Design System Fuel Inventory Control In Gas Stations With The Concept Of Min-Max Stock Level And Time Phased Order Point

Case Study Gas Stations 44.501.01

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***Abstract* -The concept of supply chain inventory requirement has been widely used by companies to improve meeting the needs of its customers. Lost sales due to inventory shortage is an important thing to be avoided by the company. This research aims to build a inventory control system supplies fuel to the method of Distribution Requirements Planning (DRP) web-based on gas stations in the area of Semarang.**

The method used for planning is the ordering of distribution requirements planning with the stage of determining the net requirements (netting), selection Lot (lotting), the timing of orders (offsetting) and the determination of gross requirements for next level (exploision). The Time Phased Order Point and min-max stock level Consept used for optimalitation needs Planning. Model Design of the system is using waterfall model which consists of system analysis, system design, system implementation and testing programs.

The research design of this system is the ordering of the supply system can be used to support and improve inventory control at retail outlets. The results of testing the system states that the system developed to support inventory control, increased security at gas stations supply needs to be better and minimize losses orders.

Keywords: Inventory Control; Needs Planning; Time Phased Order Point; Distribution Requirement Planning; Design system; Waterfall model

I. INTRODUCTION

The concept of supply chain needs has been widely used to enhance the company needs for its customers. The development of this concept is becoming a necessity for companies, as is done with the development supplay chain IKEA planning through centralized planning and inventory control activities to enter the respective needs of retail [14]

Each company will always strive to always meet consumer demand at the time and the right amount. Lost sales due to lack of inventory is an important thing to be avoided by the company. Losses resulting from a shortage of supply in addition to a shortage of sales also decreased customer trust and loyalty to the company. If the problem occurs frequently can lead to reduced corporate image in the eyes of the people who ultimately could disrupt the economy of the company. The Gas Station is an agency that distributes fuel to the community, inventory control at The Gas Station becomes a major factor in meeting community needs. With growing technology needs to be a system that can monitor fuel supplies for inventory control so that the community needs can be met. Distribution Requirements Planning (DRP) is a method used to plot the distribution in multi-echelon distribution network. DRP testing research for planning and inventory control more consistently to meet the needs of inventory [1].Research the use of Min-max stock levels and Time Phased Order Point on the DRP method to control inventories more can anticipate supply shortages [24]. DRP planning process produce compliance with the inventory calculation process that starts from the inventory and sales data that is processed through the process of determining the net requirements (Netting), determining the number of lots needs (Lotting), reservation scheduling plan (Offseting) with the concept of min-max stock level and Time Phased Order Point and the delivery of sales data to a higher level of distribution (Explosion).

Inventory control system of fuel at gas stations can be an alternative inventory planning so that the service needs of the customer demand becomes more optimal, and can anticipate the vacancy stock.

II. LITERATURE REVIEW

A. Supplay Chain Planning Concept and *Planning Proses*

The concept of supply chain inventory requirements from IKEA has a vision of "Create a better everyday life for the many people" who serve nearly all the world. Development planning of the IKEA concept are centralization of planning and inventory control activities to enter the respective needs of retail. The concept can be seen in Figure 1

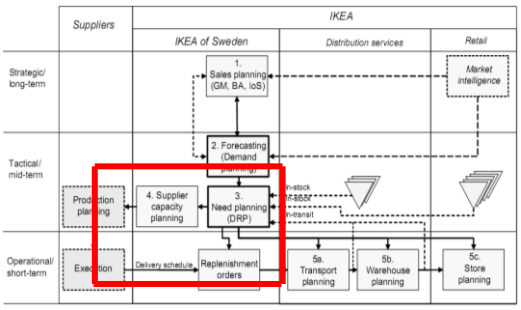

FIGURE 1. THE CONCEPT SUPPLAY PLANNING AND CHAIN PLANNING PROCESSES [14]

The concept of starting over from sales planning issued by the company management that comes from the calculation of market intelligent, then at step towards sales forecasting, to see the extent to which this sale may be realized and held improvement. The third stage of planning needs to do with the DRP to the Supplier and there are also has the Capacity Planning to meet the needs of existing retail, relpenishment finally reached the point of order that is affected by several factors such as Transport, Warehouse Planning and Store Planning.

B. Sales Planning

Planning the sale is the beginning of the commencement of proceedings on a company established by the General Manager or corporate leaders. The background of this planning is intelligent Market resulting from research carried out by the company.

