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# DRP: Joint Requirement Planning in Distribution Centre and Manufacturing

I Rizkya\*, K Syahputri, R M Sari, I Siregar, M M Tambunan and Anizar

Department of Industrial Engineering, Faculty of Engineering, Universitas Sumatera Utara

\*indahrizkya@usu.ac.id

**Abstract.** Companies are always seeking differentiation from their competitors. Efforts are made by providing the best service to consumers, fast order fulfillment, reliable delivery times, and better response to inquiries about products, orders, and deliveries. This paper aims to provide an overview of joint distribution planning between distribution centre and manufacturing industry with DRP logic. Distribution Resources Planning (DRP) is a method that can be used to integrated inventory policy in distributors and manufacturing. DRP implementation starts from managing sales forecasts, creating master schedules, and running DRP. The DRP represents a way of thinking with respect to managing the entire function of distribution. The DRP Method can be known the optimal number of order lot sizing, frequency of ordering, safety stock at each distribution centres. DRP can reduce the frequency of ordering so that the cost of the order becomes minimize. DRP implementation reduces 23,9% of order frequency and saves order cost 42,9%.

## 1. Introduction

Distribution problems often happens in companies with large marketing areas. Placement of inventory at each location should be considered and handled properly so that the inventory can be optimal or not store in large quantities [1].

Distribution is a responsible part for planning, executing, and controlling the flow of material from producer to consumer. Distribution Requirement Planning is the key in planning and controlling the companies of distribution activities [2]. Distribution Requirement Planning (DRP) is a systematic approach to get the delivery process of goods more efficient by determining which goods, in what quantities, and in which location will be delivered to anticipation of demand. DRP is used to determine the quantity of replenishment for a certain time period. DRP is used to minimize the shortage of products in the distribution location and reduce ordering cost, transporting cost, and inventory cost.

In DRP, product demand at the final distribution point determines demand at intermediate distribution centres [3]. The DRP system is a complex information and control system, combining sales forecasting, inventory levels, and delivery problems, to schedule how much is needed, where and when [4-5]. Inventory management with DRP concept based on a time horizon daily, weekly, or monthly, so that the planned orders in each distribution centers are filled using DRP logic.

DRP is capable to give a decision about how much the quantity of shipment, where the location and given delivery time. In case of a multilevel distribution network, this distribution process continue for various levels of warehouses such as the centre of warehouse, factory warehouse, etc. [6]. In case of



items distribution inventory balance for a number of distribution centers must be maintained [7], master schedules based on actual sales schedules, orders, sales forecasting can be used to encourage planning processes using DRP logic [5].

DRP system is capable to solve two main problems, there are inventory and order receiving time. DRP gives a decision on a certain echelon to place orders on the next echelon. DRP has an impact on inventory and transportation [3]. Important decisions regarding the balance between ordering and freight costs. The development of an effective inventory model will determine the number of order sizes with a minimum total inventory cost [8].

Several studies have been conducted on the application of DRP in some manufacturing industries. First implementation of DRP was conducted in the pharmaceutical industry by Andre Martin [9]. The implementation of DRP improve turnover inventory, improve service level, lower distribution costs, and increase productivity. A similar study was conducted by Collins and Whybark in the pharmaceutical industry which emphasized the role Master Production Schedule if the company plan to obtain total order costs, storage costs, transportation costs, and low stockout costs [10]. However, until now there are a simple research on control inventory at distribution center especially injection molding industry in Indonesia. This study aims to determine the distribution plan by doing joint planning between manufacturing industry and distribution center. DRP is expected to minimize the amount of inventory at each distribution center.

DRP controls the inventory of company to increase customer satisfaction with planning precisely when goods will be available. Producer satisfaction also increases of goods producing because there's not too large and too long products storing. DRP system gives customers the flexibility to deliver their orders and configurations. DRP system is capable to maintain the inventory level for distribution centre and manufacturing.

## 2. Methodology

This research was conducted in one of the injection molding company in Medan. The object of study is the inventory of plastic product company. Data collected to perform data processing in the form of product demand, data storage costs, lead time, order costs, delivery costs and bill of distribution. The data collected then processed using the method of Distribution Requirement Planning (DRP).

