Jurnal Asiimetrik: Jurnal Ilmiah Rekayasa Dan Inovasi
Accredited "**SINTA 3**" based on the Decree of Dirjendiktiristek, Number: 225/E/KPT/2022
Volume 7 Number 1, January 2025, Page 21-28
Website : http://journal.univpancasila.ac.id/index.php/asiimetrik/

p-ISSN 2655-1861
e-ISSN 2716-2923

Forecasting Methods Proposal and Implementation of Distribution Requirement Planning Method to Overcome Unfulfilled Stock Availability at PT. XYZ

Usulan Metode Peramalan dan Implementasi Metode Perencanaan Kebutuhan Distribusi untuk Mengatasi Ketidaktersediaan Stok Barang di PT. XYZ

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Article information:

Received:
07/09/2024
Revised:
14/11/2024
Accepted:
09/12/2024

Abstract

PT. XYZ is a manufacturing company engaged in the automotive sector by producing various automotive components. Based on the results of observations and interviews at PT. XYZ, it is known that there is a shortage of stock, so that customer or consumer requests are not fulfilled at each existing distribution center (DC). Based on the problems that occur, the research result suggestions for the best forecasting method based on the time series plot of each DC request processing using the Distribution Requirement Planning (DRP) method. In addition, with the DRP method, there is additional stock. The company still has remaining stock so it can still meet customer demand for each DC, and the product distribution process runs more regularly if any defective product should be replaced. Based on research results, the DRP method is able to minimize the risk of unfulfilled demand due to product defects.

Keywords: DRP, forecasting, production planning, inventory control, time series.

***SDGs*:**

Abstrak

PT. XYZ merupakan perusahaan manufaktur yang bergerak di bidang otomotif dengan memproduksi berbagai komponen otomotif. Berdasarkan hasil observasi dan wawancara di PT. XYZ diketahui bahwa terjadi kekurangan stok, sehingga permintaan pelanggan atau konsumen tidak terpenuhi di setiap distribution center (DC) yang ada. Berdasarkan permasalahan yang terjadi, hasil penelitian memberikan saran metode peramalan terbaik berdasarkan time series plot dari setiap permintaan DC dengan menggunakan metode Distribution Requirement Planning (DRP). Selain dengan metode DRP, terjadi penambahan stok. Perusahaan masih memiliki stok yang tersisa sehingga masih dapat memenuhi permintaan pelanggan untuk setiap DC, dan proses pendistribusian produk berjalan lebih teratur apabila ada produk yang cacat yang harus diganti. Berdasarkan hasil penelitian metode DRP mampu meminimalkan risiko tidak terpenuhinya permintaan karena cacat produk.

Kata Kunci: DRP, peramalan, perencanaan produksi, inventori, time series.

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1. INTRODUCTION

Today, the industrial world is growing, which can be seen from the many companies engaged in various fields, not only industrial but also service. If company wanted to survive, companies need a good and also integrated production system like production scheduling and distribution (Yuliana and Rahayu, 2019). Production scheduling is essential aspects in a company where with a good production scheduling strategy, it will be able to minimize losses caused by several unfulfilled customer requests due to delays in the distribution process to customers.

PT. XYZ is a manufacturing company that produces automotive components such as mufflers. Mufflers, better known as exhausts, have several types produced in the company. Then the production results at the company will be distributed to consumers such as PT. ABC.

Therefore, in this paper, the research raised is regarding the planning of production scheduling for PT.XYZ by implementing the DRP (Distribution Requirement Planning) method. The DRP method is a distribution method for distribution centers, using several control parameters (Ngatilah *et al.*, 2020; Bowersox *et al.*, 2023; Pujawan and Mahendrawathi, 2024). The DRP method is using data from requests distributed center, then production process will be scheduled (Erraoui, Charkaoui and Echchatbi, 2019; Yuliana and Rahayu, 2019). DRP method can make master production schedule to alleviate understock that exist at PT. XYZ (Surya, 2013; Muttaqin, Martini and Aurachman, 2017; Mansur, Bukhori and Juwita, 2019; Mukhsin and Sobirin, 2022). This study focuses on the implementation of the DRP method, this study uses the basis of the study "Forecasting Methods and Implementation of DRP (Distribution Requirement Planning) Methods in Determining the Master Production Schedule" (Magdalena and Suli, 2019; Omar, Shahin and Roshdy, 2022). The difference with previous studies is that the study by Magdalena & Suli (Magdalena and Suli, 2019), implemented DRP in a noodles and beverage company, while this study used an automotive components company.

