Increasing service systems in network distribution

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Abstract. A company that engaged in the chemical industry and produces urea and ammonia, needs an arrangement on the distribution chain to suppress the possibility of stock out. An inventory on Disaster Centre is arranged in order to meet the demand of retailers. The determination of distribution routes that can reduce waste in terms of the use of transportation facilities as to minimize the time, and distance is analyzed by Distribution requirement planning method. Using the selected forecasting function based on the time series method, the total demand for the next 12 months is obtained, by calculating by applying the distribution requirement planning method, an total request cannot be fulfilled decrease by 67.38% from 417 orders to 136 orders.

1. Introduction
Logistics is the art and science of regulating and controlling the flow of goods, energy, information, and other resources, such as products, services, and humans from production sources to markets with the aim of optimizing the use of capital [1]. One of the activities in logistics is distribution. Distribution is the process of distributing product from producers to those in need. Distribution is an important factor for companies to be able to deliver products precisely to consumers [2-4]. The accuracy of product delivery must have the basis of scheduling and determining the right route, thus speeding up product delivery times and saving product shipping costs. There are so many routes that companies can choose in distributing their products, and require different costs, due to that we need a method that can analyze product distribution in order to minimize the time, distance and cost.

The company that research was conducted engaged in the chemical industry, especially producing urea and ammonia fertilizer.

The problem faced by the company is the size of the retailer's ordering lot to Distributon Center and from the Distribution Center to the Distribution Warehouse in the North Sumatra region due to the higher number of retailer orders compared to inventory in Distribution Centre resulting in stock out. From the total demand that must be fulfilled by Distribution Centre Sumatra, information is obtained that around 10% of total requests cannot be fulfilled because shipping from the Distribution Warehouse to Sumatra Distribution Center is only done every 2 times a week as much as 3000 tons / shipment.

Table 1. Some Display of Product Delivery to Retailers in January, North Sumatra Region.

| Retailer | Num. of Request (ton) | Num. Of Shipment (ton) |
|----------|----------------------|------------------------|
|          |                      |                        |
Based on the above problems, it requires an inventory arrangement in the distribution chain to suppress the possibility of stock out, and regulate inventory in disaster centre so that it can meet retailers' demands. In addition, the determination of fertilizer distribution routes can reduce waste in terms of the use of transportation facilities so that it can minimize time, distance and energy more efficiently.

To determine the amount of inventory in the distribution chain may use methods of Distribution requirement planning. Distribution requirement planning method is a distribution planning method to calculate product requirements at each distribution. This method has been widely used in research.

2. Research Methods
The type of research used is descriptive research in which this study aims to systematically describe the facts and characteristics of an object or a particular population. This descriptive study was conducted by measuring lot orders from retailers to Distribution Centers and from Distribution Centers to Distribution Warehouses and product distribution routes from distribution centers (disaster centre) and retailers in North Sumatra.

Center distance data to the retailer. The dependent variable in this study is the distribution schedule. The Framework of Thinking in this research can be shown in Figure.1.

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| Day   | PS Line III | KJ Line III | SK Line III | AS Line III | BG Line III | RP Line III | SP Line III | GS Line III |
|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1     | 71          | 71          |             |             |             |             |             |             |
| 4     | 61          | 61          | 40          | 21          | 33          | 33          |             |             |
| 5     |             |             |             |             | 38          | 8           | 95          | 95          |

Figure 1. Research Thinking Framework.
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3. **Result and Discussion**

3.1. **Retailer Demand Forecasting Results**

Based on the data request 12 months is carried out forecasting on the respective retailer for the next 12 months. The methods used in forecasting demand for this regression is a method which is one of the methods of the times series. The selection of trend forecasting that is used is selected based on the value of the smallest of the two SEE an alternative trend used in forecasting calculations based on scatter diagram.

From the results, there is a difference between the forecasting the demand for the company’s past with the forecasting of future demand. By using the selected forecasting function then retrieved the total demand for the next 12 months can be seen in table 2.

| City | Actual Past Demand | Demand Forecast with Cyclical Method | Percentage Request Difference | Percentage of Request Difference |
|------|--------------------|-------------------------------------|------------------------------|----------------------------------|
| PS   | 9.845              | 9.849                               | 0.041%                       | 0.041%                           |
| KJ   | 10.219             | 10.225                               | 0.059%                       | 0.059%                           |
| SK   | 10.159             | 10.166                               | 0.069%                       | 0.069%                           |
| AS   | 9.861              | 9.866                                | 0.051%                       | 0.051%                           |
| BG   | 9.924              | 9.930                                | 0.060%                       | 0.060%                           |
| RP   | 9.684              | 9.690                                | 0.062%                       | 0.062%                           |
| SP   | 9.948              | 9.954                                | 0.060%                       | 0.060%                           |
| GS   | 9.106              | 9.111                                | 0.055%                       | 0.055%                           |

From table 2 it can be seen that the results of demand forecasting for the next year have approached the actual demand data, which can be seen from the minimum demand gap.

