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Application of Distribution Requirement Planning in Optimizing Packaged Drinking Water Distribution to Mitigate Lost Sales

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Abstract — The bottled water industry in Indonesia has experienced a positive growth trend due to increasing public awareness of the importance of hydration and a healthy lifestyle. However, DC Formula Paluta in Padang Lawas Utara, North Sumatra, faced a lost-sales challenge of 7% in 2023, exceeding the typical tolerance level in the FMCG industry, which ranges from 3–5%. The purpose of this study is to identify the causes of lost sales and propose solutions through demand forecasting, determining the optimal order quantity, and planning a more efficient distribution using the DRP Worksheet and fishbone diagram. Historical data analysis from January to December 2023 using Pom QM software shows that the Regression/Trend Analysis and Multiplicative Decomposition methods have the lowest Mean Absolute Deviation (MAD) values. Therefore, these two methods were selected for forecasting the demand for gallon, bottle, and cup products in the coming year. The implementation of the Economic Order Quantity (EOQ) method successfully reduced the ordering frequency from 190 times to 124 times per year, saving costs from IDR 147,440,000 to IDR 96,224,000, or approximately 35%. The application of Distribution Requirement Planning (DRP) improved the efficiency of distribution planning and inventory management, ensuring product availability according to market demand. The combination of forecasting methods, EOQ, DRP, and fishbone diagram analysis is expected to reduce mismatches between inventory and demand, improve operational and distribution management efficiency, and directly lower the level of lost sales occurring at DC Formula Paluta.

Keywords: DRP, EOQ, Forecasting, Safety Stock, Lost Sales.

I. INTRODUCTION

The bottled water industry in Indonesia has shown a positive trend in recent years. Increased public awareness of the importance of hydration and a healthy lifestyle has been the main factor driving demand for bottled water products [1]. Data from the Central Bureau of Statistics (BPS) recorded that the number of bottled water companies in Indonesia rose from 534 in 2017 to 544 in 2021, representing a 1.8% growth over the past five years. This growth has encouraged bottled water companies to implement more innovative marketing strategies, including the use of environmentally friendly packaging and distribution optimization to reach consumers more effectively.

One of the companies operating in this industry is Formula Paluta, an entity focused on distributing Bottled Drinking Water in various sizes, including 19 liters, 600 ml, and 240 ml. Headquartered in Padang Lawas Utara, North Sumatra, Formula Paluta operates a distribution center (DC) that serves as a bridge between the factory and the retail market. This distribution scheme makes DC Formula Paluta a crucial element in ensuring product availability in the market.

However, an evaluation in 2023 revealed that DC Formula Paluta faced a major problem in the form of lost sales. Based on demand and sales data, average lost sales were recorded at 7% during the January–December 2023 period, indicating a mismatch between stock availability and market demand [2]. This value is considered critical because, based on the concepts of service level and fill rate explained by Chopra and Meindl (2016) [3], distribution companies must maintain a high level of demand fulfillment to prevent stockouts. The fill rate represents the proportion of demand that can be met directly from inventory, and in FMCG industry practice, the target generally lies around 95%. This means that the tolerance for product unavailability (stockouts or lost sales) is maintained at no more than 3–5%. Therefore, the 7% lost sales rate at DC Formula Paluta has exceeded the common industry tolerance threshold and indicates a serious mismatch between inventory availability and market demand.

Lost sales problems can lead to missed sales opportunities, increased handling costs, and a decline in brand image [4]. In addition, the high ordering frequency of up to 190 times per year with distribution costs amounting to IDR 147,440,000 indicates inefficiencies in supply chain management.

This phenomenon is often caused by inaccurate data, inability to identify demand trends, supply chain complexity, and technological limitations. The lack of accurate data and sudden market changes may also reduce the effectiveness of demand forecasting [5]. These conditions highlight the importance of implementing a more effective distribution planning system.

One solution that can be applied is the use of Distribution Requirement Planning (DRP). DRP is an inventory planning method within a distribution network that integrates multiple levels to determine the optimal quantity and timing of orders [6]. Through a time-phasing approach, DRP helps companies anticipate demand fluctuations, thereby reducing distribution costs while improving product availability in the market [7]. Therefore, the application of DRP in DC Formula Paluta is expected to reduce lost sales, lower distribution costs, and improve the company's operational efficiency.