The scope of this research is on the inventory problems due to inventory stock uncertainty at all DCs, then how to apply DRP to control inventory optimally at PT. XYZ. Then the purpose of this research is based on the problems found in PT. XYZ, namely implementing Distribution Requirements Planning (DRP) at PT. XYZ to control product availability through distribution scheduling to optimize distribution activities.

In this study, the limitations given so that the research is more focused on the problems that occur, and the solution is obtained is to do practical work at PT. XYZ for one month. Then, for the data used in this study is from historical data on muffler requests for PT. ABC in 2019, DC for all mufflers. Lead time for each DC, observing the existing production scheduling system at PT. XYZ. In this study, there are also several assumptions used. Namely the supply of raw materials and auxiliary materials is assumed always to be available when the production process is started. Then for product distribution, it is assumed that one truck for each DC.

2. METHODOLOGY

To analyze the desired research objectives, the following methodology was carried out:

2.1. Data Collection and Observation

Case study for this research was PT. XYZ. This research was carried out using observation, and interview process with several people, which focused on the problem regarding the existence of non-distributed products experienced by PT. XYZ. This research was conducted on January 3, 2020, to February 3, 2020. Historical demand data, lead times for all PT.XYZ distribution center, current stock, and available distribution centers will be used for this research.

2.2. Data Processing

On Figure 1, shown the steps in processing the DRP method assisted by MINITAB software and the steps that must be carried out include forecasting historical data, determining lead times, determining lot sizes, determining safety stock, then after it's DRP manufacture. The result of DRP will be integrated to determine the master production schedule for the next 12 months.

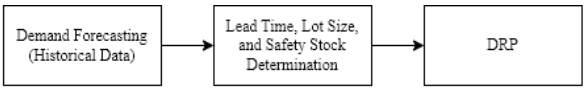

Figure 1. DRP process.

Based on the historical data that has been collected, we will analyze the trend and seasonal movement on each DC with Time Series graph. In this case, determination of forecasting methodology is based on trend and seasonal movement criteria as on Table 1. We will try all the option for each type of graph to find the best forecasting method that can be used to interpret demand pattern also to predict next 12 periods.

Table 1. Forecasting method by Trend and Season.

Trend			
Yes		No	
Season			
Yes	No	Yes	No
Decomposition Additive Decomposition Multiplicative Winter Additive Winter Multiplicative	Trend Analysis Double Exponent Smoothing -	Decomposition Additive Decomposition Multiplicative Winter Additive Winter Multiplicative	Moving Average Single Exponent Smoothing -

The forecasting method is selected using the smallest MSD value, the selected forecasting method is continued to the following 12-period forecast. The results of the 12-period forecast are used to create a DRP for each distribution center, and an MPS for all distribution centers.

3. RESULTS AND DISCUSSION

Table 2 as shown the data distribution center at PT. XYZ for PT. ABC, lead time and inventory data for each DCs spread across each plant. Table 3 is historical demand data from PT.XYZ from jannuary 2019 to December 2019. Figure 2 is the XYZ Co. distribution system, where each distribution center analyzed the trend and seasonal movement on each DC with a time series graph.

Table 2. Project on hand and lead time data.

DC	Project On Hand	Lead Time
1	5340	1
2	340	1
3	1200	1
4	1800	1
5	120	2

Table 3. 2019 Historical demand data.

Month	DC1	DC2	DC3	DC4	DC5	Total
Jan	23540	3580	17050	16070	650	60890
Feb	21000	4560	15245	12050	750	53605
Mar	20000	4800	12500	15900	625	53825
Apr	22000	5600	18700	16000	630	62930
May	23675	5250	18700	16800	550	64975
Jun	14784	4975	12900	11300	525	44484
Jul	25910	5025	16454	19600	600	67589
Aug	23050	5750	17450	17000	680	63930
Sep	24925	5360	17100	18800	510	66695
Oct	23750	5410	13000	19800	530	62490
Nov	23650	5525	13500	20700	675	64050
Dec	15170	5795	9800	17669	700	49134

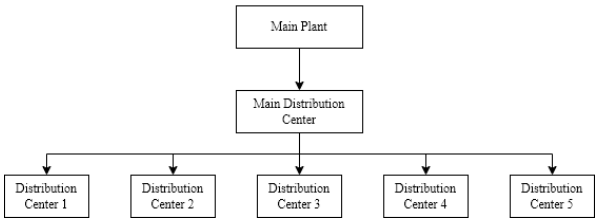

Figure 2. Company distribution system.