1. Forecasting (Demand Planning)

Forecasting requirement is needed to estimate the sales that occur every day, according to Makridakis[15]. forecasting is an ability to predict product demand situation in the future that is uncertain. With estimates that things will happen, appropriate action can be taken to be able to handle it. Based on the time horizon, forecasting that is used in this study is the short-term forecasting is done continuously for sales data, this is because short-term forecasting will be more accurate

a) *Moving Average* (MA)

Forecasting technique used is the method of Forecasting Moving Average (MA) or a moving average where with this method can predict the future with past data to determine patterns and mengextrapolasi pattern for the days to come. Moving average is obtained by averaging the number of data requests based on the most recent past, the main goal is to eliminate random variations in demand in relation to time. This goal is achieved by averaging the number of data values together, and using the average value as the demand forecasts for the coming period [9]. From the analysis of several types of forecasting proved that a single moving average are forecasting the most suitable for filling stations [17]. Forecasting equations with moving average method is defined by the equation 2.1. :

$$\mathbf{MA}=\frac{\mathbf{A_t + A_{t-1} + \cdots + A_{t-(N-1)}}}{\mathbf{N}} \ldots \quad \mathbf{(2.1)}$$

MA = Sales Forecasting
At = actual sales in period t
N = Number of Sales data were included in the calculation of MA, the greater the value of N will be more subtle changes in the value of MA from period to period. Conversely the smaller the value of N, the results of forecasting will be more aggressive in anticipating changes in the most recent data are taken into account.

C. Distribution Requirement Planning (DRP)

Methods to handle the procurement of inventory in a multi-echelon distribution network is the Distribution Requirements Planning (DRP). This method uses independent demand, which made forecasting to meet its procurement structure. In this method more emphasis on scheduling activities rather than ordering activity. DRP anticipate future needs by planning at every level in the distribution network. This method can predict problems before those problems occur to give the point of view to the distribution network. Distribution Requirements Planning is based on forecasting needs at the lowest level in the network that will determine the need for inventory at a higher level. General concept of the DRP can be seen in Figure 2

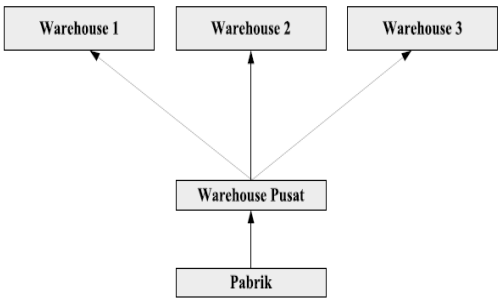

FIGURE 2. *DISTRIBUTION REQUIREMENT PLANNING*[23]

The process of scheduling reservations that exist in this method has the steps [23] as below.

1). Netting

Netting is a process of calculation to determine the amount of net requirements which amount represents the difference between gross requirements with the state of inventories. Netting process is defined by the equation 2.2:

NR=(GR+SS)– POH…….(2.2)

NR = *Net Requirement* (kebutuhan bersih)
SS = *Safety Stock* (Persediaan Cadangan)
GR = *Gross Requirement* (kebutuhan Kotor)
POH = *Project On Hand* (stok Akhir)

2). Lotting

Lists different types of process steps for determining the optimal number of orders based on the needs of the net that has been done on the previous process. Lot which is used in the scheduling system is tailored to the lot specified by PERTAMINA, :

a) Lot 1 = 8000 liters capacity
b) Lot 2 = 16,000 liters capacity
c) Lot 3 = 24,000 liters capacity
d) Lot 4 = 32,000 liters capacity, a combination of Lot 3 and Lot 1
e) Lot 5 = 40,000 liters capacity, the combination of Lot 3 and Lot 2

If the sum value of stock and Lot late orders exceed the capacity of the tank buried, then the Lot reservations will be replaced by a system with lots of one level below.

3). Offsetting

This step aims to determine the right time to make plans in order to meet the needs of reservation net. Plan view of the way orders obtained:

Tp =(Ts – L) + Ph…….(2.3)

Tp = *Tanggal Pesan* (Order Date)
Ts = *Tanggal Sekarang* (Now Date)
L = Lead Time

Is the time required between raw materials order until in the company. This lead time will affect the amount of raw materials used during the lead time. The longer lead time make the larger the material needed during the lead time.

$$Ph = \frac{Sak}{Pj} \quad \textbf{…….(2.4)}$$

Ph = *Prediksi Habis* (Empty Stok Prediction)
Sak = *Stok akhir* (End Of Stok)
Pj = *Rata-rata Penjualan Per hari* (sales average in 1 day)

In case of Ph value then the value behind the decimal point will be calculated into hours, with a conversion table like Table 1.

