Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2021, 8(2):223-228**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Application of Distribution Requirement Planning (DRP) in Motorcycle Tire Industry

Andary Asvaroza Munita*

*Industrial Engineering Department, Mercu Buana University, Indonesia
Email*: andary.asvaroza@mercubuana.ac.id

Abstract In a motorcycle tire manufacturing company, where the products are distributed through a 3 (three) echelon of supply chain consist of a Manufacture, several Depots and a number of Retailers, there are problems in managing the delivery schedule and allocating the number of goods to be delivered. The large number of depots & retailers to be served, ordering pattern which did not fulfill the demand and no planning on procurement process are problems that often occurs in the distribution process. To solve this problem, the company needs a well-patterned distribution system. Distribution Requirement Planning (DRP) is one of the method to provide the planning of the product distribution, in terms of quantity, time, and costs which obtained from the selection of the lotting method that provides the smallest total cost. By applying this DRP method, the company can have better planning in distributing their products and controlling costs for their operations.

Keywords Distribution Requirement Planning (DRP), Total Cost of Distribution, EOQ, POQ

Introduction

Indonesia is a country where the use of motorcycle is an alternative vehicle which have a huge quantity in demand by the residents. High mobility, traffic congestion experienced, and relatively low operational costs make the Motorcycle as a mode of transportation solution for residents in Indonesia. This need has certainly become a target for motorcycle producers which offering all the advantages and supporting facilities for their products. The Incensement of growth numbers of motorcycle manufacturers, will drive manufacturer in a competition to provide excellence services in terms of product features and after-sales service by providing spare parts and services facility. In generals, manufacturers of this motorcycle will be more focusing on their core of business such as design, manufacturing the engine, assembly, etc. and transfer the process of manufacturing support parts to the other professional company.

In a manufacturing company for motorcycle tires, the products are made in accordance to the characteristics and specifications of each Motorcycle brands requirement. After being produced, the tires are then stored in finished goods warehouses and will then be distributed to all Depots in each regions of Indonesia. In its distribution activities, the company carries out delivery of finished goods from the Storehouse at the factory location to the warehouse of finished goods in each region in Indonesia or what is referred to as Depots. These depots are located in several big cities such as Depot A in Sumatra, Depot B in West Java, Depot C in Central Java, Depot D in East Java, Depot E in Sulawesi, and Depo F in Kalimantan. The distribution channel applied by the company is from the factory to the Depot, and then the Depot distributes to retails within the Depot coverage area, as can be seen from the bill of distribution in Figure 1.

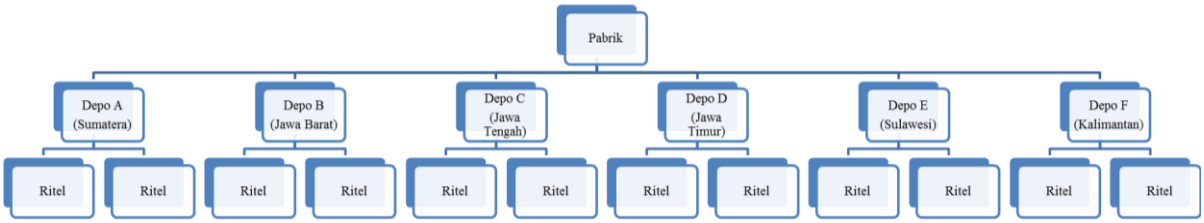


Figure 1: Bill of Distribution (BOD) of Motorcycle Tires

The numbers of Depot and Retail to be served by the company causes many obstacles in distributing the products. Each Depot which requesting various numbers of inventory with various requesting time has contribute many obstacles such as the number of late delivery schedules, the quantity which not appropriate with the request was the most frequent problem happen to the distribution system. The distribution channel was expected to provide the product to be available at the right time, place and number by selecting and implementing the right distribution channel using its function such as transportation and storage [1].

To ensure that the distribution process operate with minimum operational costs, surely a good arrangement and coordination is needed for all parties. Meanwhile, the number of Depots and Retails to be served has great potential for irregular schedules and amount that needs to be allocated to each customers. To improve these conditions, several models of replenishment systems for inventory in a distribution chain can be applied, such as Distribution Requirement Planning (distribution activity scheduling system). The advantage of implementing the Distribution Requirement Planning (DRP) compared to other systems is that DRP is able to overcome the surge in demand in the decision planning process of replenishing stock of products that are owned with all the irregularities.

