Inventory and Purchasing Analysis of Main Distribution Materials: Case Study in An Electrical Company Unit

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Abstract

Consumable materials in the electricity industry are the important materials needed to meet consumer demand for both new electrical installations and power addition. Stock-out on consumable materials often occur in the company used in this research case study. The purpose of this paper is to analyze and determine the safety stock, reorder point, and lot size policies to manage and control consumable materials in the case study. The forecasting method used in this research is ARIMA and Artificial Neural Network (ANN), as well as two types of lot-sizing rules, Economic Order Quantity (EOQ) and Periodic Order Quantity (POQ). Based on last year's demand data for new electrical installations and power addition, the ANN forecasting method is shown to be more appropriate because it has a smaller error than the ARIMA method. Twenty consumable materials were analyzed in this paper. Thirteen materials need to use the POQ lot-sizing rule, while the remaining seven need to use the EOQ rule correctly. The result shows that a change in the lot size rules used for each material, cause an increase in the service level.

Keywords
Material Control, Material Inventory, MRP, Lot Sizing, Forecasting

1. Introduction

A company must be able to manage and hold its inventory to create effective and efficient operational activities. Pujawan and Mahendrawati (2010) said that inventory along the supply chain has significant implications for a company's financial performance. The amount of money embedded in inventory is usually so large that inventory is one of the most important assets in a supply chain. Tersine (1994) stated that the basic understanding of inventory is the amount of material available at certain time intervals. Material inventory in the warehouse must be considered and controlled, and material control is applied even when inventory is stored and will not be used. Planning for material purchases is also important. According to Assauri (2008), purchasing is one of the essential functions for the success of a company's operations. This function is responsible for getting the quantity and quality of materials available when needed at prices that match the prevailing prices. If there is a basic error in planning purchases, the company can experience losses when inventory excess or shortage occurs.

Indications of material control problems occur in this research case study of an electrical company unit, i.e., Customer Service Implementing Unit. For the last two years, fulfillment of demand has been constrained by material stock-out, which happen because the material orders to the suppliers are not adjusted to the uncertain or probabilistic market demand. This triggers a continuous increase in the waiting list for new installations of electricity along with the long addition of electrical power until the end of 2020. Some customers have to receive payment refunds or service delays because the company is unable to meet the demand for new installation materials within a certain time which then becomes a loss for the company. Until December 2020, 2,163 potential customers were on the waiting list for 2020. The length of service days from the date of application until the customer turns on is 25 days. If the deadline cannot be met, the customer will get a refund. Based on the data, 3,381 customers received refunds in 2020. Moreover, based on the data obtained from the marketing department, several refunds occurred due to a stock-out in the material for kWh Meters and Mini Circuit Breaker (MCB) 1 Phase and 3 Phase with the details of running out include 1 Phase MCB by 9.33%, 46.6% for kWh Prepaid Electricity Meters (LPB) 1 Phase, 1.26% for MCB 3 Phase, 4.06% for kWh Meter LPB 3 Phase and 0.09% for 3 Phase Postpaid kWh Meter. That means a total of 61.34% restitution occurred due to a stock-out of kWh Meter and MCB materials.

Based on the fulfillment of demand, it can be seen that the fulfillment value is not normal. For instance, the fulfillment of new installation and migration applications in the current month, such as in May, is 277%. This happened due to the fulfillment of the waiting list from the previous months, which can only be realized in that month. However, in June, there was a shortage of material for the pre-paid 1 Phase kWh Meter, and as a result the fulfillment only reached 87%. This condition continued until September, and so some customers had to be put on the waiting list. This also happened because the requests for a new installation, electricity addition, and migration every month are not well predicted. Stock-out problems do not only occur in the pre-paid 1 Phase kWh Meter material but also occur in some MCB materials or power limiters installed in the kWh Meter. The kWh Meter and MCB are part of the main distribution material, which included as materials with continuous movement or is used continuously for new installation, power addition, migration of customers or maintenance and replacement of damaged materials. According to Ghobbar (2002), materials with a continuous use pattern are included in the fast-moving material type. Inventories of fast-moving materials should be managed properly to avoid stock-out. Therefore, the problem that would be solved through this research is how to determine the right lot-sizing method, how many kWh Meter and MCB materials need to be purchased, and how the inventory conditions in each period should be, based on the results of the demand forecast for kWh Meters and MCB from new installation, electricity addition, and migration applications.

The objective of the research is to analyze the number of purchases and inventories of kWh Meters and MCB to determine the case study's company most optimal lot-sizing policy. The optimal number of purchasing calculated based on Economic Order Quantity (EOQ) and Periodic Order Quantity (POQ) will determine the cost-saving and service level through the comparison between the results and the existing lot size calculation method.