The first step in the use of DRP method begins by determines the demand forecasting based on historical data from January 2017 to December 2017. The second step is to determine the lot sizing by considering the demand variance value, order cost, and storage cost. Lot Sizing is used to determine the quantity of shipment by Economic Order Quantity (EOQ) method. The EOQ equation is:

$$Q_{\text{optimal}} = \sqrt{\frac{2 D k}{h}} \quad (1)$$

$Q_{\text{optimal}}$  value shows optimal shipment quantity,  $D$  shows the number of items required for one period,  $k$  shows order cost at every order, and  $h$  indicates the holding cost for one period. The next step is the calculation of safety stock by considering the service level that has been established by the company and standard deviation of annual demand. The calculation of safety stock is done by using equation 2.

$$SS = Z_{0,95} \frac{\sum_{i=1}^n (x - \bar{x})^2}{n-1} \quad (2)$$

In DRP planning can be seen gross requirement and net requirement. Gross requirement analogized as expected demand. Net requirements obtained from gross requirement reduced by available inventory [11].

The final step is to determine product distribution plan needed after the delivery quantity of each product is optimal. Master scheduled of distribution identifies the product needed at each period and plans of replenishment order to fulfil the demand. The key element of DRP is DRP table, which is

includes important elements such as: (1) demand forecast, (2) current inventory level, (3) safety stock target, (4) amount of charge recommendation, (5) lead time for replenishment.

Master scheduled of distribution obtained by current period to the end of horizon planning. Time interval sets by management cover of the longest cumulative lead time in bill of distribution, includes the allowance for leadtime manufacturing. Master scheduled of distribution includes some important items in DRP table. DRP Table can be seen in Table 1.

DRP table includes gross requirements, scheduled receipts from the higher distribution centers, available quantities (on hand inventory), net requirements, planned order receipts, and planned order releases [3, 4, 12]. After the distribution plan is obtained, it is calculated inventory cost in all distribution center.

<b>Table 1. DRP table.</b>							
<b>Periods</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>..</b>	<b>n</b>	
Gross Requirements							
Scheduled Receipts							
Project on Hand							
Net Requirements							
Planned Order Receipts							
Planned Order Releases							

DRP table is filled for each distribution center. Gross requirement value at distribution center is obtained from master scheduled central facility supply. DRP table is entered following bill of distribution.

### 3. Results and discussion

#### 3.1. Forecast demand

Forecasting demand by time series method of historical demand data. Forecasting is done to predict the monthly demand of distribution center for the next years. Forecasting is done at each distribution center in Banda Aceh, Binjai, Medan, Lubuk Pakam, Tebing Tinggi, Rantau Prapat, and Sibolga. Election of forecasting method based on the smallest error value using MAPE (Mean Absolute Percentage Error) calculation. Total demand (for a year) at each distribution center is 157178, 30689, 168993, 13278, 13668, 74919, 71386 units.

#### 3.2. Shipment quantity

Shipment quantity is the optimal delivery amount for each DC. In this research, economic order quantity (EOQ) method is used to determine shipment quantity. Shipment quantity for each Distribution Center of Banda Aceh, Binjai, Sibolga, Medan, Tebing Tinggi, Lubuk Pakam and Rantau Prapat respectively 15604, 3500, 7314, 9784, 2285, 2393 and 9900 units.

#### 3.3. Safety stock

Planning of DRP system, safety stock estimation at each distribution center is obtained by looking at the demand standard deviation and service level of the company which is the service level of company about 95% ( $Z=1,65$ ). Recapitulation of safety stock distribution center calculation can be seen in Table 2.

**Table 2.** Recapitulation of safety stock in each distribution centre.

Distribution Centre	Safety Stock (unit)
Banda Aceh	220
Binjai	120
Sibolga	232
Medan	152
Tebing Tinggi	127
Lubuk Pakam	150
Rantau Prapat	184

### 3.4. Distribution resources planning

In processing DRP, bill of distribution is needed to see the structure of product distribution network. Bill of distribution describes the structure of a particular product distribution network. Bill of distribution indicates the number of storage locations based on distributors needed to meet customer demand. Related of the relationship between each distribution point (central supply facility and distribution centers), bill of distribution shows the lead time relationship is expected time between preparation of order in master scheduled location and re-stocking in the distribution center. Lead time between injection molding industry at each distribution center is 1 week. Bill of distribution for industry injection molding can be seen in Figure 1.

