – 18	144
Fp_5	= 194 – 50	144
Fp_6	= 54 – 50	4

From Table 4.42, it can be seen that Fp_x at Tank 4 and 5 can cover current day of shipping plan which are 120 and 90. So, the Tank status changed as below:

Table 4.43 Tank Status Update at 9 July 2007

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Loading
5	Loading
6	Operable

Step 4 Use $XL_5 = 200$ in step 5 until step 8 calculation, because $XL_4 = 120$ and other current day of shipping plan are fulfilled. So, it will develop a planning for fulfilling the 5 th day of the shipping planning that unfulfilled.

Step 5 From x tank/s selected; calculate each ΔF_x with each Cs_x.

Table 4.44 Filing Amount at 9 July 2007

Notation	Formula	Amount
ΔF_1	= 200 – 54 +17	163
ΔF_2	= 200 – 68 +14	146
ΔF_3	= 200 – 27+19	192
ΔF_6	= 200 – 54 + 50	196

Step 6 Determine (P_i) by ranking the lowest value of $\Delta F_{\mathbf{x}}$ as the highest priority to be filled and respectively.

Table 4.45 Priority based on filling amount at 9 July 2007

Notation	Formula	Amount	Priority	New Notation
ΔF_1	= 200 – 54 +17	163	2nd	P_2
ΔF_2	= 200 – 68 +14	146	1st	P_1
ΔF_3	= 200 – 27+19	192	3rd	P_3
ΔF_6	= 200 – 54 + 50	196		

Step 7 Determine the R_{ix} of the priority chosen.

Table 4.46 Require amount based on priority at 9 July 2007

Notation	Formula	Amount
$R1_2$	=(20% * 200) + 146	186
$R2_1$	=(20% * 200) + 163	203
$R3_3$	=(20% * 200) + 192	232

Step 8 Determine the F_i based on the availability of E_{OIL}

≤ 250 so:

Table 4.47 Result Filling Day 4 (9 July 2007)

Notation	Formula	Amount
F1 at 2	$=R1_2$, because $R1_n \leq E_{oil1}$ = 186, because $186 \leq 250$	186
F2 at 1	$= E_{oil2}$, because $R2_n \geq E_{oil2}$ = 64, because $203 \geq (250-186)$	64

Step 9 The Result of this algorithm can be seen in attachment.

4.2.5 Day 5 (10 July 2007)

From previous filling planning, stock in storage tank for today is:

Table 4.48 Tank's Current Stock at 10 July 2007

Storage Tank	Amount
1	118
2	254
3	27
4	72
5	74
6	54

Step 1 Select x tank/s which is/are available and operable to be processed using algorithm.

Table 4.49 Tank Status at 10 July 2007

Storage Tank	Status
1	Operable
2	Operable
3	Operable
4	Operable
5	Operable
6	Operable

Step 2 Define XL_m that will become an input for filling planning.

Since $XL_5 = 200$.

Step 3 Select tank/s which is/are available for loading and the remaining of tank/s will become the candidate of filling tank selected. Note that the current day of shipping plans are 200, 90, and 50.

Table 4.50 Fixed Pumpable Amount (Fp_x) at 10 July 2007

Notation	Formula	Amount
Fp_1	= 118 – 17	101
Fp_2	= 254 – 14	240
Fp_3	=27 – 19	8
Fp_4	= 72 – 18	54
Fp_5	= 74 – 50	24
Fp_6	= 54 – 50	4

From Table 4.50, it can be seen that Fp_x at Tank 1, 2 and 4 can cover current day of shipping plan which are 90 , 200 and 50. So, the Tank status changed as below:

Table 4.51 Tank Status Update at 10 July 2007

Storage Tank	Status
1	Loading
2	Loading
3	Operable
4	Loading
5	Operable
6	Operable

Step 4 Use XL_6 = 180 in step 5 until step 8 calculation, because XL_5 = 120 and other current day of shipping plan are fulfilled. So, it will develop a planning for fulfilling the 6^{th} day of the shipping planning that unfulfilled.

Step 5 From x tank/s selected; calculate each ΔF_x with each Cs_x.

Table 4.52 Filing Amount at 10 July 2007

Notation	Formula	Amount
ΔF_3	= 180 – 8 +18	190
ΔF_5	= 180 – 24+50	206
ΔF_6	= 180 – 4 + 50	226

Step 6 Determine (P_i) by ranking the lowest value of ΔF_x as the highest priority to be filled and respectively.