3.1. Forecasting

In Figure 3, the result time series plot of the DC 1 shows that there is no trend because there is no rising or falling demand trend, while it has seasonal pattern where where the demand will be decreasing significantly every 6 months. Based on this condition, the forecasting methods to be used are Decomposition Additive, Decomposition Multiplicative (Mbuli *et al.*, 2020), Winter Additive, and Winter Multiplicative methods.

Since DC 2 and DC 3 showed there was any trend movements but no seasonal pattern, we will use trend analysis and Double Exponential Smoothing method for forecast the demand. For DC 4 and DC 5, we concluded that there is no trend movement or seasonal pattern, so we will use Moving Average and Single Exponential Smoothing as our method for their Dcs.

There are two methods of moving average, namely the single moving average and the double moving average. Forecasting methods for DC 1, DC 4 and DC 5 had similar result with Magdalena & Suli (2019) which They discovered that some distribution centers exhibited time series plots characteristic of non-trending, non-seasonal data, while others displayed trends and seasonality.

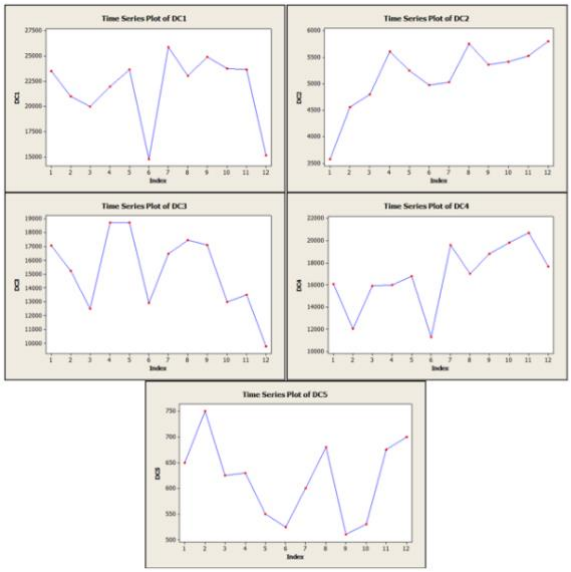

Figure 3. Time series plot for all distribution center.

3.2. Best Forecasting Selection

Figure 4 is the forecasting result for Distribution Center 1, with periods 13-24 indicating the period January – December 2020. At present, the company does the forecast based on the total demand from all DC and based on product family. This research tried to forecast the demand of each DC and for specific product, which is a muffler. Theoretically, forecast accuracy is higher on family products than individual products, as well as for all DC than each DC. In this research, MSD shows a huge number, implying its low accuracy to forecast the demand (Supriyadi and Riskiyadi, 2016; Widodo, 2018).

Based on Table 4, the Decomposition Multiplicative method is choosen as best forecasting method, because the error value of the Decomposition Multiplicative method is the smallest value indicating that the error of this forecasting method is smaller than the other methods.

Based on Table 5, there are differences in the results for each DC. When viewed at DC 4, the forecasting results are constant for each period because the forecasting method used is a linear forecasting method, so the forecasting results are considered constant. The moving average method is a very useful for forecasting short-term trends, this aligns with several studies using the moving average method (Ardian *et al.*, 2021; Huriati *et al.*, 2022). For DC 2 and DC 3 which use the double exponential smoothing method, it is appropriate where based on research by Kurniawan & Herwanto, it shows that data with a trend pattern when using double exponential smoothing will provide better results than the moving average method which is suitable for data without a trend pattern and season (Kurniawan and Herwanto, 2022).

The red dot shows the forecast values, but it become the fitted values to compare with actual demand and as a basis to calculate the forecast error. The green dot is become the forecast value for the next period.