Fogarty [1991] as cited in Herdiani & Kustiawan [2], explain that DRP will influence production by determining the aggregate time in stages of net requirements in the same period. Furthermore, DRP can provide future demand visibility related to the need for shipping from the source stocking point to the destination point. By applying this DRP method, company can information on the number of quantity and final inventory for each week, the time and number of orders that need to be placed, and when the order must be received. By applying this DRP method, company can manage to arrange all requests of the products to anticipate sales and furthermore controlling the cost of distribution process [3].

Methods

Distribution Requirement Planning (DRP) is a method of procuring supplies in a multi-echelon distribution network. This method applied for independent demand, where forecasting is performed to figure future demand to meet the procurement structure. No matter how many levels in the distribution network, all of them are independent variables except the level that directly meets the consumer. The DRP method can assist in arranging product distribution scheduling through various distribution channels, with the aim of planning how many and when product shipments should be allocated for each distribution channel [4].

Tersine [2003] as cite in Harsono and Putro [5] states that DRP has 2 (two) different meanings namely Distribution Requirement Planning, a method to determine the need to replenish inventory at the distribution center and Distribution Resource Planning which an extension of the Distribution Requirement Planning which includes more than just the planning and inventory replenishment control system, but also added the planning and control of sources involved in distribution such as the Distribution Requirement Planning application of the Material Requirement Planning (MRP) logic in inventory. The Bill of Material Distribution (BOM) in the MRP is replaced by the Bill of Distribution (BOD) in the Distribution Requirement Planning. Distribution Requirement Planning uses Time Phased Order Point (TPOP) logic to determine the procurement requirements on the network.

Distribution Requirement Planning system works based on scheduling that has been made for future requests so that it can anticipate future planning earlier at each level of distribution.

This research was conducted by forecasting demand of product for the year 2019 using the historical demand from each Depot in the year 2018, using Linear Regression Method. According to Tersine [1994] as cite in

Anistya [6] distribution planning starts from the retail demand level forecasting calculation, from the sales forecast results obtained then the net requirement for the retailer level is calculated where this net requirement will be a Planned Order Release, until the determination of the order planning is sent. Determination of the number of orders or lot sizes for each distribution network on this research are using the minimum total cost of distribution from EOQ and FOQ lotting method. Planned Order Release is the difference between forecasting results with inventory held in the previous period for the lotting policy to be used and also as a reference for the desired Planned Order Receipt schedule. The Planned order release at the retail level will be a gross need at the distribution level above.

Results & Discussion

This research started by forcasting the distribution needs in order to calculate the net requirement to determine the schedule for delivery for each location, based on historical demand of year 2018 using regresion linier. By forecasting the needs of the product, the company could have a better planning to manage the distribution schedule in order to create an effective process and furthermore a cost of efficiency. Table 1 showing the demand for year 2019 for all the tire tipe, which classified based on location of Depot all over Indonesia.

Table 1: Forcasting of Tire Product Demand for the year 2019

NO	DEPO LOCATION	PRODUCT TYPE						FORECASTING 2019
		TIRE FDR TUBETYPE	TIRE FDR TUBELESS	TUBE FDR	TIRE RACING	TIRE HGP	TUBE HGP	
1	SUMATERA	5.372.456	5.670.469	9.808.199	7.556.688	7.335.461	1.092.653	36.835.925
2	WEST JAVA	3.714.641	4.128.837	9.348.687	5.645.803	6.761.535	1.170.992	30.770.495
3	CENTRAL JAVA	4.512.740	5.146.956	9.481.368	8.895.799	4.848.377	2.519.439	35.404.680
4	EAST JAVA	4.568.575	4.451.793	8.886.376	7.091.689	4.893.889	880.979	30.773.300
5	SULAWESI	4.408.801	4.340.321	7.643.781	7.944.695	5.306.750	1.271.170	30.915.519
6	KALIMANTAN	3.346.494	3.551.691	9.443.289	6.895.910	3.353.352	23.058	26.613.794
TOTAL		**25.923.708**	**27.290.066**	**54.611.699**	**44.030.585**	**32.499.365**	**6.958.291**	**191.313.713**

The criteria of performance on this distribution activity is to obtain the minimum of total cost of distribution, which consist of ordering cost, holding cost and transportation cost which calculated based on the transport costs of each type of truck. There are two type of vehicle, Small vehicle (SV) and Big Vehicle (BV) which every type have different charge to distribute the product from factory to each depot location with limitation of the capacity of each vehicle, as shown in Table 2 and Table 3.