2. Literature Review

A few research related to material inventory in a case study has also been carried out. Agustina (2020) controls the inventory of main distribution materials using continuous review and periodic review by predicting the material demand for the main distribution of new installation and electricity addition to household tariff customers using exponential smoothing and double exponential smoothing methods in a case study. Fitriani (2020) did a forecast without inventory control on new installation and electricity addition material demand using double exponential smoothing method and Artificial Neural Network (ANN) in a case study. The two studies do not specifically analyze the demand for kWh Meters and MCBs because the supply problem for each electrical company unit is different.

This research focuses on analyzing the number of purchases and supplies of kWh Meter and MCB materials by using EOQ and POQ methods on all new installation, electricity addition, and migration applications. The demand used in this research is forecasted using the ANN and ARIMA methods. Several studies related to forecasting methods and lot size are by Rahmawati (2010), in the analysis of the method selection in controlling the inventory of consumable materials of the B737 aircraft based on material classification. The study aims to determine the control method for consumable materials on the B737 aircraft by forecasting material requirements using the Croston method, which is then followed by lot-sizing using min-max level, periodic review and continuous review. The results of the lot-sizing are then used as an MRP. Rodrigues et al (2012) studied on spare parts inventory control for non-repairable items based on prognostic and health monitoring information, which aims to show a comparison between two different inventory control policies for non-repairable parts in terms of the average total cost required and the level of service achieved. The inventory model [R, Q] (reorder point, economic order quantity) is used as a reference. This model is compared with a model based on information obtained from the Prognostics and Health Monitoring (PHM) system. Discrete event simulation is used to simulate and assess the performance of both models. Meanwhile, Pratiwi (2017) analyzed the planning of raw material requirements for PC I Girder production at PT. Adhimix Precast Indonesia to obtain sales forecast and determine the optimum quantity of raw material purchases for PC I Girder products. The forecasting method used in the study is ARIMA Box-Jenkins. EOQ is then used to determine the purchase quantity of the raw materials.

The demand used in this research is obtained based on demand forecasting using ARIMA and ANN methods. Several studies with similar methods have also been carried out by Tauchid (2015) on the analysis of demand forecast for thermal paste in CV. Siplho Corporation using the Box-Jenkins ARIMA method. The study aims to find out the descriptive statistics on Thermal Paste demand and forecast the demand for the next several periods. In the forecasting, ARIMA (0,1,1) is found to be the best model. Arianto (2017) did a forecasting on the number of train passengers on Java and Sumatra islands using the ARIMA Box-Jenkins.

The concept of this research is to analyze the number of purchases and supplies of kWh Meter and MCB materials on all new installation, electricity addition, and migration applications, by forecasting the demand using the ANN and ARIMA methods as the basis for next year's demand. The forecasted demand is used as the basis for the EOQ and POQ calculation to find the most effective and efficient number of purchases, so that customer demand can be met with the most optimal inventory costs.

3. Methods

Several theories and references are used to support this research, especially regarding to forecast using the ARIMA and ANN methods, as well as lot size calculations using EOQ and POQ. Field studies are also carried out to know the actual situation of the research object so that what happens in the field can synergize with the existing theories. According to Hidayat (2012), the important thing in estimating demand is to combine forecasting, inventory status, and demand planning. There are two main data in the data collection process. The first is new installation, electricity addition, and migration application data, while the second is Material Requirement Planning (MRP) input data such as Master Production Schedule (MPS) and Bill of Materials (BOM), to determine the number of purchases and inventories of kWh Meters and MCBs using the MRP method. These data are obtained from historical data of material usage, material price, connection requests, power addition, customer migration, and disturbance reports from the year 2018 to 2020. Furthermore, the data is converted into material movement during that period. The conversion result will be used as the historical demand data for kWh Meters and MCBs in the past 3 years which will become the input data for forecast using ARIMA and ANN. In Subagyo (2002), the error value of forecasting from each forecasting period can be obtained by calculating the Mean Absolute Percentage Error (MAPE) and Root Mean Square Error (RMSE) values. The most accurate forecasting results will become the input of the MRP. At the material inventory calculation stage, apart from being a comparison for EOQ calculations, POQ is also used as a consideration for inventory fulfillment within a period, because there is a lead time in each material delivery. The results of the two-lot sizing method will be applied to the MRP to determine which method is the most efficient in terms of cost and material inventory in the warehouse.