3.2. **Order Quantity Calculation**

The method used in calculating order quantity for each retailer is economic order quantity.[11-12] Order Quantity calculations are performed using different economic order quantity methods with Quantity Order calculations on companies that use trial methods and errors where each shipment does not send the same amount, but on request. EOQ calculation is done using the following formula:

\[
EOQ = \sqrt{\frac{2 \times D \times k}{h}}
\]  

(1)

Description:
- D = Number of goods needs during one period (weeks)
- k = Ordering cost per message
- h = Holding cost for one period (weeks)

Calculation of EOQ values for line III PS

D = 220
K_PS = 2,940,000
h = 10% of units sold = 10% * 90,000 = 9,000

\[
EOQ = \sqrt{\frac{2 \times D \times k}{h}} = \sqrt{\frac{2 \times 220 \times 2,940,000}{9,000}} = 352
\]
The following is the EOQ calculation for each retailer:

Table 3. Recapitulation of Order Quantity Calculations in Weekly.

| Retailer | Economic Order Quantity (Ton) |
|----------|------------------------------|
| Line III PS | 352 |
| Line III KJ | 379 |
| Line III SK | 352 |
| Line III AS | 532 |
| Line III BG | 530 |
| Line III RP | 531 |

Table 4. Recapitulation of Order Quantity Calculations in Weekly.

| Retailer | Economic Order Quantity (Ton) |
|----------|------------------------------|
| Line III SP | 542 |
| Line III GS | 555 |

From the table above, it can be seen that by sending based on calculations using the EOQ method, the optimum number of deliveries that can meet consumer demand is obtained, whereas compared to actual shipments that are based on the request of each retailer that disaster centre cannot meet due to out of stock. So that by implementing shipments based on EOQ calculations, it is expected that there will be no out of stock conditions due to the uncertain number of shipments and can improve the service system.

3.3. Frequency Ordering and Safety Stock Calculation

The amount of ordering frequency from retailers is one of the important factors affecting the cost of distributing products from the factory to retailers, where the high frequency of product delivery means reducing the cost of storage, and vice versa, if the low frequency of delivery raises the risk of high storage costs. In Table 5, You can see the comparison of the order frequency 12 months ago with the order frequency plan for the next 12 months.

Table 5. Comparison of Order Frequency (Times).

| No | Retailer | Actual Order Frequency for Last 12 Months (Without Distribution requirement planning) | Planned Frequency of 12 Months Ordering (With Distribution requirement planning) | Percentage of Order Frequency Difference |
|----|----------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------|
| 1  | Line III PS | 50 | 25 | 50,000 % |
| 2  | Line III KJ | 52 | 26 | 50,000 % |
| 3  | Line III SK | 57 | 31 | 54,386 % |
| 4  | Line III AS | 50 | 38 | 76,000 % |
| 5  | Line III BG | 50 | 38 | 76,000 % |
| 6  | Line III RP | 55 | 43 | 78,182 % |
Table 5. Comparison of Order Frequency (Times) (continue).

| No | Retailer | Actual Order Frequency for Last 12 Months (Without Distribution requirement planning) | Planned Frequency of 12 Months Ordering (With Distribution requirement planning) | Percentage of Order Frequency Difference |
|----|----------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------|
| 7  | Line III SP | 53                                                                               | 41                                                                            | 77,358%                                  |
| 8  | Line III GS | 50                                                                               | 39                                                                            | 78,000%                                  |
|    | Total      | 417                                                                               | 136                                                                           | -                                         |

By using the Distribution requirement planning method, the frequency of the number of orders is obtained from 417 orders to 136 orders with a percentage decrease of 67.38%.

Safety stock in this system is a reference for reorder to fulfill forecasting results. Calculation of safety stock can be calculated using the formula:

\[
\text{Safety Stock} = s \times Z
\]  

(2)

The following is the calculation of the safety stock for each retailer:

Table 6. Retailer Safety Stock (Ton).

| Retailer | Safety Stock |
|----------|--------------|
| PS       | 39           |
| KJ       | 41           |
| SK       | 37           |
| AS       | 33           |
| BG       | 35           |
| RP       | 33           |
| SP       | 43           |
| GS       | 32           |

Table 7. Safety Stock of Retailers of Every Months (Ton).