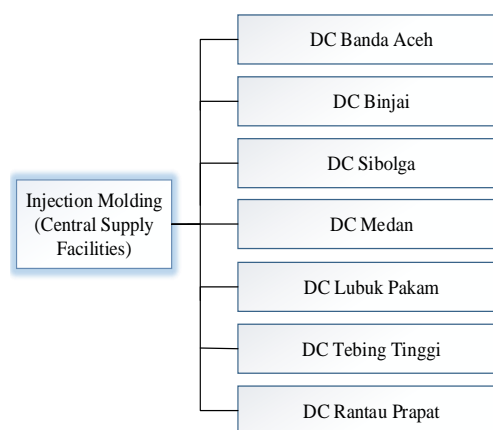
**Figure 1.** Bill of distribution.

Figure 1 shows that the transportation system for product distribution is done in several areas such as Banda Aceh, Binjai, Medan, Lubuk Pakam, Tebing Tinggi, Rantau Prapat and Sibolga. The company will send the goods if the demand were received as needed because the company production based on "make to stock" system.

Based on the bill of distribution, design of distribution requirement by DRP method. DRP is designed at weekly period from January 2017 to December 2017. Weekly period for 1 year is 52 weeks.

Before performing the distribution activity it is necessary thing to know that the status on hand inventory at each distribution center. Next step, gross requirements of each product. Net requirements shows that the product quantity needed at each distribution center must be done by the company to meet consumer demand.

Net requirements are the result of reducing the required amount (gross requirements plus safety stock) and the number of products available (schedule receipt plus projected on hand previous period). Planned order release is obtained from planned order receipt by considering leadtime order fulfillment. Table 2 shows the summary of DRP results by looking at quantity of shipment (lotting) and period of shipment.

**Table 3.** Product delivery period using DRP method.

Distribution Centre	Shipment Qty (unit)	Period of Shipment (week)
Banda Aceh	15604	1,5,11,16,21,27,32,37,42,46,52
Binjai	3500	1,6,12,18,24,30,33,36,42,47
Sibolga	7314	1,5,10,16,20,26,31,37,42,47
Medan	9784	1,3,6,9,12,15,18,21,24,28,30,33,36,40,42,45,48,52
Tebing Tinggi	2285	1,8,16,25,33,43,55
Lubuk Pakam	2393	1,9,19,29,38,47
Rantau Prapat	9900	1,7,14,20,28,34,41,48

Period of shipment in Table 3. obtained from the period of delivery on the plan order release from DRP table. Based on Table 2 can be seen that the number of shipment for distribution center in Banda Aceh, Binjai, Sibolga, Medan, Tebing Tinggi, Lubuk Pakam, and Rantau sequentially are 11, 10, 18, 7, 6 and 8 times a year.

Table 4 shows the delivery frequency of injection molding products based on DRP method and historical company at each Distribution Center. Actual shipment quantity made to distribution center about 92 times and decreased by 23.9% using DRP method. DRP method is also able to reduce the storage cost for the entire distribution center by 42.9%. This result clarify some previous research that DRP methods are able to handle the problem of product deficiencies at distribution location, reducing inventory, ordering, transportation and storage costs [1, 3, 11].

**Table 4.** Comparison of delivery frequency actual by DRP method.

Distribution Centre	Actual Shipment Frequency (times)	Shipment Frequency with DRP (times)
Banda Aceh	15	11
Binjai	13	10
Sibolga	14	10
Medan	23	18
Tebing Tinggi	9	7
Lubuk Pakam	8	6
Rantau Prapat	10	8

DRP is able to handle inventory problems in the distribution center with dependent demand and independent characteristics. DRP is one of the best approaches to integrate the plan needed in manufacturing and distribution centers. DRP managed to find the required stock and keep product priorities up to date with rescheduling [11].

#### 4. Conclusions

DRP ideally combines the service levels of pull system with the efficiency of push system, but depends on accurate forecasting and stable processing. DRP produces high fulfillment performance with minimal inventory. Companies usually using safety stock to handle demand fluctuated, but that can reduce the overall effectiveness of DRP, resulting in higher inventory levels or shortages.

The projection of distribution scheduling in injection molding industry at each distribution center clearly projected that ordering requirement is suitable with order quantity calculation to meet the demand but on hand project stay in control of safety stock to avoid delay or delay in future. DRP is able to minimize the frequency of ordering, reducing of order costs and save costs. DRP is an appropriate method for designing distribution needs by considering manufacturing status and distribution center.

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