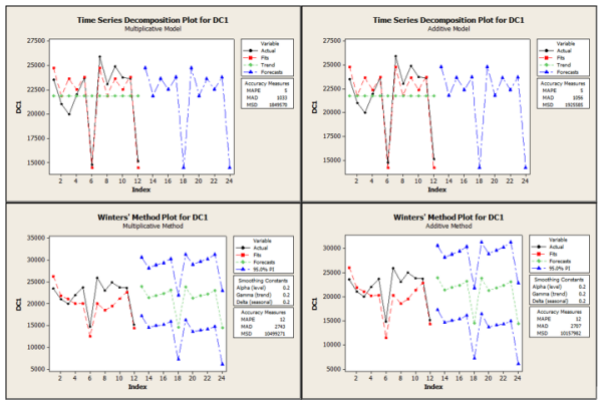

Figure 4. DC1 forecast result.

Table 4. Accurate level based on forecasting result.

DC 1	Decomposition		Winter	
	Additive	Multiplicative	Additive	Multiplicative
MAPE	5	5	12	12
MAD	1056	1033	2707	2743
MSD	1925585	1849570	10157982	10499271

Table 5. Result for all distribution centers.

Forecasting Result					
Period	**DC1**	**DC2**	**DC3**	**DC4**	**DC5**
13	24751	5406	9413	19390	635
14	21879	5268	7442	19390	635
15	23628	5090	5240	19390	635
16	22520	4874	2807	19390	635
17	23818	4619	141	19390	635
18	14480	4326	0	19390	635
19	24751	3994	0	19390	635
20	27879	3624	0	19390	635
21	23627	3214	0	19390	635
22	22520	2766	0	19390	635
23	23818	2280	0	19390	635
24	14480	1755	0	19390	635

3.3. Distribution Requirement Planning

In Table 6, 19425 in period 0 is not included in the master production schedule because it is assumed to have been produced in the December 2019 period. From the results of the planned order release, the results are relatively constant because the specified lot value is a multiple of 25. Based on Table 6, Table 7, Table 8, Table 9, and Table 10, we use forecasting results for gross requirement. Schedule receipt has 0 value because assumption that there is no production subcontracting. The project on hand is obtained by subtracting planned order receipt and net requirement, while net requirement is got from subtracting gross requirement and project on hand in the previous period.

3.4. Master Requirement Planning

The MPS (see Table 11) is obtained from the Table 6 until Table 10 adding up each DC. Based on the results of the research and analysis that has been carried out, several evaluations or improvement can be made in the company. The following are some comparisons that can be recommended to companies under current conditions. The company only adds up the requests from each DC and is used as a master production schedule. Meanwhile, when using the DRP method, every incoming request for each DC will be processed first by considering the lead time and the existing lot size so that production will be carried out more optimally (Wahyuningsih, Pradana and Hamidah, 2018).

Table 6. DRP for DC1

DRP DC1													
FOQ = 25		Lead Time = 1		Safety Stock = 0					On Hand = 5340				
Period	0	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement		24751	21879	23628	22520	23818	14480	24751	27879	23627	22520	23818	14480
Schedule Receipt		0	0	0	0	0	0	0	0	0	0	0	0
Project On Hand	5340	14	10	7	12	19	14	13	9	7	12	19	14
Net Requirement		19411	21865	23618	22513	23806	14461	24737	27866	23618	22513	23806	14461
Planned Order Receipt		19425	21875	23625	22525	23825	14475	24750	27875	23625	22525	23825	14475
Planned Order Release	19425	21875	23625	22525	23825	14475	24750	27875	23625	22525	23825	14475	0

Table 7. DRP for DC2

DRP DC2													
FOQ = 25		Lead Time = 1		Safety Stock = 0					On Hand = 340				
Period	0	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement		5406	5268	5090	4874	4619	4326	3994	3624	3214	2766	2280	1755
Schedule Receipt		0	0	0	0	0	0	0	0	0	0	0	0
Project On Hand	340	9	16	1	2	8	7	13	14	0	9	4	24
Net Requirement		5066	5259	5074	4873	4617	4318	3987	3611	3200	2766	2271	1751
Planned Order Receipt		5075	5275	5075	4875	4625	4325	4000	3625	3200	2775	2275	1775
Planned Order Release	5075	5275	5075	4875	4625	4325	4000	3625	3200	2775	2275	1775	0