II. RESEARCH METHOD

The object of this research is the distribution scheduling planning at the Distribution Center (DC) of Formula Paluta, with a focus on the distribution of Formula Paluta Bottled Drinking Water in three sizes: 19 liters, 600 ml, and 240 ml. The subject of the study is the Formula Paluta DC company, which operates in the field of bottled water distribution in the Padang Lawas Utara region, North Sumatra.

Data collection was carried out through interviews with management and operators of the Formula Paluta DC to obtain primary information related to distribution, inventory management, and operational constraints. In addition, field observations were conducted to strengthen data validity. Secondary data were obtained from the company's internal records, which included data on demand, sales, inventory, lead time, as well as shipping and storage costs.

The analytical method used in this study is Distribution Requirement Planning (DRP). The DRP method has the advantage of projecting potential problems that may arise. This system is capable of generating its own schedule to anticipate future demand [8]. The benefits of implementing the DRP method include the ability to identify the interdependencies between stock in the distribution system and the manufacturing process, the establishment of a comprehensive distribution structure that provides an overall vision of the entire network hierarchy, the determination of a working structure to manage logistics ranging from distribution, manufacturing to acquisition, as well as providing valuable input in planning distribution schedules from suppliers to distribution points [9].

Primary and secondary data were processed using Excel and POM-QM software to evaluate the causes of lost sales, forecast demand, and develop an optimal distribution plan. The stages of data analysis include:

1. Calculating Lost Sales – identifying the gap between demand and actual sales to determine the number of lost sales.
2. Demand Forecasting – analyzing historical data to estimate future demand requirements. The forecasting process is an estimation of future demand based on forecasting variables, often derived from historical time-series data. The types of forecasting patterns include horizontal data patterns, seasonal patterns, trend patterns, and cyclical patterns [10].
3. Determining Lead Time – setting the ordering lead time to support more accurate inventory planning. Lead time for gallon products is 1 working day while bottles and glasses are 2 working days, based on recorded data of the time between placing orders to the factory and receiving the goods at the DC throughout 2023.
4. Calculating Safety Stock – using time series analysis and standard deviation to determine the optimal level of safety stock. By utilizing inventory storage, business entities are able to carry out production and resource procurement in specific volumes that can reduce the cost per unit [11].
5. Determining Lot Size – applying the Economic Order Quantity (EOQ) method to minimize ordering and storage costs. The purpose is to determine the quantity of materials that must consistently be purchased in each procurement to meet the needs for one period efficiently [12]. The method applied in determining lot sizing is based on the concept of Economic Order Quantity (EOQ). The calculation is performed using the following formula:

$$EOQ = \frac{\sqrt{2DS}}{H} \quad (1)$$

Notation:
D = total demand during one period (per year)
S = ordering cost per order
H = holding cost per unit per period (per year)

The following are the EOQ assumptions:

- Annual demand is known and constant - the value of Demand for each product is used as an EOQ input (e.g., Gallon Demand = 169,497 pcs; Bottle Demand = 147,515 boxes; Cup Demand = 214,099 boxes).
- Ordering (setup) cost is known and fixed per order - Setup is used according to each product's value (e.g., Setup Gallon = Rp 292,000; Bottle = Rp 252,000; Cup = Rp 232,000).

- Annual holding cost per unit is constant (H = Rp 5,000/unit/year) - the same Holding is applied to all products in the calculations.
- Replenishment arrives in batches (instant replenishment) - each order is assumed to arrive at once (full lot arrival), so maximum inventory = Quantity, following the basic EOQ model principles.
- No quantity discounts (unit price does not affect EOQ) - in the POM-QM output, the unit price is listed as zero; thus EOQ formation does not consider purchase discounts.
- No shortages/backorders allowed — the EOQ model used assumes no early ordering; the objective is to minimize total cost (holding + setup).
- Lead time is treated separately (used in DRP) - although lead time is applied in DRP scheduling, the EOQ calculation itself does not modify the demand assumption; EOQ only determines the order size, while safety stock and lead time are used to determine order release timing in DRP.
- EOQ results are used as the lot size for the Planned Order Receipt - the calculated EOQ values (Gallon 4,449 pcs; Bottle 3,856 boxes; Cup 4,456 boxes) become the basis for shipment quantities in the DRP.
- Costs remain constant throughout the analysis period - Setup, Holding, and Demand are assumed to be stable across the analysis horizon so that frequency and annual costs can be compared (result: frequency decreases from 190 → 124 orders and total cost decreases by ~35%).