Table 2: Transportation Cost of Each Vehicle to Point of Destination

Transportation Cost	DESTINATION					
Vehicle Size	Sumatra	West Java	Central Java	East Java	Sulawesi	Kalimantan
Small (IDR)	9.000.000	3.500.000	5.800.000	7.500.000	9.000.000	13.000.000
Big (IDR)	14.000.000	5.500.000	10.000.000	12.000.000	14.000.000	21.000.000

Table 3: Vehicle Capacity for Each Type of Product

Vehicle Size	VEHICLE CAPACITY FOR TIRE PRODUCT					
	Tire FDR Tubetype (pcs)	Tire FDR Tubeless (pcs)	Tube FDR (pcs)	Tire Racing (pcs)	Tire HGP (pcs)	Tube HGP(pcs)
Small Vehicle	20.000	20.000	432.000	20.000	20.000	432.000
Big Vehicle	40.000	40.000	864.000	40.000	40.000	864.000

On current condition, where company did not apply any distribution method, the process of distribution only based on request that company received on daily basis. Table 4 is the data recorded for the vehicle used on the year 2018 to distribute the product. The problem occurred from this current condition was that the company often had an irregular schedule for the distribution and difficult to booked the vehicle as the impact of having no proper planning for the distribution.

Table 4: The number of vehicle usage on 2018

	SUMATERA		WEST JAVA		CENTRAL JAVA		EAST JAVA		SULAWESI		KALIMANTAN	
	BV	SV	BV	SV	BV	SV	BV	SV	BV	SV	BV	SV
Tire FDR Tubetype (pcs)	0	134	0	142	0	245	0	189	0	183	0	27
Tire FDR Tubeless (pcs)	0	93	0	103	0	234	0	141	0	169	0	29
Tube FDR (pcs)	0	5	12	0	0	11	0	10	0	6	6	0
Tire Racing (pcs)	0	114	0	111	444	0	0	177	0	122	44	0
Tire HGP (pcs)	0	108	0	109	382	0	0	199	0	133	64	0
Tube HGP(pcs)	0	4	8	0	22	0	16	0	8	0	0	0
Total	0	459	20	465	848	490	16	716	8	613	113	57

In the current condition, the company did not allocate any inventory on hand in every location of Depot. Lead time is assumed as 0 (zero) since the delivery process was settled in the same month with the ordering process.

Distribution Requirement Planning (DRP)

This research is implement the *Economic Order Quantity* (EOQ),*Period Order Quantity* (POQ), dan *Fixed Period Requirement* (FPR) as the lot sizing technique for DRP, in order to obtain the economic number of ordering products. An order is made when the amount of available inventory is no longer sufficient to fulfill the distribution activities in the following month.

EOQ

$$Q^* = \sqrt{\frac{2DS}{H}},$$

Where :

Q^* = Economic order quantity

D = Demand of product

S = Ordering Cost

H = Holding cost on each Period

Ordering cost for all product at each Depot is assumed to be IDR 4.625.000,- which is calculated based on administrative and labor cost. Holding cost for each product referring to the company's data is IDR 100,- per unit product per year. The results of the calculation of the economic lot size for each type of the product and Depot can be seen in Table 5.

Table 5: Quantity to order for each product type in All Depot using EOQ lotting method

	SUMATERA	WEST JAVA	CENTRAL JAVA	EAST JAVA	SULAWESI	KALIMANTAN
TIRE FDR TUBETYPE	704.948	586.178	646.087	650.072	638.603	556.373
TIRE FDR TUBELESS	724.236	617.995	689.995	641.709	633.624	573.177
TUBE FDR	952.501	929.921	936.497	906.636	840.863	934.614
TIRE RACING	836.058	722.660	907.117	809.927	857.254	798.669
TIRE HGP	823.729	790.849	669.683	672.819	700.624	556.943
TUBE HGP	317.916	329.115	482.751	285.466	324.904	155.525

POQ

POQ method help to determine lot size based on the number of requirements in a certain period. In EOQ methodthe quantity per order is constant, while in this POQ method the order period interval is constant.

$$N = \frac{Q}{\bar{d}}$$

Where :

N = Number of order period

Q = Economic Quantity (Q^*)

$\bar{d}$ =Demand average quantity

The calculation of this POQ method for all type of product and depot can be seen in Table 6.