Table 4.53 Priority based on filling amount at 10 July 2007

Notation	Formula	Amount	Priority	New Notation
ΔF_3	= 180 – 8 +18	190	1^{st}	P_1
ΔF_5	= 180 – 24+50	206	2^{nd}	P_2
ΔF_6	= 180 – 4 + 50	226	3^{rd}	P_3

Step 7 Determine the R_{ix} of the priority chosen.

Table 4.54 Require amount based on priority at 10 July 2007

Notation	Formula	Amount
$R1_3$	=(20% * 180) + 190	226
$R2_5$	=(20% * 180) + 206	242
$R3_6$	=(20% * 180) + 226	262

Step 8 Determine the F_i based on the availability of E_{OIL}

≤ 250 so:

Table 4.55 Result Filling Day 5 at 10 July 2007

Notation	Formula	Amount
F1 at 3	$= R1_3$, because $R1_n \leq E_{oil1}$ = 226, because $226 \leq (250)$	226
F2 at 5	$= R2_5$, because $R2_n \geq E_{oil2}$ =24, because $242 \geq (250-226)$	24

Step 9 The Result of this algorithm can be seen in attachment.

4.2.6 Shipping Schedule Accomplishment

There are few differences between the Shipping Schedule Accomplishment between the actual system during 6 July – 10 July 2007 and the proposed system using algorithm for handling the shipping plan during 6 July – 10 July 2007.

4.2.6.1 Actual System Analysis

In actual condition, there are a few customer order delayed from its initial shipping schedule requested. It can be seen as follows:

Table 4.56 Actual Shipping Schedule Accomplishments

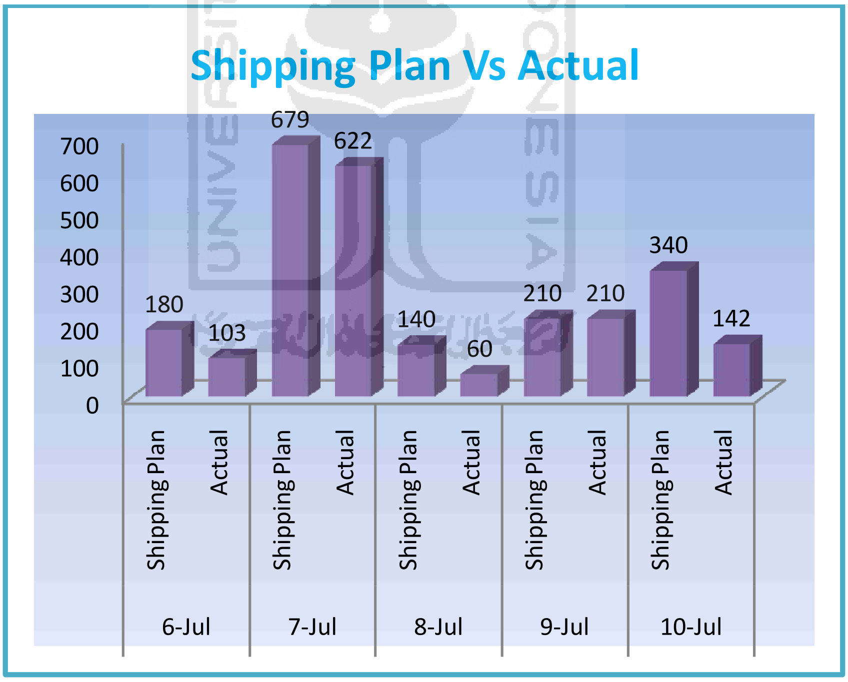

Figure 4.2 Shipping Plan Vs Actual

From figure 4.2 above, it can be see that the accomplishment of shipping schedule is rarely fulfilled.

The delays resulted in this condition were caused by several reasons. One of the reasons is the improper filing activity strategy. The improper filling strategy was caused by the human habit factor and the regulation factor. The human habit factor appears as the result of the lack regulation factor. In actual condition at 6 July 2007, as it can be seen in Table 4.8, the filling operator had chosen Tank 1 to be filled twice a day. Meanwhile at that day, the company must fulfill two costumer demands which are PP7 No.1 and PP7 No.2. The human habit factor shows that the operator is prefer to choose Tank 1 for fulfills PP7's demand. This can be seen from their decision to choose Tank 1 to be filled twice a day in order to fulfill PP7's demand instead of used other tank. So they had waited until Tank 1 is being filled in the morning and perform the loading activity when the crude oil was sufficient enough. After that, Tank 1 is being filled again, and being used for loading activity again. This situation happen ed because of the regulation factor; means there are no regulations exist for creating filling strategy. Everything is based on employee or operator's assumptions and experiences. Define a filing strategy based on assumptions and experiences is not wrong as long as it is not creates a problem for further. But in this case, this condition created problems. Delay was occurs when PP7 No.2's must wait until Tank 1 is being done to be filled for the second time. While at that time, Tank 2 and Tank 3 is available for fulfill PP7 No.2's demand. The question had risen why the employee not used Tank 2 or Tank 3 for fulfills PP7's demand instead of waiting for Tank 1? The answer for the question is because the habits of the employee or operator that tend to use Tank 1 for fulfill PP7's demand. Once again, it is back to their assumptions and experiences .