| Period | Week | Line III | Line III | Line III | Line III | Line III | Line III | Line III | Line III |
|--------|------|----------|----------|----------|----------|----------|----------|----------|----------|
|        |      | PS       | KJ       | SK       | AS       | BG       | RP       | SP       | GS       |
| Jan    | 4    | 210      | 221      | 216      | 202      | 198      | 205      | 217      | 194      |
| Feb    | 4    | 218      | 214      | 211      | 206      | 197      | 207      | 227      | 192      |
| Mar    | 5    | 171      | 165      | 166      | 159      | 166      | 186      | 152      |          |
| Apr    | 4    | 207      | 200      | 205      | 212      | 202      | 206      | 230      | 187      |
| May    | 5    | 160      | 158      | 164      | 171      | 166      | 163      | 178      | 148      |
| Jun    | 4    | 194      | 200      | 206      | 212      | 212      | 201      | 211      | 185      |
| Jul    | 4    | 191      | 205      | 209      | 209      | 216      | 199      | 199      | 186      |
| Aug    | 5    | 154      | 171      | 170      | 165      | 174      | 158      | 151      | 151      |
| Sep    | 4    | 197      | 221      | 217      | 202      | 216      | 198      | 184      | 191      |
| Oct    | 4    | 204      | 227      | 219      | 200      | 212      | 199      | 185      | 193      |
| Nov    | 5    | 169      | 183      | 176      | 159      | 166      | 161      | 154      | 156      |
| Dec    | 4    | 217      | 227      | 219      | 200      | 203      | 204      | 204      | 195      |
| Total  | 52   | 2302     | 2392     | 2378     | 2306     | 2320     | 2266     | 2326     | 2130     |
3.4. Distribution requirement planning and Pegging Information

Distribution requirement planning can be arranged for each retailer on a weekly time bucket, because the lead time of each reviewer does not exceed 1 month or only weekly. Distribution requirement planning sheet is obtained after going through several stages, namely: [13-15]

1. Gross Requirement (GR): the number of requests to be distributed obtained from the results of forecasting
2. Schedule receipt (SR): the number of receipts that have been scheduled from the previous PORel results
3. Project on Hand (PoH): projection of the amount of inventory that still exists at a certain time phased.
4. Plan Order Receipt (PORec): the number of orders scheduled for the period needed
5. Plan Order Release (PORel): order plan after the lead time information is taken into account. Lead time is the grace period between ordering and receiving orders.

Stock On Hand = 59    Safety stock = 41
Order Quantity = 379    Lead Time = 1 Week
PoH periode 1 = SRi+ POh(i-1)-Gri............(3)
PoH periode 2 = POh(i-1) + PoReci– Gri...(4)

Table 8. Distribution requirement planning Sheet Line III KJ.

| Post Due | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13   | 14   |
|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| GR       | 221  | 221  | 221  | 214  | 214  | 214  | 165  | 165  | 165  | 165  | 165  | 200  |      |      |
| SR       | 379  |      |      |      |      |      |      |      |      |      |      |      |      |      |
| PoH      | 59   | 217  | 375  | 154  | 312  | 98   | 263  | 49   | 214  | 49   | 263  | 98   | 312  | 147  |
| PoRec    | 379  | 0    | 379  | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  |
| PoRel    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    |
| Post Due | 15   | 16   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 24   | 25   | 26   | 27   | 28   |
| GR       | 200  | 200  | 200  | 158  | 158  | 158  | 158  | 200  | 200  | 200  | 200  | 205  | 205  | 205  |
| SR       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| PoH      | 326  | 126  | 305  | 105  | 326  | 168  | 389  | 231  | 73   | 252  | 52   | 231  | 410  | 205  |
| PoRec    | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  |
| PoRel    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    | 379  | 0    |

4. Conclusion

The conclusions that can be concluded in the final assignment research are as follows.

- Using the forecasting function selected based on the times series method, the total demand for the next 12 month, namely 9.849 tons at PS line, 10.225 tons at KJ line, 10.166 tons at SK line, 9.866 tons at AS line, 9.930 ton at BG line, 9.690 ton at RP line, 9.954 ton at PS line, and 9.111 ton at GS line
- The optimum amount obtained based on the EOQ method for each retailer is 352 tons on the PS line, 379 tons on the KJ line, 352 tons on the SK line, 532 tons on the AS line, 530 tons on the BG line, 531 tons on the line RP, 542 tons on the PS line and 555 tons on the GS line.
- The calculation of order frequency for each retailer is 25 times on the PS line, 26 times on the KJ line, 31 times on the SK line, 38 on the AS line, 38 on the BG line, 43 on the RP, 41 times on the PS line and 39 times on the GS line.
- Safety stock calculation results for each calculation of safety stock for each retailer is 39 tons on the PS line, 41 tons on the KJ line, 37 on the SK line, 33 tons on the AS line, 35 tons on the BG line, 33 tons on line RP, 43 tons on line PS and 32 tons on line GS.
By applying the distribution requirement planning method, the distribution schedule planning becomes an order. Product distribution carried out by the company throughout was 417 orders. When applying the distribution requirement planning distribution method only 136 orders were made, with a percentage decrease of 67.38%.

Application of the distribution requirement planning method with the Q model inventory system, yields lot order size of 352 tons on the PS line, 379 tons on the KB line, 352 tons on the SK line, 532 tons on the AS line, 530 tons on the Balige line, 531 tons on line RP, 542 tons on the PS line and 555 tons on the GS line with recapitulation of orders totaling 135 times.

By applying the distribution requirement planning method, there was a decrease in the number of orders by 67.38% from 417 orders to 136 orders.

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