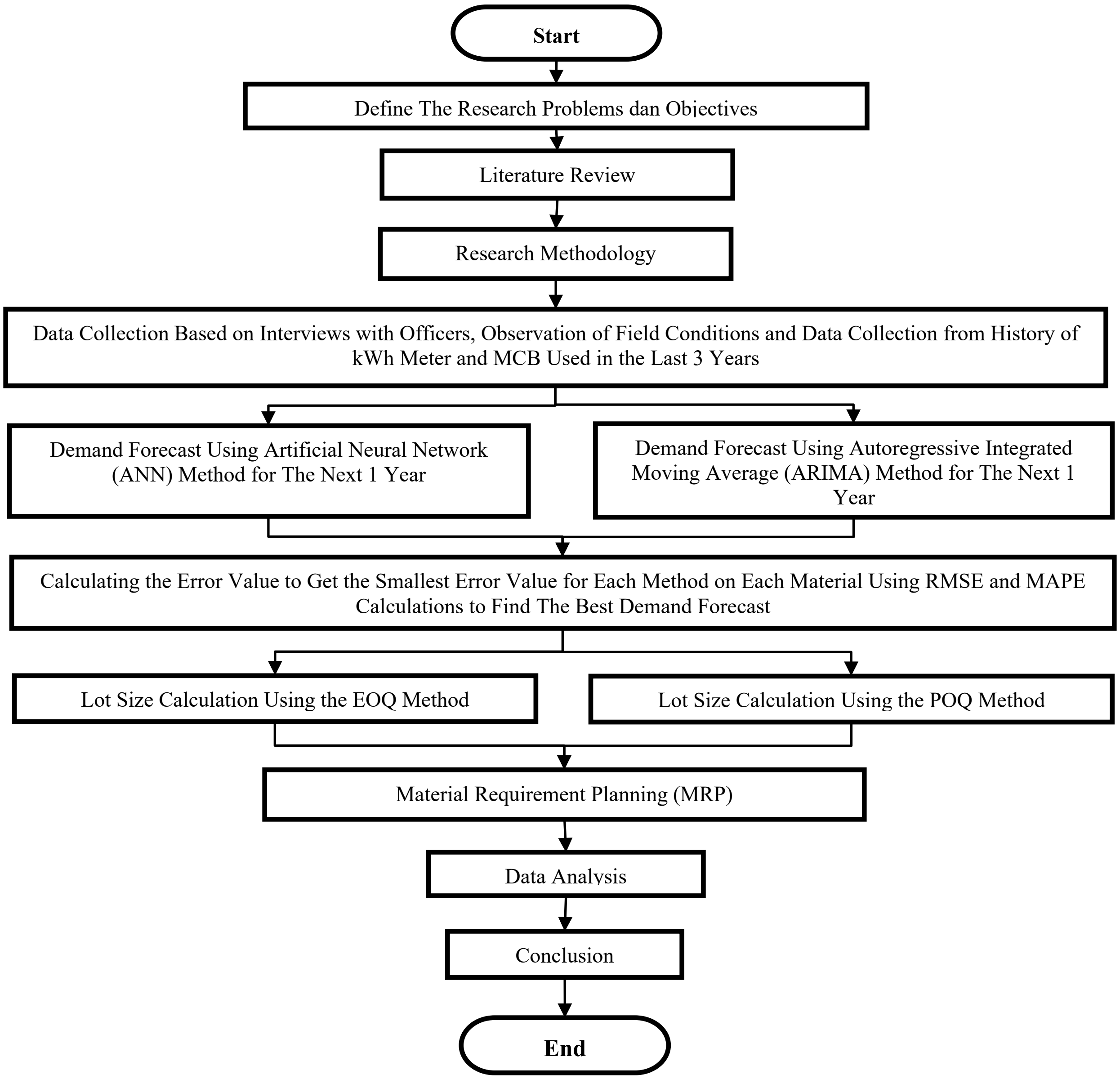

Figure 1. Research Method Flow Diagram

4. Data Collection

The new installation, electricity addition, and migration requests data in this research is taken from the year 2018 to 2020. The new installation, electricity addition, and migration requests data will be converted into main distribution materials demand according to the BOM used. Then, based on the BOM, the kWh Meter and MCB requirements will be taken as the historical data of new installation, electricity addition, and migration materials. The conversion results are shown in Table 1.