From the wrong filling strategy in Day 1, it creates a problems for further loading activities. At Day 2, 7 July 2007, the company can fulfill Venus's demand by using two tanks. This is happen because there are no sufficient amounts of crude oil inside all storage tanks that applicable in handling SLC at that time. And the delay has occurs when the company want to fulfills PP7 No.4's demand, caused by insufficient amount in storage tank. So the company can started to fulfill PP7 No.4's demand when Tank 5 had finished being filled again, which is at 21.40 PM. From the wrong filling strategy in Day 2, it also creates a problem for loading activity in Day 3. The demand of Jupiter was being fulfilled by Tank 5. But, it can be fulfilled after Tank 5 had finished being filled.

So, delay was occurs again when Jupiter's demand are waiting to be filled until Tank 5 had finished being filled. In Day 4, all demand is fulfill. But in Day 5, Neptune's demand can be fulfilled by using 2 tanks because of insufficient. It can be seen in Table 4.7, where the demand is not enough for fulfill Nept une's demand by using only one tank.

4.2.6.2 Proposed System Analysis

In Proposed System condition, there are no customer orders delayed from its initial shipping schedule requested. In addition, the loading activity is more effective and efficient because they are using only one tank in every shipping schedule accomplishment. It can be seen below :

Table 4.57 Proposed System Shipping Schedule Accomplishments

Vessel	Loading		6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	Tank
	Start	Finish						
PP7 No.1	5.00/06	12.00/06	90					2
PP7 No.2	15.00/06	22.00/06	90					3
Venus	1.00/07	12.00/07		269				6
Earth	1.00/07	10.00/07		200				1
PP7 No.4	1.00/07	8.00/07		90				3
Mars	13.00/07	24.00/07		120				5
PP7 No.5	00.30/08	05.30/08			50			6
PP7 No.6	06.00/08	13.00/08			90			2
Jupiter	0.30/09	11.30/09				120		5
PP7 No.8	12.00/09	19.00/09				90		4
PP7 No.9	00.00/10	07.00/10					90	1
Neptunus	01.00/10	10.00/10					200	2
PP7 No.10	12.00/10	17.00/10					50	3

Figure 4.3 Shipping Plan Vs Proposed System

From figure 4.3 above, it can be seen that the accomplishments of shipping schedule is always fulfilled.

This is happened by eliminates the human habit factor and optimize the regulation factor. The regulation is being optimized using algorithm, so no more assumptions and it also lead to eliminate the human habit factor. For example, the employee or operator is no longer able to choose Tank 1 to be filled twice a day in Day 1 based on their habit and experiences, since the filling strategy instructions for filling scheduling has been made and provide the fixed number amount to be filed into the fixed storage tank. For more details, the loading and filling consolidation for current and proposed system will be present in attachment.

CHAPTER V

DISCUSSION

Based on the research objective which is to scope down the application of VMI concept in replenishment activities by developing an algorithm to find the filling strategy, the comparison result between actual and proposed system is being discussed to see the benefits of replenishment policy optimization.

5.1 Actual System

In actual condition, there are a few loading problems because of several reasons. One of the reasons is because of the improper filling strategy. From the actual system analysis in previous chapter, it can be seen how the decision of amount filled and tank chosen will affect the loading activity. If it is just being chooses without any regulation, the employee will creates an assumptions and use their experiences in creating the filling strategy. Nothing wrong with this condition as long as it is not creates a problem. But, it did create problems. In actual system analysis, there are a few conditions where the company cannot provide the crude oil for shipping schedule unless the company use more than one tank to cumulative the amount. And if the current stocks are still insufficient to fulfill the shipping schedule, the company makes the costumer wait until the storage tank being filled and have enough crude oil to be loaded. This is where the inconsistency of shipping schedule accomplishment occurs, as we can see in Table 4.56 .