6. Developing the DRP Worksheet – identifying products, distribution locations, and net requirement calculations based on forecasting results and lead time data.

III. RESULT

A. Factors Causing Lost Sales

The analysis of lost sales at DC Formula Paluta was carried out using the fishbone diagram method, which effectively identifies the main factors in a structured manner through a marketing management approach. This approach encompasses product, price, promotion, and distribution aspects that influence sales performance. By mapping out clear cause-and-effect relationships, the analysis assists the company in finding comprehensive solutions to address lost sales issues and formulating more targeted corrective actions, as illustrated in Fig.2.

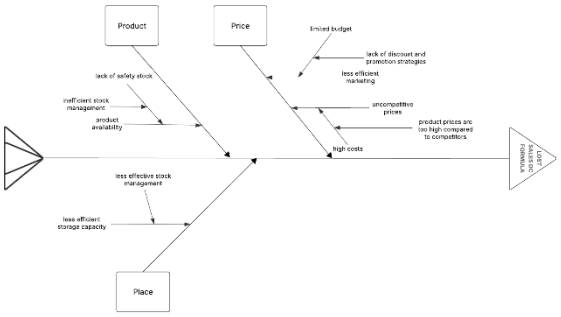

Fig.2. Fishbone Diagram

Based on Fig.2, several factors contributing to lost sales in the company can be identified. These include limited budgets leading to suboptimal promotional activities and ineffective promotional strategies in attracting consumer interest. In addition, the lack of innovation in packaging design and minimal collaboration with external designers resulted in less appealing product packaging. Another factor is uncompetitive product pricing compared to competitors due to high production costs, as well as ineffective product distribution, indicated by low product availability.

B. Lost Sales Calculation

In calculating lost sales, Microsoft Excel was used, where each product experiencing lost sales is listed in Table 1.

Table 1. Lost Sales Calculation Data

Demand and Sales Data for the 2023 Period										
Period	Product Demand			Product Sales			Lost Sales			Lost Sales
	GALLON	BOTTLE	GLASS	GALLON	BOTTLE	GLASS	GALLON	BOTTLE	GLASS	
January	15353	7560	16619	14900	7400	16222	3%	2%	2%	7%
February	14348	6870	17303	14334	6680	17293	0%	3%	0%	3%
March	14734	14905	16161	14701	14497	15943	0%	3%	1%	4%
April	12702	10321	17679	12700	10224	17344	0%	1%	2%	3%
May	15843	11421	13783	15821	11266	13743	0%	1%	0%	2%
June	16588	13875	13158	15903	13874	12143	4%	0%	8%	12%
July	14362	20534	13828	14312	20222	13728	0%	2%	1%	3%
August	15838	14325	19949	15236	14103	18939	4%	2%	5%	10%
September	14514	12572	18533	13722	12527	16557	5%	0%	11%	16%
October	12678	12365	25602	12556	12365	25602	1%	0%	0%	1%
November	10156	11248	16541	10116	10814	15270	0%	4%	8%	12%
December	12381	11519	24943	11859	11489	24705	4%	0%	1%	5%

Based on Table 1, it can be concluded that the lost sales data for each product, including 240 ml, 600 ml, and 19-liter products, show occurrences of lost sales in certain months and the specific products affected. In addition, it is evident that cup products experienced the highest level of lost sales in September, reaching 11%. Meanwhile, the highest lost sales occurred in September at 16% during the period of January to December 2023.

C. Forecasting Results

Haizer and Render define forecasting as the knowledge and skills to anticipate future events. This approach involves collecting historical data and

interpreting it toward the future through the application of mathematical models [13].