Table 6: Quantity to order for each product type in All Depot using POQ lotting method

	SUMATERA	WEST JAVA	CENTRAL JAVA	EAST JAVA	SULAWESI	KALIMANTAN
TIRE FDR TUBETYPE	704.948	586.178	646.087	650.072	638.603	556.373
TIRE FDR TUBELESS	724.236	617.995	689.995	641.709	633.624	573.177
TUBE FDR	952.501	929.921	936.497	906.636	840.863	934.614
TIRE RACING	836.058	722.660	907.117	809.927	857.254	798.669
TIRE HGP	823.729	790.849	669.683	672.819	700.624	556.943
TUBE HGP	317.916	329.115	482.751	285.466	324.904	155.525

The lotsize quantity to order is then plotted in the DRP table as a plan order receipt quantity, which then reduces the gross requirements as needed in the receiving period. The remaining quantity is the number of projects on hand that will be used to meet the needs in the following month period. Table 7 is an example of a DRP plot with EOQ lotting for a Tube type FDR Tire Product in Sumatra depot. In the DRP table, quantity and type of vehicle can also be informed to plan the product distribution during the month. The DRP plotting table is carried out for all types of products at each depot.

Table 7: DRP Table with EOQ lotting method for Tire FDR Tube type on Sumatra Depot

LEAD TIME	0	TIRE FDR TUBETYPE SUMATERA											
ON HAND	0	MONTH											
SAFETY STOCK	0												
LOT SIZE	EOQ	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
	GROSS REQUIREMENT	408.496	415.625	422.754	429.882	437.011	444.140	451.269	458.398	465.527	472.656	479.785	486.914	5.372.456
	SCHEDULE RECEIPT													
	PROJECT ON HAND	296.453	585.776	163.023	438.089	1.077	261.885	515.565	57.167	296.588	528.881	49.096	267.131	3.460.730
	NET REQUIREMENT	408.496	119.172	0	266.860	0	443.063	189.384	0	408.360	176.068	0	437.818	2.449.220
	PLAN ORDER RECEIPT	704.948	704.948	0	704.948	0	704.948	704.948	0	704.948	704.948	0	704.948	5.639.587
	PLAN ORDER RELEASE	704.948	704.948	0	704.948	0	704.948	704.948	0	704.948	704.948	0	704.948	5.639.587
	BIG VEHICLE	18	18	0	18	0	18	18	0	18	18	0	18	144
	SMALL VEHICLE													0

Total distribution cost was consist of ordering cost, holding cost and transportation cost. From the Table 7, the total distribution cost for Tire FDR Tubetype product on Sumatra Depot can be calculated as follow:

TC = Ordering Cost + Holding Cost + Transportation Cost

= (8xIDR 4.625.000) + (3.460.730pcs xIDR 8,333/ month) +(144 vehicle x IDR 14.000.000)

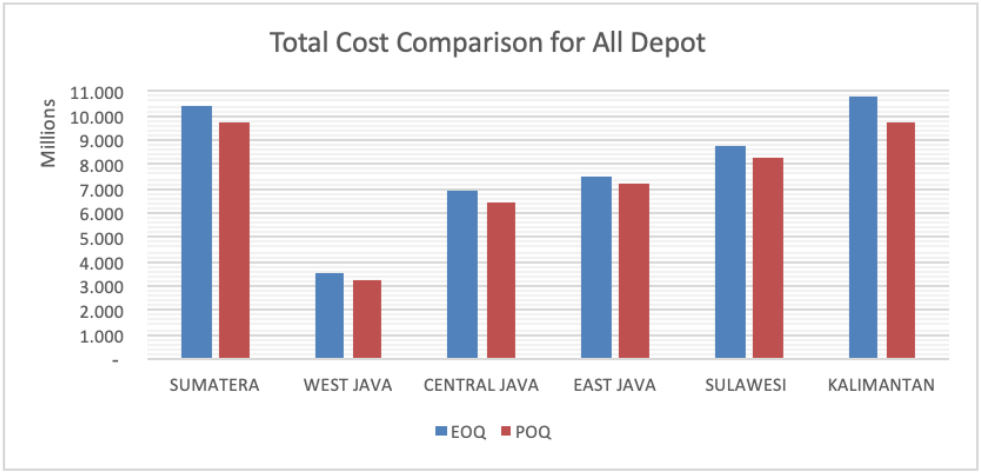
= IDR 2.081.839.417

Calculation of this total cost of distribution is applied to all products for each depot. The best method obtained from the minimum of total cost incurred to distribute all product using EOQ and POQ Lotting model in each depot, as shown in Table 8.