TABLE 1. *CONVERTION DESIMAL TO HOURS*

Desimal	Hours
0.01	0:14:24
0,02	0:28:48
0,03	0:43:12
….	….
0.99	23:45:36

Offseting steps of DRP need for a calculation that can be optimized and determine the scheduling order to be more secure, informative and precise. Calculations for Inventory control system uses the concept of min-max stock and Time Phased Order Point [24]. Description of the concept of such calculations as below.

a). The concept of Min-Max Stock Level

The concept of minimum and maximum Stock can be done any time, with the concept of reorder point [12]. In this concept each item is determined maximum-minimum stock levels to be adequate and not excessive. So if the stock has reached the minimum amount the immediate purchase of goods, until the goods have reached the maximum of the purchase of discontinued inventory. if the goods in stock is continued then a time will arrive at the minimum inventory again, do the purchase again, and so on [21]. Min-Max concept is formulated as follows

Q = Max - Min ... . (2.5)

Q = The amount that needs to be re-order for inventory replenishment. In this case the number of charging stations Scheduling is based on the value of Q but based on the Net Requirements and Lot at Pertamina.

Min = (LD x AU) + SS. ... ... (2.6)

Min = Minimum stock, is the amount of usage during the time the purchase order that is calculated from the multiplication between the time of the order (in months) and the average usage in a month plus the safety stock. The minimum value of this stock will be used to determine the lowest level of premium at The Gas Station, if below this value then the level of inventory is worth LESS.

Max = 2x (T x AU). .... (2.7)

Max = Maximum stock, is the maximum allowed number stored in inventory, ie the amount of usage for 2 x time of the order, which is calculated from the multiplication of 2 times of the order and the average usage for a month. Maximum value of this stock will be used to determine the highest level of premium inventory at The Gas Station, if the value of premium inventory levels above this value then the stock is worth SAFE.

SS = (AU / 24) x K ... ... (2.8)
SS = (Safety Stock)
K = Arrived Order Delay (Hours)
LD = Lead Time
AU = Average Usage = Use average in 1 day

Safety Stock is an inventory of stored reserves in anticipation of customer demand that is difficult to know with certainty. Reserve stock is kept to meet seasonal or cyclical demand [13]. In the case of scheduling at The Gas Station Stock no real security on the other tanks because each tank of gas stations do not have the reserves to accommodate this safety stock. So that the safety stock calculation only to delay the arrival of orders only and stored in the same tank, with the calculation of the average amount of usage in one day divided by 24 hours and multiplied by the number of hours of delay.

b). The concept of Time Phased Order Point

The point of order based on the time frame or time-phased order point is a different concept with the concept of ordinary reorder point, where the system is based on the number in stock or can be called quantity-based order point. Time phasing is the exposure range of goods based on the needs of the future. This method is focused on managing the flow of inventory within a certain timeframe [6]. Anticipation is expected from the way this is the first deficiency or excess inventory can be known or calculated before, orders made in anticipation of the need to come and the rest of the existing inventory. Both the horizon view of the need, inventory, plan and plan for the arrival of income that will come, beyond the time of order. The third provision of goods can recognize problems before they occur, so that preventive measures can be done earlier. Time Phased Order Point (TPOP) can be searched with the following formula:

TPOP = ID + DD + SS.....(2.9)

ID = *Independent Demand During Lead Time*
DD = *Dependent Demand During Lead Time*
SS = *Safety Stock*

c). Independent Demand

Is a demand for an item that is not related to demand for other items. These requests need to be predicted to get a more accurate prediction. In this study the determination of independent demand forecasting using moving averages.

d). Dependent Demand

Is a demand for items that are directly related to other items or end products. Inventory items that follow a pattern of "dependent demand" should be counted, so it does not need to be foreseen. In this study the dependence of other items are lead time, so the calculated value of the dependent demand during lead time is only just.

