Analysis of crude oil inventory using the material requirement planning method

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Abstract. Inventory management plays an important role in the company's success in producing products in quantities based on customer demand. This study uses the MRP method to determine the management of PT. X crude oil inventories so far and produce crude oil inventory management and the arrival schedule of crude oil that must be applied at PT. X. The results show that when manipulating MRP Super Heavy Crude oil from 10 days to 6 days (exercise), better inventory management ie crude oil stocks are in a safe position between safety stock and tank capacity.

1. Introduction
PT. X is a branch of a state-owned company that has the authority to manage oil, gas and geothermal resources in Indonesia. PT X uses crude oil as the main raw material in producing its products. PT. X produces three types of products namely Fuel Oil, Special Fuel, and Non-Fuel Oil. PT. X must be able to plan precisely the number of products to be produced so that consumer needs can be met properly. Planning the right amount of products can be realized, among others, by having good raw material inventory management.

Inventory management is a technique related to determining the amount of inventory that must be held to ensure the smooth operation of production, as well as determining the procurement schedule and the number of goods ordered to be carried out by the company [1]. One technique that can be used in managing inventory management is to use the MRP method. Therefore this study uses the MRP method to determine the management of crude oil inventories that have been carried out by PT. X so far and produce crude oil inventory management and the arrival schedule of crude oil which must be applied at PT. X

2. Literature Review

2.1. Inventory Management
Inventories are material deposits in the form of raw materials, processed goods and finished goods [2]. Inventory is defined as goods that are stored for use or sale in future periods [3]. Inventory is needed to ensure the smooth process of meeting the demand for goods according to user needs economically, reducing irregular demand or supply fluctuations and speculation tools for future profits [4].

2.2. Scheduling
Scheduling can be interpreted as allocating several resources to perform several tasks or operations in a certain period to achieve the goals and objectives of the company more optimally [5]. Scheduling is always related to the allocation of available resources at a certain period, and it is a decision making process whose purpose is for optimality [6]. The purpose of scheduling is to increase machine productivity, minimize production costs, reduce delays because they have exceeded the time limit and the fulfillment of the deadline [5].

2.3. Material requirement planning (MRP)

MRP is a bound demand model that uses a list of material requirements, inventory status, estimated revenues, and a master production schedule, which is used to determine the material requirements to be used [7]. MRP as an information system used to plan and control inventory and capacity [8]. MRP is a technique or set of systematic procedures in determining the quantity and time in the process of controlling the needs of materials for interdependent demand components [9].

The purpose of the application of MRP is to minimize inventory where the MRP can determine how much and when an item is needed is adjusted to the master production schedule, increasing efficiency whereby applying MRP, the amount of inventory, production time, and time of delivery of goods can be planned better according to the master production schedule [7]. MRP also aims to reduce risk due to delays in production or delivery [7]. MRP identifies the number of materials and items needed both in terms of quantity and time by taking into account the production grace period and component procurement.

3. Methodology

The object of research is the management of PT X crude oil inventory. The data used in this study is historical crude oil inventory data in the refinery Planning & Optimization division. The data is then processed using the MRP method to calculate crude oil inventory data and schedule the arrival of crude oil. Also, interviews were conducted with staff at the Refinery Planning & Optimization division to analyze the results of the calculation of crude oil inventories according to safety stock and tank capacity.

4. Result

PT X uses two types of crude oil namely Super Heavy Crude Oil and Heavy Crude Oil. Based on historical data of crude oil inventories that have been processed, the calculation results are obtained in table 1 and table 2.