The data used in this method refers to the previous 12 months, from January 2023 to December 2023. The selected forecasting approach was the one with the lowest Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). The following is a comparison of the accuracy of each forecasting method:

Table 2. Accuracy Comparison MAD, MSE, and MAPE

Method	Gallon	Bottle	Glass
Moving Average	MAD: 1610,05	MAD: 3066,70	MAD: 3167,4
	MSE: 3618619	MSE: 16672397,4	MSE: 14850306,5
	MAPE: 0,123237	MAPE: 0,208422	MAPE: 0,170221
Naïve	MAD: 1719,82	MAD; 3007,18	MAD: 3691,3
	MSE: 3570689	MSE: 16419404,3	MSE: 23839315,3
	MAPE: 0,128332	MAPE: 0,217598	MAPE: 0,192606
Exponential Smoothing	MAD: 1741,73	MAD: 5288,64	MAD: 3083,5
	MSE:5009523	MSE:37127989,7	MSE:17668542,1
	MAPE: 0,140576	MAPE: 0,38335	MAPE: 0,159815
Regresi/Trend	MAD: 1200,50	MAD: 2518,21	MAD: 2785,9
	MSE:2197260	MSE: 10405825,9	MSE: 10278890
	MAPE: 0,088497	MAPE: 0,213795	MAPE: 0,1627
Multiplicative Decomposition	MAD: 1216,96	MAD: 2550,23	MAD: 2128,1
	MSE: 2192331	MSE: 9645144,68	MSE: 7158067
	MAPE: 0,08969	MAPE: 0,214689	MAPE: 0,1279
Additive decomposition	MAD: 1214,39	MAD: 2538,07	MAD: 2198,2
	MSE: 2187631	MSE: 9588616,13	MSE: 7578020
	MAPE: 0,089502	MAPE: 0,213666	MAPE: 0,13234

Based on the calculations using Pom QM software, the forecasting results show that the Regression/Trend Analysis and Multiplicative Decomposition methods provided the most optimal results for each product type, based on the lowest MAD, MSE, and MAPE values. The results of these forecasting calculations can be seen in the recap of the next year's forecast presented in Table 3.

Table 3. Forecasting Results of Products

	DC Formula Paluta		
	Regression/Trend analysis		*Multiplicative decomposition*
	Gallon (pcs)	Bottle (box)	Glass (box)
January	15625	10528	13685
February	15352	10849	16894
March	15079	11170	14612
April	14807	11490	18002
May	14534	11811	15539
June	14261	12132	19109
July	13988	12453	16467
August	13716	12774	20216
September	13443	13095	17394
October	13170	13416	21323
November	12898	13737	18321
December	12625	14058	22430

The forecasting results, which serve as the basis for next year's demand, were then converted into weekly data to facilitate the preparation of the DRP worksheet, as shown in Table 4.

Table 4. Weekly Demand Data

Period	Number of week	Number of demand					
		Gallon (pcs)		Bottle (box)		Glass (box)	
		Month	Week	Month	Week	Month	Week
January	5	15625	3125	10528	2106	13685	2737
February	4	15352	3838	10849	2712	16894	4224
March	5	15079	3016	11170	2234	14612	2922
April	4	14807	3702	11490	2873	18002	4500
May	4	14534	3633	11811	2953	15539	3885
June	4	14261	3565	12132	3033	19109	4777
July	5	13988	2798	12453	2491	16467	3293
August	4	13716	3429	12774	3194	20216	5054
September	4	13443	3361	13095	3274	17394	4348
October	4	13170	3293	13416	3354	21323	5331
November	4	12898	3224	13737	3434	18321	4580
December	5	12625	2525	14058	2812	22430	4486

D. Safety Stock Calculation

According to Rendra Trisyanto [14], safety stock refers to additional inventory kept by a company to ensure the continuity of production and sales processes while avoiding stockouts that could disrupt business operations. The primary purpose of safety stock is to cope with uncertainties in customer demand and supplier lead times, as well as to maintain customer satisfaction and loyalty.