III. METHODOLOGY

A. Tools Research

The research tools associated with the tools used to process data and retrieve data and perform manufacturing applications, including:

1. Computer specification used in this study is the Intel Xeon Processor 2.4 GHz, 2G RAM, 160g hard drive, monitor and mouse devices and keyboards.
2. Operating System Microsoft Windows 7 Ultimate 32-bit.
3. Designing Software for the system:
   a) Use Case Diagram, Entity Relatioship diagrams, flow charts
   b) Microsoft Visio, Microsoft Office, , Microsoft Visio, Macromedia Dreamweaver, a Web-based Programming Language.
4. Server for WEB
   a) program for a server with Apache Friends XAMPP (Base Package) version 1.7.3
   b) Processing a database with MySQL 5.1.41 (Community Server) with engine PBXT 1.0.09-rc
   c) PHP 5.3.1 (PEAR, Mail_Mime, MDB2, Zend)
5. Web Browser Mozila FireFox 4.0, Opera version 11.0

B. Materials Research

As materials research is ordering inventory control model Premium by optimizing point-based order period (Time Phased Order Point) as Figure 3.

1). Inventory Control System Model

Premium inventory control model on Figure 3 originated from the reduction in premium on the stock tank buried because of the sales process, if the stock reaches the point of ordering based on time range (Time Phased Order Point) or are below the system will give warning to hold a reservation premium.

If there is delay in the arrival ordering the sale will still be met with a safety stock that has been calculated based on the safety order time. Premium stock position is measured to determine inventory level indicator, if the inventory level is above Qmax is SAFE, if below Qmin the Inventory Level is LESS and if it is between Qmin and Qmax the inventory level is MEDIUM.

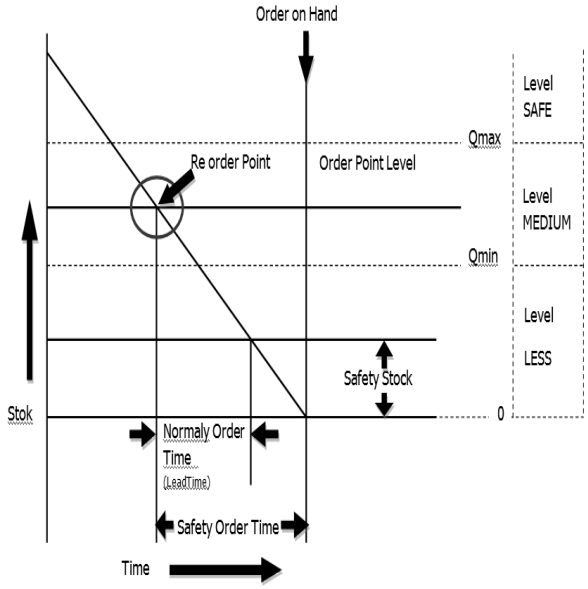

FIGURE 3. INVENTORY CONTROL SYSTEM MODEL

C. System Architecture

The system will be built where the Web-based program will be run and stored on the server. All data will be stored in a database by using the My SQL database. Data processed by the method of sales forecasting moving average,. further define the method of inventory control Distribution planning requirements through the process of netting, lotting, offsetting and explosion. The following description inventory control system architecture.

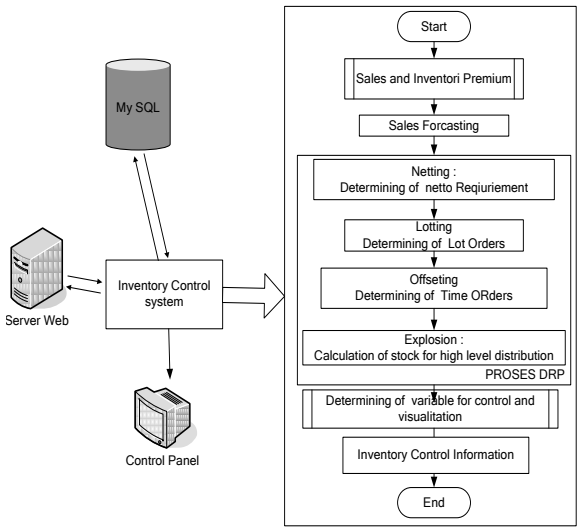

FIGURE 4. INVENTORY CONTROL SYSTEM ARCHITECTURE

D. Design System

At this stage of the process of designing systems using Unified Modeling Language (UML) which is an object-oriented modeling language for specification, visualization, and construction of system or software [5]. The following are the models used in the development of scheduling systems:

1). Use Case Diagram

Describe activities that can be done by the system from the viewpoint of the user as the user (external observer) and is associated with scenarios that can be done by the user.