5.2 Proposed System

The proposed system is build based on the problem which occurs in the actual system. In regard to find the filling strategy, the algorithm for replenishment activity based on VMI concept is being develops. The proposed system will integrate the information needed in creating a good Filling strategy where no more inconsistency in fulfilling shipping schedule. Table 4.57 shows us that what being planned is always fulfilled. In addition, no more loading activity is using more than one tank. From the company operational point of view, by using only one tank, the effectiveness in operational activity is increase s due to flexibility and the efficiency of loading activity is also increase due to more time utilization. Figure 4.3 will stronger the idea of why optimizing replenishment activity to find the best filling strategy by using algorithm which based on VMI concept can create a consistency of shipping schedule.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The conclusions from this research study are as follow:

1) By using the algorithm which is based on VMI concept, the optimal amount of crude oil to be filled into the tank for Day 1 (6 July 2007) is 82 barrels and 168 barrels, for Day 2 (7 July 2007) is 114 barrels, 115 barrels, and 21 barrels, for Day 3 (8 July 2007) is 117 barrels, 120 barrels, and 13 barrels, for Day 4 (9 July 2007) 90 barrels, 186 barrels, and 64 barrels, for Day 5 (10 July 2007) is 226 and 24.
2) The correct tank selected to be filled by crude oil for Day 1 (6 July 2007) is Tank 6 for 82 barrels and Tank 1 for 168 barrels, for Day 2 (7 July 2007) is Tank 5 for 114 barrels, Tank 2 for 115 barrels, and Tank 4 for 21 barrels, for Day 3 (8 July 2007) is Tank 4 for 117 barrels, Tank 5 for 120 barrels, and Tank 1 for 13 barrels, for Day 4 (9 July 2007) is Tank 2 for 186 barrels, and Tank 1 for 64 barrels. For Day 5 (10 July 2007) is Tank 3 for 226 barrels, and Tank 5 for 24 barrels.
3) From results of the algorithm, it can be seen that for Day 1 (6 July 2007), the first priority to be filled is Tank 6 from 00.00 -11.00 and followed by Tank 1 from 11.00 – 24.00, for Day 2 (7 July 2007), the first priority to be filled is Tank 5 from 00.00 – 11.00, followed by Tank 2 from 11.00 – 22.00, and followed by Tank 4 from 22.00 – 24.00, for Day 3 (8 July 2007), the first

priority to be filled is Tank 4 from 00.00 – 11.00, followed Tank 5 from 11.00 – 23.00, and followed by Tank 1 from 23.00 – 24.00, for Day 4 (9 July 2007), the first priority to be filled is Tank 2 from 00.00 – 19.00, and followed by Tank 1 from 19.00 – 24.00. For Day 5 (10 July 2007), the first priority to be filled is Tank 3 from 00.00 – 22.00, and followed by Tank 5 from 22.00 – 00.00.

6.2 Recommendation

The recommendation produced from this research study is as follows:

1) For company, it is better to re-evaluate their filling system due to their loading activity which is not aligns with the shipping schedule.
2) For further research study, it is better to include the cost calculation in performance measurement. And it is better to try another method to create the best filling system scenario.

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RESULTS OF ALGORITHM

6-Jul-07

LOADING

Start	Finish	Vessel	Tank	Amount Shipped
5.00/06	12.00/06	PP7 No.1	2	90
15.00/06	22.00/06	PP7 No.2	3	90

FILLING

Start	Finish	Tank	Filling Amount
0.00/06	11.00/06	6	82
11.00/06	00.00/07	1	168

Stock at 00.00

Tank	**Stock**
1	73
2	133
3	207
4	24
5	80
6	291

Stock at 24.00

Tank	**Stock**
1	241
2	43
3	117
4	24
5	80
6	373

7-Jul-07

LOADING

Start	Finish	Vessel	Tank	Amount Shipped
1.00/07	12.00/07	Venus	6	269
1.00/07	10.00/07	Earth	1	200
1.00/07	8.00/07	PP7 No.4	3	90
13.00/07	00.00/08	Mars	5	120

FILLING

Start	Finish	Tank	Filling Amount
00.00/07	11.00/07	5	114
11.00/07	22.00/07	2	115
22.00/07	00.00/08	4	21