Table 8. DRP for DC3

DRP DC3													
FOQ = 25		Lead Time = 1		Safety Stock = 0					On Hand = 1200				
Period	0	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement		9413	7442	5240	2807	141	0	0	0	0	0	0	0
Schedule Receipt		0	0	0	0	0	0	0	0	0	0	0	0
Project On Hand	1200	12	20	5	23	7	0	0	0	0	0	0	0
Net Requirement		8213	7430	5220	2802	118	0	0	0	0	0	0	0
Planned Order Receipt		8225	7450	5225	2825	125	0	0	0	0	0	0	0
Planned Order Release	8225	7450	5225	2825	125	0	0	0	0	0	0	0	0

Table 9. DRP for DC4

DRP DC4													
FOQ = 25		Lead Time = 1		Safety Stock = 0				On Hand = 1800					
Period	0	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement		19390	19390	19390	19390	19390	19390	19390	19390	19390	19390	19390	19390
Schedule Receipt		0	0	0	0	0	0	0	0	0	0	0	0
Project On Hand	1800	10	20	5	15	0	10	20	5	15	0	10	20
Net Requirement		17590	19380	19370	19385	19375	19390	19380	19370	19385	19375	19390	19380
Planned Order Receipt		17600	19400	19375	19400	19375	19400	19400	19375	19400	19375	19400	19400
Planned Order Release	17600	19400	19375	19400	19375	19400	19400	19375	19400	19375	19400	19400	0

Table 10. DRP for DC5

DRP DC5													
FOQ = 25		Lead Time = 2		Safety Stock = 0				On Hand = 120					
Period	0	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement		635	635	635	635	635	635	635	635	635	635	635	635
Schedule Receipt		0	0	0	0	0	0	0	0	0	0	0	0
Project On Hand	120	10	0	15	5	20	10	0	15	5	20	10	0
Net Requirement		515	625	635	620	630	615	625	635	620	630	615	625
Planned Order Receipt		525	625	650	625	650	625	625	650	625	650	625	625
Planned Order Release	625	650	625	650	625	625	650	625	650	625	625	0	0

Table 11. Master Production Schedule

Period	Master Production Schedule											
	1	2	3	4	5	6	7	8	9	10	11	12
PO Release 1	21875	23625	22525	23825	14475	24750	27875	23625	22525	23825	14475	0
PO Release 2	5275	5075	4875	4625	4325	4000	3625	3200	2775	2275	1775	0
PO Release 3	7450	5225	2825	125	0	0	0	0	0	0	0	0
PO Release 4	19400	19375	19400	19375	19400	19400	19375	19400	19375	19400	19400	0
PO Release 5	650	625	650	625	625	650	625	650	625	625	0	0
Total	54650	53925	50275	48575	38825	48800	51500	46875	45300	46125	35650	0

DRP method also has several advantages of several pieces of product, but this can be used as an anticipation if there are products that do not pass inspection or are defective so that the company can minimize if the DC demand is not fulfilled. As for the forecasting method used by the company at this time, if there is a product defect, it is likely to hamper distribution, so the demand from DC is not fulfilled. The difference in the DRP results for PT XYZ with the DRP of other studies lies in the quantity of safety stock (Hanafie, Syarifuddin and D, 2020; Guslan and Indah, 2022). PT XYZ currently lacks a policy for determining safety stock levels. If there's a risk of delayed raw material deliveries or stockouts (Hanafie, Syarifuddin and D, 2020; Guslan and Indah, 2022), implementing safety stocks or buffer stocks is recommended to mitigate the bullwhip effect (Erraoui, Charkaoui and Echchatbi, 2019).

4. CONCLUSION

The research was conducted at the manufacturing company PT. XYZ related to production scheduling using forecasting methods, distribution requirement planning, and master production schedule. Master production schedule is prepared for each DC, project on hand and FOQ to control and optimize distribution activities. FOQ lot sizes can minimize the risk of not fulfilling requests in the event of a product defect. Based on the research conducted, there are several solutions that can be implemented, such as creating an integrated information system using the DRP method, forecasting production demand to anticipate demand variability, and controlling product availability to avoid stock shortages.

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