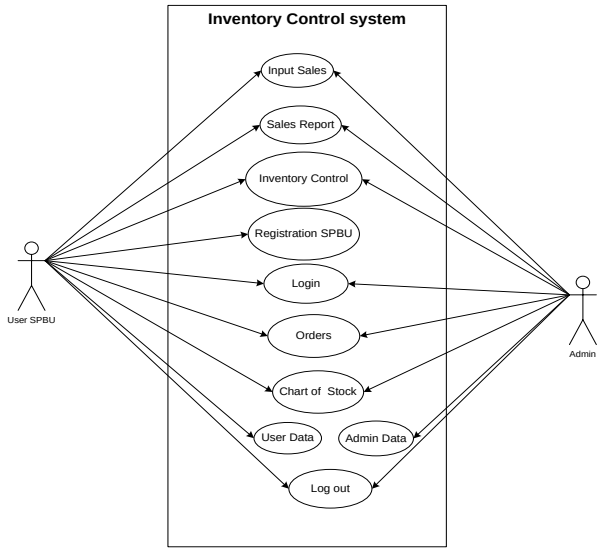

FIGURE 5. USES CASE DIAGRAM INVENTORY CONTROL SYSTEM

Figure 5. indicates that the system will be developed to have an actor and 10 use cases, as for the details of actors and use cases are as follows:

1. Actors in this inventory control system is The Gas Station that is user supervisor stations.
2. Use Case
   a. Input Sales: activities include premium sales data into the system every day, the time determined policy of Gas Station head office.
   b. Sales Report: check sales that can be viewed every time.
   c. Inventory Control: with this case uses the user can see when to place an order right
   d. Stock charts stations: aktifikas is used to view the inventory from time to time in graphical form.
   e. Inventory reservations: activities that are used to place an order premium, for which data are sent directly to the distribution center.
   f. Acceptance of Order: activities that used to make ordering premium receipts, which have been accepted by retail outlets.
   g. User registration: Activities that used to enter user data
   h. Edit User: Activities that used to edit user data.
   i. Login / Log out: used for entry / exit system

2). Class Diagram

A diagram illustrates the object contained in the system and the relationships among these objects [5]. Class diagram below a portrait of the object contained in the inventory scheduling system at the gas station and the relation between thoseobjects.

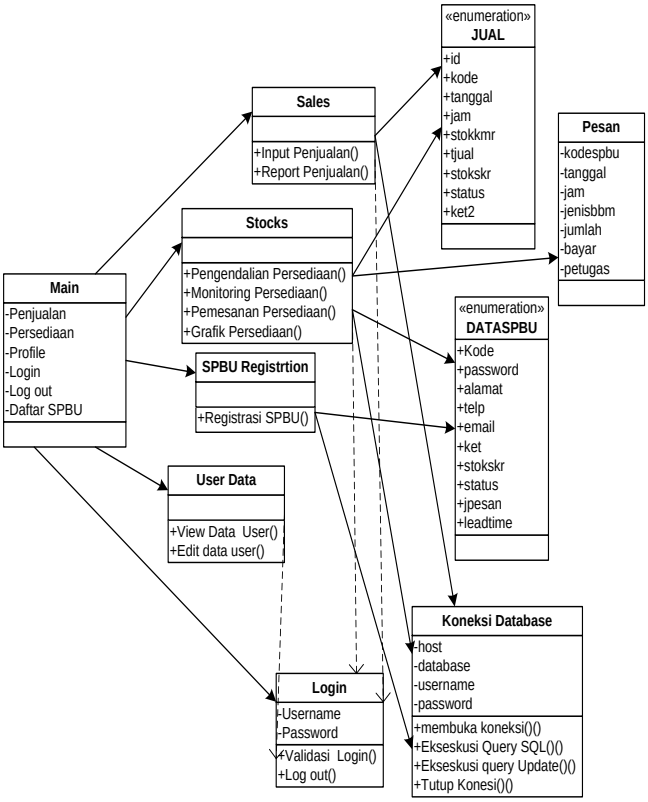

FIGURE 6. CLASS DIAGRAM INVENTORY CONTROL SYSTEM

Figure 6. above shows the performance of objects in the system and its relation database used in the process therein. The first class are sales, inventory, monitoring, profile, login, log out, view filling stations and retail outlets Register. Class diagram of the two is the first description of the class diagram, as follows:

1. Login User Class is used to validate the user will enter as the responsible retail outlets. This class as a condition to be able to access other classes in the system.
2. Sales class contains a user's form input process sales and sales report that uses a table selling, database connections. Where this class can be accessed after login.
3. Class caches contain a user process in the form of inventory scheduling, monitoring inventory, ordering, receiving orders and graphics supplies. Each class uses a table filling stations, selling, messaging and database connections. Where this class can be accessed after login.
4. Class list of gas stations is a class that is used for the registration of retail outlets. The data is stored in the user table.
5. Class Profile In the user menu there are several menus that are used to manage user data, sales data, inventory monitoring, scheduling and ordering supplies to the receipt of inventory.

3). Conceptual Data Model Diagram

Is a diagram that shows the relationship between data entities and attributes of the database system. For a portrait of a database design that will be used in system design with Conceptual Data Model (CDM). Relationships between entities in the Conceptual Data Model can be seen in Figure 7. The system uses four tables for the manufacture of these systems. Each table has its own functions, fields, the number of different fields.

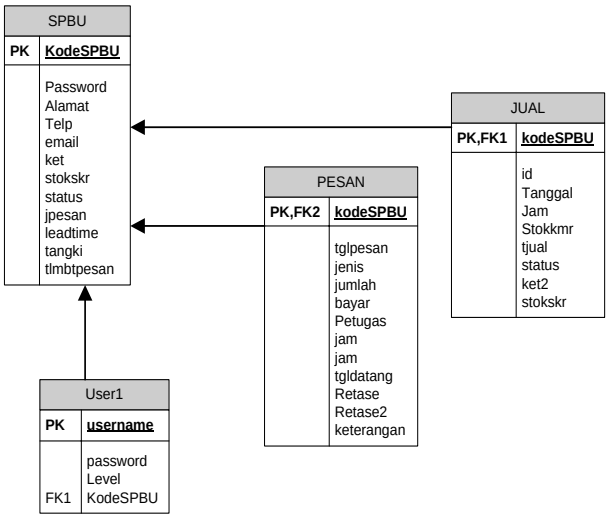

FIGURE 7. CONCEPTUAL DATA MODEL INVENTORY CONTROL SYSTEM

The tables are used there are 4 pieces of User1, gas stations table, the table and the table Selling Book, each of which has a primary key (PK) used to be in charge of data in the table will not happen duplication of data and foreign key (FK) as a key guests for the relation between the tables. Field underlined the primary key of the table and. In figure 5.4 will be seen around the relationships between tables.

IV. RESULT AND ANALYSIS

A. Result Implementation System

Information systems inventory control premium at The Gas Station is made using the programming language PHP 5.0, MySQL database. After all the design is complete and the system has been implemented subsequent testing system is used to solve the case using sales data in retail outlets.

1). Inventory Control System Interface

The results of the interface design of web-based inventory scheduling system is implemented in two web pages by using Web-based programming language is PHP. The first page is the start page for the user that contains the command functions for the user. First display to be viewed by the user is the login page, in which there are functions login, and list of retail outlets. Only registered users can login.

2). User Menu Inventory Control system

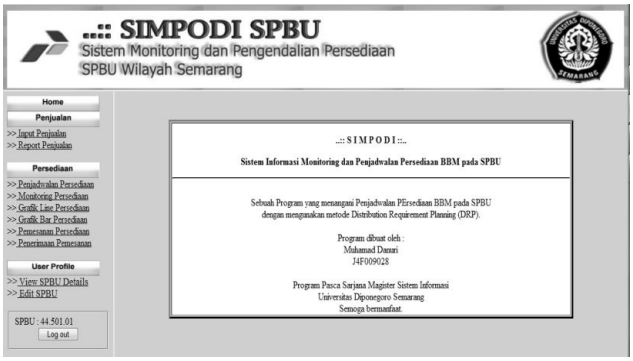

FIGURE 8. USER MENU INVENTORY CONTROL SYSTEM

First display to be viewed by the user after a login process is as Figure 8, in which there are knobs for the collection of sales, inventory data collection and user profile and log out. All activities start from the input of sales, then check the scheduling with the inventory control button and inventory chart button, after which it can place an order and its acceptance. On this page user can see the gas station profile data and user data changes entered by pressing the edit key retail outlets. If the user is finished can press a button and it will log out leaving this page Log in to the courtyard.