In this system, safety stock serves as a reference to initiate additional orders in order to meet the forecasted demand. Within the context of Distribution Requirement Planning, the estimation of safety stock is simplified by assuming stable demand during the distribution lead time, while still considering the company's desired service level of 90%. The formula used to calculate safety stock is as follows:

$$Safety\ stock\ = \mathrm{Z} \times \sigma\ demand \times \sqrt{L} \qquad (2)$$

Z = procurement factor at the desired service level
σ = standard deviation of demand
$\sqrt{L}$ = average lead time

Z is the coefficient value from the normal distribution that indicates how far the desired service level is. Since the targeted service rate is 90%, it means the company wants to ensure that 90% of customer dsemand is fulfilled without stockouts. The value Z = 1.28 comes from the normal distribution table (Z-table), which links the target service level with the probability of avoiding a stockout. Standard deviation (σ) is a measure of how much variation or deviation exists between actual data and its average. Standard deviation is calculated using the population or sample standard deviation formula [15]:

$$\sigma = \sqrt{\frac{\sum(x_i - \overline{x})^2}{n-1}} \qquad (3)$$

σ = standard deviation of demand
x_i = monthly forecast values
$\overline{x}$ = monthly average
n = 12 months

The following are the standard deviation calculations for the gallon, bottle, and cup products.

Standard deviation of gallons:

$$\sigma = \sqrt{\frac{10.634.292}{11}}$$

$$\sigma = \sqrt{967{,}663}$$

$$\sigma = 983{,}28$$

Standard deviation of bottle:

$$\sigma = \sqrt{\frac{14.693.237}{11}}$$

$$\sigma = \sqrt{1.335.749}$$

$$\sigma = 1.155{,}74$$

Standard deviation of glass:

$$\sigma = \sqrt{\frac{76.671.336}{11}}$$

$$\sigma = \sqrt{6.969.212}$$

$$\sigma = 2.639{,}93$$

Based on the calculation using the formula, the safety stock for each product type was obtained. The detailed results of these calculations are presented in Table 5.

Table 5. Safety Stock Calculation Results

	DC		
	Types of products		
Safety Stock	Gallon (pcs)	Bottle (box)	Glass (box)
	228	380	866

E. Lot Sizing Determination

Lot-sizing is the process of calculating the optimal order quantity for a material based on the net requirements derived from netting calculations [16]. This lot-sizing process is closely related to determining the quantity of materials that must be ordered or prepared. The detailed results of these calculations are presented in Table 6.

Table 6. Lot Sizing Calculation Results

DC Formula	*Order Quantity*		
Product	Gallon (pcs)	Bottle (box)	Glass (box)
Amount	4449	3856	4456

F. Order Frequency

The calculation of order frequency for each product at the Formula Paluta Distribution Center is carried out using the following formula.

$$Frequency\ of\ orders = \frac{number\ of\ requests\ (year)}{order\ quantity} \qquad (4)$$

After conducting demand forecasting and applying the Economic Order Quantity (EOQ) method at the Formula Paluta Distribution Center, the order frequency for the following year is presented in Table 7.

Table 7. Order Frequency Data

DC	Order Frequency/Year		
	Gallon	Bottle	Glass
DC Formula Paluta	38	38	48

G. DRP Worksheet

Distribution Requirement Planning is a scheduling planning method used to align product inventories at each distribution center (DC) [17]. Distribution

Requirement Planning (DRP) is a management process that coordinates a series of essential activities required to organize and oversee distribution operations. This process integrates operational requirements with the available inventory capacity.

Based on the calculation results, the preparation of the Distribution Requirement Planning (DRP) worksheet needs to be carried out for all products available at the Formula Paluta Distribution Center. A weekly time bucket approach was selected to ensure that the lead time of each product can be more effectively controlled, kept within one month, and even monitored on a weekly basis.

The process of preparing the DRP worksheet for gallon, bottle, and cup products begins with determining the lead time as the basis for order and delivery scheduling. Next, the order quantity is calculated to determine the optimal purchase volume, accompanied by the establishment of safety stock to maintain product availability during demand fluctuations. The following step is to calculate the gross requirement (GR), which represents the total product demand in a given period.

Subsequently, the projected on-hand inventory is calculated to identify the remaining stock available in the current period, including surpluses or shortages carried over from previous periods (past due). These results are then used to determine the net requirement (NR), which is the actual demand after considering available inventory. Afterward, the planned order receipts (POR) are calculated to schedule the quantity of goods to be received according to the net requirement. Finally, the planned order releases (PORI) are established, specifying the timing and quantity of orders that must be placed to ensure that goods are received on time according to the distribution schedule. The proposed DRP worksheets for gallon, bottle, and cup products are presented in the following tables.