Stock at 00.00

Tank	**Stock**
1	241
2	43
3	117
4	24
5	80
6	373

Stock at 24.00

Tank	**Stock**
1	41
2	158
3	27
4	45
5	74
6	104

8-Jul-07

LOADING

Start	Finish	Vessel	Tank	Amount Shipped
0.30/08	05.30/08	PP7 No.5	6	50

FILLING

Start	Finish	Tank	Filling Amount
00.00/08	11.00/08	4	117

06.00/08	13.00/08	PP7 No. 6	2	90

11.00/08	23.00/08	5	120
23.00/08	00.00/09	1	13

Stock at 00.00

Tank	**Stock**
1	41
2	158
3	27
4	45
5	74
6	104

Stock at 24.00

Tank	**Stock**
1	54
2	68
3	27
4	162
5	194
6	54

9-Jul-07

LOADING

Start	Finish	Vessel	Tank	Amount Shipped
0.30/09	11.30/09	Jupiter	5	120
12.00/09	19.00/09	PP7 No.8	4	90

FILLING

Start	Finish	Tank	Filling Amount
00.00/09	19.00/09	2	186
19.00/09	00.00/10	1	64

Stock at 00.00

Tank	**Stock**
1	54
2	68
3	27
4	162
5	194
6	54

Stock at 24.00

Tank	**Stock**
1	118
2	254
3	27
4	72
5	74
6	54

10-Jul-07

LOADING

Start	Finish	Vessel	Tank	Amount Shipped
01.00/10	10.00/10	Neptune	1	200
00.00/10	07.00/10	PP7 No.9	2	90
12.00/10	17.00/10	PP7 No.10	3	50

FILLING

Start	Finish	Tank	Filling Amount
00.00/10	22.00/10	3	226
22.00/10	00.00/11	5	24

Stock at 00.00

Tank	**Stock**
1	118
2	254
3	27
4	72
5	74
6	54

Stock at 24.00

Tank	**Stock**
1	28
2	54
3	253
4	22
5	98
6	54

Actual and Proposed Loading Consolidations

Vessel	Loading		6-Jul		7-Jul		8-Jul		9-Jul		10-Jul		11-Jul		Tank	
	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed
PP7 No.1	05.00/06-12.00/06	5.00/06-12.00/06	90	90											1	2
PP7 No.2	23.00/06-06.00/07	15.00/06-22.00/06	13	90	77										1	3
Venus	01.00/07-18.00/07	1.00/07-12.00/07			269	269									3, 2	6
Earth	05.00/07-21.40/07	1.00/07-10.00/07			200	200									6	1
Mars	13.00/07-02.00/08	13.00/07-00.00/08			105	90	15								5	5
PP7 No.4	22.00/07-3.37/08	1.00/07-08.00/07			48	120	42								4	3
PP7 No.5	11.00/08-17.10/08	00.30/08-05.30/08					50	50							1	6
PP7 No,6	23.00/08-08.00/09	06.00/08-13.00/08					10	90	80						3	2
Jupiter	01.00/09-11.12/09	00.30/09-11.30/09							120	120					5	5
PP7 No.8	01.00/10-08.00/10	12.00/09-19.00/09							90	90					1	4
PP7 No.9	20.00/10-03.00/11	00.00/10-07.00/10									51	90	39		1	2
Neptune	20.30/10-04.10/11	01.00/10-10.00/10									91	200	109		3, 2	1
PP7 No.10	06.00/11-10.50/11	12.00/10-17.00/10										50	50		1	3

Actual and Proposed Filling Consolidations

Date	Filling		Tank											
			1		2		3		4		5		6	
	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed
6-Jul-07	0.00/06 - 4.30/06	00.00/06-11.00/06	40											82
	4.30/06 - 17.10/06	11.00/06-00.00/07		168					120					
	17.10/06 - 22.30/06	-	87											
	22.30/06 - 24.00 /06	-											14	
7-Jul-07	0.00/07 - 4.00/07	00.00/07-11.00/07										114	36	
	04.00/07 - 04. 10/07	11.00/07-22.00/07				115	0							
	4.00/07 - 21.40/07	22.00/07-00.00/08								21	187			
	21.40/07 - 00.00/08	-	36											
8-Jul-07	00.00/08-11.00/08	00.00/08-11.00/08	50							117				
	11.00/08-23.00/08	11.00/08-23.00/08									66	120		
	23.00/08-00.00/09	23.00/08-00.00/09		13			92							
9-Jul-07	0.00/09 - 8.35/09	00.00/09-19.00/09				186	75							
	8.35/09 - 20.40/09	19.00/09-00.00/10		64	130									
	20.40/09 - 00.00/10	-	55											
10-Jul-07	0.00/10 - 7.45/10	00.00/10-22.00/10	75					226						
	7.45/10 - 00.00/11	22.00/10-00.00/11							183			24		