3). Inventory Control System Information

The main function for the user stations are order information Inventories can be displayed by pressing the menu button Inventory control, and will appear as Figure 9.

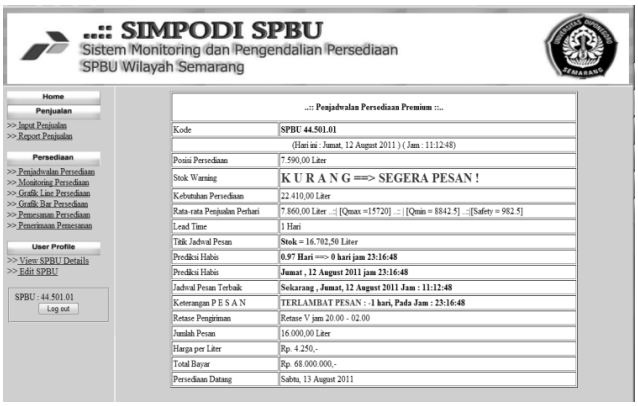

FIGURE 9. INVENTORY CONTROL SYSTEM INFORMATION

B. Analysis

From the case study of sales data and inventory replenishment in March and April 2011 at the gas station 44.501.01 using inventory control system can provide inventory fulfillment, even this control system can reduce the level value is less and the number of ordering supplies.

A case study of sales data and inventory replenishment in March and April 2011 obtained the results as Figure 10.

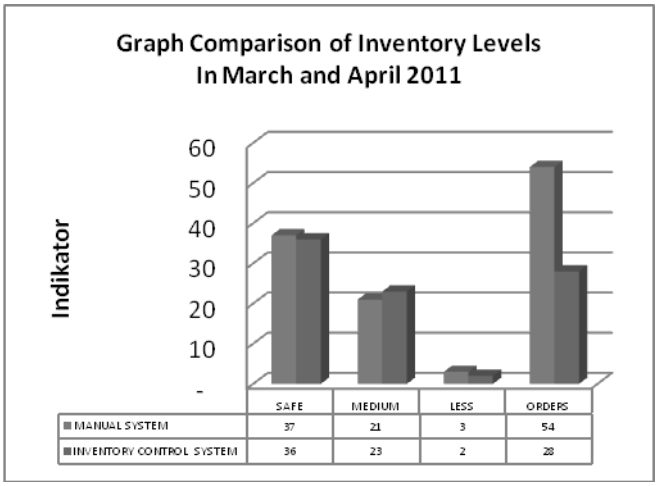

FIGURE 10. GRAPH COMPARISON OF INVENTORY LEVELS IN MARCH AND APRIL 2011

From the results above shows that the level of inventory control system for two months less a decline of 3 times to 2 times, then the number of orders decreased significantly from 54 times to 28 times the message the message, this can reduce the losses that occur on the reservation, demolition and sales at Gas Station. The level was increased 2 times and down 1 times safe levels. This means that the inventory control system can provide efficiency and efektifity at the Gas Station.

V. CONCLUSIONS

Based on the results of research and discussion of inventory control system of premium fuel with the concept of Min-Max Stock Level and Time Phased Order Point on the DRP method can be put forward some conclusions as follows:

1. Fulfillment Systems stock before the research is quite able to cope with meeting the needs of customers at gas stations but contains a lot of risk because the process is still using instinct and lack of monitoring of premium inventory at all times.
2. Inventory control system with the concept of min-max stock levels and Time Phased Order Point may be an alternative in the fulfillment of ordering inventory and reduce losses, dismantling and sales that occur at gas stations. It was shown that the scheduling system with this method has several advantages including:
   a. Scheduling plan premium inventory to be more controllable because no supporting information at any time in the form of monitoring sales and inventory stock.
   b. Provide security and convenience in data processing because all the data stored in the database.
   c. Reduce the risk of losses due to shortage of supplies and ordering losses.

From the sales data and inventory replenishment in March and April 2011 proved inventory control system with the concept of min-max stock level and time phase order point is able to handle inventory and fulfillment ordering reduce some losses, dismantling and sales that occur at gas stations. From the data in the system has only 2 times less level position in the tank capacity 7.590 liters and 7.908 liters, but this position is sufficient for the needs of the day because the average sales is 7.137 liters per day. This means the system can meet the needs of inventory control in Gas Station 44.501.01.

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