| Week number | Gross requirements | Schedule Receipt | Project on Hand | Safety stock | Tank Capacity | Safety stock Minimum check | Maximum Tank Maximum check |
|-------------|--------------------|------------------|-----------------|--------------|---------------|--------------------------|---------------------------|
| 1           | 81.25              | 921              | 812.5           | 1200         |               |                          |                           |
| 2           | 81.25              | 400              | 1239.75         | 812.5        | 1200          | 108.50                   | 39.75                     |
| 3           | 81.25              | 1158.5           | 812.5           | 1200         | 427.25        | 122.75                   | 346.00                    |
| 4           | 81.25              | 1077.25          | 812.5           | 1200         | 264.75        | 122.75                   | 346.00                    |
| 5           | 81.25              | 996              | 812.5           | 1200         | 108.50        | 122.75                   | 346.00                    |
| 6           | 81.25              | 914.75           | 812.5           | 1200         | 183.50        | 122.75                   | 346.00                    |
| 7           | 81.25              | 833.5            | 812.5           | 1200         | 102.25        | 122.75                   | 346.00                    |
| 8           | 81.25              | 752.25           | 812.5           | 1200         | 21.00         | 122.75                   | 346.00                    |
| 9           | 81.25              | 671              | 812.5           | 1200         | 60.25         | 122.75                   | 346.00                    |
| 10          | 81.25              | 200              | 789.75          | 812.5        | 141.50        | 122.75                   | 346.00                    |
Based on data from table 1, it can be seen that the management of Super Heavy Crude Oil inventory in several periods is lower than the value of the safety stock, amounting to 812.5 MB. Meanwhile, in some periods crude oil inventories have exceeded tank capacity.

Table 2. Minimum maximum check heavy crude oil

| Week number | Gross requirements | Schedule Receipt | Project on Hand | Safety stock | Tank Capacity | Safety stock minimum check | Maximum Tank Capacity |
|-------------|--------------------|-----------------|----------------|--------------|---------------|--------------------------|----------------------|
| 1           | 43.75              | 0               | 1190 .5        | 1146 .25     | 1600          | 437 .5                   | 453.75               |
| 2           | 43.75              | 0               | 1322.25        | 1335.5       | 1200          | 437 .5                   | 277.50               |
| 3           | 43.75              | 220             | 1278.75        | 1281.75      | 1200          | 437 .5                   | 321.25               |
| 4           | 43.75              | 0               | 1235 .5        | 1191.25      | 1200          | 437 .5                   | 841.25               |
| 5           | 43.75              | 0               | 1147.5         | 1147.5       | 1200          | 437 .5                   | 753.75               |
| 6           | 43.75              | 0               | 1103.75        | 1103.75      | 1200          | 437 .5                   | 710.00               |
| 7           | 43.75              | 0               | 1235 .5        | 1235.5       | 1200          | 437 .5                   | 496.25               |
| 8           | 43.75              | 0               | 1322.25        | 1322.25      | 1200          | 437 .5                   | 408.75               |
Based on data from table 2 it is known that the inventory management for Heavy Crude Oil is still in a safe situation because the value of crude oil inventories is still in the range between the minimum safety stock value and the maximum tank capacity.

Based on the MRP calculation of the proposal on Crude Oil, after the manipulation of the 6-day review period, the calculation results obtained as in table 3 and table 4.
Table 3. Results of the proposed super heavy crude oil