Table 8: Comparison of total cost of Distribution using EOQ and POQ

	SUMATERA	WEST JAVA	CENTRAL JAVA	EAST JAVA	SULAWESI	KALIMANTAN
EOQ	10.419.139.767	3.506.136.073	6.909.102.323	7.486.540.043	8.776.389.430	10.827.505.394
POQ	9.687.470.897	3.193.316.360	6.403.550.805	7.167.756.249	8.321.553.902	9.698.284.698

From graphic on Picture 1 we can conclude that POQ give the minimum total cost on every depot comparing to the EOQ method.



Picture 1: Comparison of Total Cost Distribution using EOQ and POQ Method

This research also considering the current method comparing with both EOQ and POQ lotting method in DRP. In current distribution method, there are no planning on the operation, so that the product distribution implement based on every period requirement of each product. From the three method, current method impact a higher cost than other POQ and EOQ method, although they contribute a low transportation cost, but it also impact higher other cost. In this research, DRP lotting with POQ lot sizing contribute lowest cost in all criteria with accumulate total cost IDR 44.193.182.771.

Table 9: Total cost comparison of distribution method

	METHOD		
	CURRENT	EOQ	POQ
ORDERING COST	Rp1.998.000.000	Rp1.299.625.000	Rp1.290.375.000
HOLDING COST	Rp19.131.371.299	Rp1.210.389.185	Rp375.261.446
TRANSPORTATION COST	Rp38.903.583.688	Rp45.414.924.443	Rp42.527.546.325
TOTAL COST	Rp60.032.954.987	Rp47.924.938.628	Rp44.193.182.771

Conclusion

1. Application method of Distribution Requirements Planning (DRP) for the upcoming demand will be more efficient as a well-coordinated and effective for the optimal delivery of products to meet the demand of each corresponding Depot with consideration of truck capacity utilities.
2. Method of Distribution Requirements Planning (DRP) with POQ lotting in this research method contribute distribution cost efficiency of product with total IDR44.193.182.771, Where this amount is lower than the cost of current company method with total IDR 60.032.954.987. In the other way the application of this POQ in the DTP will reduce costs by up to IDR Rp15.839.772.216 or 920.563 or reducing 26,38% from the total of current method applied by the company.

Acknowledgment

Author would like to thank to Universitas Mercu Buana Indonesia and The Research Centre of Universitas Mercu Buana which have funded this research.

References

[1]. Bahagia. 2006. Inventory System. Bandung: Bandung Institute of Technology.

[2]. Herdiani, L., & Kustiawan, R. (2015). Penjadwalan distribusi produk larutan kaki tiga menggunakan Distribution Requirement Planning (DRP) di PT. Duta Lestari Sentratama Bandung. *Jurnal Transportasi Multimoda*. 41–52.

[3]. Suseno, L., & Ikatrinasari, Z. F. (2015). Analisis Bullwhip Effect Terhadap Penerapan Distribution Resource Planning di PT. MNJ. Jurnal Teknik Industri 10, 141-148.

[4]. Kulsum K., Muharni, Y., Mulyawan, M.R. (2020). Penjadwalan distribusi produk dengan metode distribution requirement planning (Studi kasus produk air minum dalam kemasan). Teknika : Jurnal Sains dan Teknologi. 16 (01).

[5]. Harsono, A., Putro, G.M. (2017). Perencanaan Pendistribusian Produk untuk Minimasi Biaya (Studi Kasus di CV. Gunakarya Mandiri Yogyakarta). *Jurnal OPSI*. Vol 10 (1).

[6]. Anistya, R. (2014). Penerapan Distribution Requirement Planning (DRP) Pada CV Three J – Bali. Jurnal Ilmiah Mahasiswa Universitas Surabaya. 3(2).