Table 8. DRP Worksheet Gallon

		Safety Stock	228		Periode																
Lot size	4449	Lead time	1 hari	PD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Gross Requirement (GR)					3125	3125	3125	3125	3125	3838	3838	3838	3838	3026	3026	3026	3026	3026	3702	3702	3702
Project On Hand (POH)				842	2166	3490	365	1689	3013	3624	4235	397	1008	2431	3854	828	2251	3674	4421	719	1466
Net Requirement (NR)					2283	959		2760	1436	825	214		3441	2018	595		2198	775	28		2983
Planned Order Receipts (POR)					4449	4449		4449	4449	4449	4449		4449	4449	4449		4449	4449	4449		4449
Planned Order Releases (PORI)					4449		4449	4449	4449	4449		4449	4449	4449		4449	4449	4449		4449	4449

Table 9. DRP Worksheet Gallon (Continued)

`Periode																				
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
3702	3633	3633	3633	3633	3565	3565	3565	3565	2798	2798	2798	2798	2798	3429	3429	3429	3429	3361	3361	3361
2213	3029	3845	4661	1028	1912	2796	3680	4564	1766	3417	619	2270	3921	492	1512	2532	3552	4640	1279	2367
2236	1420	604	212		2537	1653	769	115		1032		2179	528		2937	1917	897	191		2082
4449	4449	4449	4449		4449	4449	4449	4449		4449		4449	4449		4449	4449	4449	4449		4449
4449	4449	4449		4449	4449	4449	4449		4449		4449	4449		4449	4449	4449	4449		4449	4449

Table 10. DRP Worksheet Gallon (Continued)

`Periode													
39	40	41	42	43	44	45	46	47	48	49	50	51	52
3361	3293	3293	3293	3293	3224	3224	3224	3224	2525	2525	2525	2525	2525
3455	4611	1318	2474	3630	406	1631	2856	4081	1556	3480	955	2879	354
994	162		1975	819		2818	1593	368		969		1570	
4449	4449		4449	4449		4449	4449	4449		4449		4449	
4449		4449	4449		4449	4449	4449		4449		4449		

Table 11. DRP Worksheet Bottle

		Safety Stock	380		Periode																
Lot size	3856	Lead time	2 hari	PD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Gross Requirement (GR)					2106	2106	2106	2106	2106	2712	2712	2712	2712	2234	2234	2234	2234	2234	2873	2873	2873
Project On Hand (POH)				1026	2776	670	2420	4170	2064	3208	496	1640	2784	550	2172	3794	1560	3182	4165	1292	2275
Net Requirement (NR)					1080		1436	314		648		2216	1072		1684	62		674	309		1581
Planned Order Receipts (POR)					3856		3856	3856		3856		3856	3856		3856	3856		3856	3856		3856
Planned Order Releases (PORI)					3856	3856		3856		3856	3856		3856	3856		3856	3856		3856	3856	3856

Table 12. DRP Worksheet Bottle (Continued)

`Periode																				
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
2873	2953	2953	2953	2953	3033	3033	3033	3033	2491	2491	2491	2491	2491	3194	3194	3194	3194	3274	3274	3274
3258	4161	1208	2111	3014	3837	804	1627	2450	3815	1324	2689	4054	1563	2225	2887	3549	4211	937	1519	2101
598	305		1745	842	19		2229	1406	41		1167	198		1631	969	307	355		2337	1755
3856	3856		3856	3856	3856		3856	3856	3856			3856		3856	3856	3856	3856		3856	3856
	3856	3856	3856		3856	3856	3856			3856		3856	3856	3856	3856		3856	3856	3856	3856

Table 13. DRP Worksheet Bottle (Continued)

`Periode													
39	40	41	42	43	44	45	46	47	48	49	50	51	52
3274	3354	3354	3354	3354	3434	3434	3434	3434	2812	2812	2812	2812	2812
2683	3185	3687	4189	835	1257	1679	2101	2523	3567	755	1799	2843	31
1173	671	169	333		2599	2177	1755	1333	289		2057	1013	
3856	3856	3856	3856		3856	3856	3856	3856	3856		3856	3856	
3856	3856		3856	3856	3856	3856	3856		3856	3856			