| Week number | Gross requirements | Schedule Receipt | Project on Hand | Safety stock | Tank Capacity | Safety stock minimum check | Maximum Tank Capacity check |
|-------------|--------------------|------------------|-----------------|-------------|--------------|---------------------------|----------------------------|
| 1           | 0                  | 921.00           | 812.5           | 1200        | 108.50       | 355.25                    |                             |
| 2           | 81.25              | 0                | 844.75          | 812.5       | 1200         | 32.25                     | 36.50                      |
| 3           | 81.25              | 0                | 1082.25         | 812.5       | 1200         | 351.00                    | 117.75                     |
| 4           | 81.25              | 0                | 1001.00         | 812.5       | 1200         | 269.75                    | 199.00                     |
| 5           | 81.25              | 0                | 919.75          | 812.5       | 1200         | 188.50                    | 280.25                     |
| 6           | 81.25              | 0                | 919.75          | 812.5       | 1200         | 107.25                    | 280.25                     |
| 7           | 81.25              | 0                | 838.50          | 812.5       | 1200         | 107.25                    | 361.50                     |
| 8           | 81.25              | 0                | 1157.25         | 812.5       | 1200         | 26.00                     | 42.75                      |
| 9           | 81.25              | 0                | 1076.00         | 812.5       | 1200         | 344.75                    | 124.00                     |
| 10          | 81.25              | 0                | 994.75          | 812.5       | 1200         | 263.50                    | 205.25                     |
| 11          | 81.25              | 0                | 913.50          | 812.5       | 1200         | 182.25                    | 286.50                     |
| 12          | 81.25              | 0                | 913.50          | 812.5       | 1200         | 101.00                    | 286.50                     |
| 13          | 81.25              | 0                | 832.25          | 812.5       | 1200         | 101.00                    | 367.75                     |
| 14          | 81.25              | 0                | 1151.00         | 812.5       | 1200         | 19.75                     | 49.00                      |
| 15          | 81.25              | 0                | 1069.75         | 812.5       | 1200         | 338.50                    | 130.25                     |
| 16          | 81.25              | 0                | 988.50          | 812.5       | 1200         | 257.25                    | 211.50                     |
| 17          | 81.25              | 0                | 907.25          | 812.5       | 1200         | 176.00                    | 292.75                     |
| 18          | 81.25              | 0                | 907.25          | 812.5       | 1200         | 94.75                     | 292.75                     |
| 19          | 81.25              | 0                | 826.00          | 812.5       | 1200         | 94.75                     | 374.00                     |
| 20          | 81.25              | 0                | 1144.75         | 812.5       | 1200         | 13.50                     | 55.25                      |
| 21          | 81.25              | 0                | 1063.50         | 812.5       | 1200         | 332.25                    | 136.50                     |
| 22          | 81.25              | 0                | 982.25          | 812.5       | 1200         | 251.00                    | 217.75                     |
| 23          | 81.25              | 0                | 901.00          | 812.5       | 1200         | 169.75                    | 299.00                     |
| 24          | 81.25              | 0                | 901.00          | 812.5       | 1200         | 88.50                     | 299.00                     |
| 25          | 81.25              | 0                | 819.75          | 812.5       | 1200         | 88.50                     | 380.25                     |
| 26          | 81.25              | 0                | 1138.50         | 812.5       | 1200         | 7.25                      | 61.50                      |
| 27          | 81.25              | 0                | 1057.25         | 812.5       | 1200         | 326.00                    | 142.75                     |
| 28          | 81.25              | 0                | 976.00          | 812.5       | 1200         | 244.75                    | 224.00                     |
| 29          | 81.25              | 0                | 894.75          | 812.5       | 1200         | 163.50                    | 305.25                     |
| 30          | 81.25              | 0                | 894.75          | 812.5       | 1200         | 163.50                    | 305.25                     |

Based on the calculation of the MRP proposal on Super Heavy Oil, after manipulation of the review period of 6 days, a waiting time of 10 days (arrival of crude oil raw materials every 5 days) with a parcel (lot size) of 400 MB, no crude oil inventory is found that is less than the stock value safety or not exceed the capacity of the existing tank. However, as an improvement step in ensuring the availability of Crude Oil, the initial inventory would be better if it was changed at least 950 MB, with the consideration that this could prevent the project value which is less than the security value of the inventory.
| Week number | Gross requirements | Schedule Receipt | Project on Hand | Safety stock | Safety stock minimum check | Tank Capacity | Maximum Tank Maximum check |
|-------------|--------------------|------------------|-----------------|--------------|--------------------------|--------------|-----------------------------|
| 1           | 0                  | 1190,00          | 437,5           | 1600         | 752,50                   | 453,75       |
| 2           | 43,75              | 1146,25          | 437,5           | 1600         | 708,75                   | 497,50       |
| 3           | 43,75              | 1102,50          | 437,5           | 1600         | 665,00                   | 541,25       |
| 4           | 43,75              | 1058,75          | 437,5           | 1600         | 621,25                   | 585,00       |
| 5           | 43,75              | 1015,00          | 437,5           | 1600         | 577,50                   | 628,75       |
| 6           | 43,75              | 971,25           | 437,5           | 1600         | 533,75                   | 672,50       |
| 7           | 43,75              | 927,50           | 437,5           | 1600         | 490,00                   | 716,25       |
| 8           | 43,75              | 883,75           | 437,5           | 1600         | 446,25                   | 760,00       |
| 9           | 43,75              | 840,00           | 437,5           | 1600         | 402,50                   | 803,75       |
| 10          | 43,75              | 796,25           | 437,5           | 1600         | 358,75                   | 847,50       |
| 11          | 43,75              | 752,50           | 437,5           | 1600         | 315,00                   | 691,25       |
| 12          | 43,75              | 708,75           | 437,5           | 1600         | 471,25                   | 735,00       |
| 13          | 43,75              | 665,00           | 437,5           | 1600         | 427,50                   | 778,75       |
| 14          | 43,75              | 621,25           | 437,5           | 1600         | 383,75                   | 822,50       |
| 15          | 43,75              | 577,50           | 437,5           | 1600         | 340,00                   | 866,25       |
| 16          | 43,75              | 533,75           | 437,5           | 1600         | 296,25                   | 910,00       |
| 17          | 43,75              | 490,00           | 437,5           | 1600         | 252,50                   | 753,75       |
| 18          | 43,75              | 446,25           | 437,5           | 1600         | 208,75                   | 797,50       |
| 19          | 43,75              | 402,50           | 437,5           | 1600         | 165,00                   | 841,25       |
| 20          | 43,75              | 358,75           | 437,5           | 1600         | 127,50                   | 885,00       |
| 21          | 43,75              | 315,00           | 437,5           | 1600         | 928,75                   | 928,75       |
| 22          | 43,75              | 277,50           | 437,5           | 1600         | 233,75                   | 972,50       |
| 23          | 43,75              | 231,25           | 437,5           | 1600         | 190,00                   | 816,25       |
| 24          | 43,75              | 190,00           | 437,5           | 1600         | 346,25                   | 860,00       |
| 25          | 43,75              | 150,00           | 437,5           | 1600         | 302,50                   | 903,75       |
| 26          | 43,75              | 111,25           | 437,5           | 1600         | 258,75                   | 947,50       |
| 27          | 43,75              | 652,50           | 437,5           | 1600         | 215,00                   | 991,25       |
| 28          | 43,75              | 565,00           | 437,5           | 1600         | 171,25                   | 1035,00      |
| 29          | 43,75              | 721,25           | 437,5           | 1600         | 127,50                   | 878,75       |
| 30          | 43,75              | 721,25           | 437,5           | 1600         | 127,50                   | 878,75       |

Based on the proposed MRP calculation on Heavy Crude Oil, after doing the 6-day review period (exercise), the MRP calculation method for Heavy Crude Oil, while using a lead time of 10 days (arrival of crude oil raw materials every 5 days) with a parcel amount (lot size) 200MB, because the value of Crude Oil inventories is still in the range between the minimum safety stock value and the maximum tank capacity.
5. Conclusion

- Through the MRP calculation method based on preliminary data, it was found that the Super Heavy Crude Oil inventory management in some periods was lower than the value of the safety stock, amounting to 812.5 MB. This can stop the implementation of production at PT X if the supply of super-heavy crude oil runs out while the raw materials ordered have not yet arrived. Meanwhile, in some periods, it is known that crude oil supplies exceed tank capacity, this is also not good for the company because it will increase the cost of saving for the company. Whereas inventory management for Crude Oil Heavy Crude Oil is still in a safe situation because the value of Crude Oil inventory is still in the range between the minimum safety stock value and maximum tank capacity.

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