Table 14. DRP Worksheet Glass

		Safety Stock	866		Periode																
Lot size	4456	Lead time	2 hari	PD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Gross Requirement (GR)					2737	2737	2737	2737	2737	4224	4224	4224	4224	2992	2992	2992	2992	2992	4500	4500	4500
Project On Hand (POH)				428	2147	3866	1129	2848	4567	4799	5031	5263	1039	2503	3967	975	2439	3903	3859	3815	3771
Net Requirement (NR)					2309	590		1608	111	343	575	807		1953	489		2017	553	597	641	685
Planned Order Receipts (POR)					4456	4456		4456	4456	4456	4456	4456		4456	4456		4456	4456	4456	4456	4456
Planned Order Releases (PORI)						4456	4456	4456	4456	4456		4456	4456		4456	4456	4456	4456	4456	4456	4456

Table 15. DRP Worksheet Glass (Continued)

Periode																			
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
4500	3885	3885	3885	3885	4777	4777	4777	4777	3293	3293	3293	3293	3293	5054	5054	5054	5054	4348	4348	4348
3727	4298	4869	984	1555	1234	913	592	271	1434	2597	3760	4923	1630	1032	434	4292	3694	3802	3910	4018
729	158	413		2901	3222	3543	3864	4185	3022	1859	696	467		3424	4022	4620	762	654	546	438
4456	4456	4456		4456	4456	4456	4456	4456	4456	4456	4456	4456		4456	4456	8912	4456	4456	4456	4456
4456		4456	4456	4456	4456	4456	4456	4456	4456	4456		4456	4456	4456	4456	8912	4456	4456	4456	4456

Table 16. DRP Worksheet Glass (Continued)

Periode													
39	40	41	42	43	44	45	46	47	48	49	50	51	52
4348	5331	5331	5331	5331	4580	4580	4580	4580	4486	4486	4486	4486	4486
4126	3251	2376	1501	626	502	378	254	130	100	70	40	10	4436
330	1205	2080	2955	3830	3954	4078	4202	4326	4356	4386	4416	4446	4476
4456	4456	4456	4456	4456	4456	4456	4456	4456	4456	4456	4456	4456	8912
4456	4456	4456	4456	4456	4456	4456	4456	4456	4456	4456	8912		

IV. DISCUSSION

Demand forecasting at the Formula Paluta Distribution Center (DC) was conducted by analyzing historical data from January to December 2023 using Pom QM software. Several forecasting methods were applied, including moving averages, naive method, exponential smoothing, regression/trend analysis, as well as multiplicative and additive decomposition. The selection of methods was based on the lowest values of MAD, MSE, and MAPE. As a result, the regression/trend analysis method was chosen for gallon and bottle products with forecasted demands of 169,497 pcs and 147,515 boxes, respectively, while the multiplicative decomposition method was selected for cup products with a demand of 213,992 boxes.

The calculation of safety stock, based on forecasting results, indicated the need for 228 pcs of gallons, 380 boxes of bottles, and 866 boxes of cups. This serves as a critical guideline in maintaining product availability in the face of demand fluctuations. Furthermore, the economic order quantity (EOQ) analysis showed optimal order quantities of 4,449 pcs for gallons, 3,856 boxes for bottles, and 4,456 boxes for cups. The EOQ method successfully reduced the order frequency from 190 times/year to 124 times/year, and lowered costs from Rp147,440,000 to Rp96,224,000, achieving savings of approximately 35%.

The implementation of distribution requirement planning (DRP) helped streamline product flows, allowing delivery schedules to be controlled according to demand. Through the DRP worksheet, the company was able to establish a clear master schedule, avoid both overstocking and stockouts, and minimize the risk of lost sales. Analysis using a fishbone diagram revealed that the main factors contributing to lost sales were uncompetitive pricing, ineffective marketing, limited storage capacity, and unstable product availability. These findings provide the foundation for Formula Paluta DC to develop corrective strategies aimed at improving distribution performance and sales outcomes.

V. CONCLUSSION

The application of DRP and the master schedule worksheet proved to optimize inventory planning by calculating safety stock and order quantity, while also reducing delivery frequency from 190 times to 124 times per year and lowering distribution costs by up to 35%, thereby improving operational efficiency and minimizing the risk of lost sales. Future research is recommended to extend the scope to the distribution level from the distribution center to retail, as well as to formulate more effective methods for addressing distribution-related challenges at that stage.

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