Table 2. kWh Meters and MCBs demand in 3 years

No.	Customer Type	Material Number	Material Name	kWh Meters and MCBs Demand (Unit)	
				In 3 Years	Average in Each Year
1	1 Phase	2190222	MTR;kWh ECOM;;1P;230V;5-40A MINMCB;1	13,119	4,373
2		2190224	MTR;kWh E-PR;;1P;230V;5-60A;1;;2W	101,772	33,924
…		…	…	…	…
10		3250131	MCB;230/400V;1P;35A;50Hz;MIN BOX	34	11
11		3250169	MCB;230/400V;1P;50A;50Hz;MIN BOX	6	2
12	3 Phase	2190218	MTR;kWh E;;3P;230/400V;5-80A;1;;4W	1,407	469
13		2190252	MTR;kWh E-PR;;3P;230/400V;5-80A;1;;4W	2,534	845
…		…	…	…	…
19		3250029	MCB;380/440V;3P;50A;50Hz;	169	56
20		3250032	MCB;380/440V;3P;63A;50Hz;MCCB	90	30

To calculate the most efficient total cost based on the lot-sizing calculation results, the material purchase costs, ordering costs, holding costs, and stock-out costs data are needed. Table 2 shows the price and stock-out cost of each material. Ordering costs are costs incurred when placing an order for materials. These costs are assumed to be unchanged for each order, which is Rp. 1,000,000.00/order. Meanwhile, the calculation of holding costs per material per year is 28% of the price of each material.

Table 2. Material price and stockout cost

No.	Customer Type	Material Number	Material Name	Material Price	Stockout Cost
1	1 Phase	2190222	MTR;kWh ECOM;;1P;230V;5-40A MINMCB;1;;	$12.50	$13.30
2		2190224	MTR;kWh E-PR;;1P;230V;5-60A;1;;2W	$16.41	$13.30
…		…	…	…	…
10		3250131	MCB;230/400V;1P;35A;50Hz;MIN BOX	$2.00	$69.39
11		3250169	MCB;230/400V;1P;50A;50Hz;MIN BOX	$2.07	$69.39
12	3 Phase	2190218	MTR;kWH E;;3P;230/400V;5-80A;1;;4W	$89.98	$22.60
13		2190252	MTR;kWH E-PR;;3P;230/400V;5-80A;1;;4W	$113.65	$36.30
…		…	…	…	…
19		3250029	MCB;380/440V;3P;50A;50Hz;	$23.12	$110.46
20		3250032	MCB;380/440V;3P;63A;50Hz;MCCB	$79.49	$138.91

In forecasting using ANN method, the authors use one hidden layer architecture with the number of neurons as a predictor variable. According to Gerhenson (2003), the working principle of ANN is inspired by the human neural network system. The more the neurons are, the better. The number of neurons in the hidden layer is determined by trial & error starting from n to 3n, where n is the number of neurons in the input layer. In this research, the predictor or input layer variables used consist of five variables or in ANN terms, are called 5 neurons. These predictor variables influence each other. These variables are kWh Meter demand / MCB demand (the results of conversion of new installation, electricity addition, and migration applications), increase in number of customers, connected power, kWh sold, and Rupiah / kWh. Hence, the number of hidden layers used in the trial & error is 5 (n), 10 (2n), and 15 (3n) neurons. Hyperbolic tangent is used as an activation function. The hyperbolic tangent was chosen because according to Wibawa (2017), the hyperbolic tangent, in general, can reach the convergence faster than the sigmoid and logistic activation functions and can produce higher accuracy than the Rectifier Linear Unit. Forecasting with ANN is done using the add-ins NeuroXL Predictor software in Microsoft Excel. The predictor variable data is shown in Table 3.

Table 3 ANN predictor variable

Month	Customer Increase (Thousand Customer)	Power Installed (MVA)	kWh Sold (MWh)	Rupiah / kWh (Rp)
Jan 2018	750.071	738.638	86.827	925
Feb 2018	751.823	742.666	165.105	926
Mar 2018	753.698	746.623	253.706	931
…	…	…	…	…
Okt 2020	828.490	956.575	1,099.482	813
Nov 2020	832.412	967.832	1,209.670	788
Des 2020	837.180	981.310	1,318.867	780

5. Results and Discussion

5.1 Numerical Results

Table 4 shows the evaluation of the forecasting results using ARIMA and ANN methods. The ANN method produces smaller RMSE and MAPE values for most materials except for Material 3250027. Hence, Material 3250027 will use the forecast result from ARIMA.

Table 4. Forecasting method evaluation

No.	Material Number	ARIMA		ANN		Chosen Forecast Method
		RSME	MAPE	RSME	MAPE	
1	2190222			192.59	238%	ANN
2	2190224	875.48	34%	620.59	15%	ANN
3	3250047	126.85	60%	113.67	36%	ANN
4	3250049	407.90	35%	251.66	18%	ANN
5	3250051	195.00	33%	169.78	21%	ANN
6	3250053	215.07	52%	232.99	24%	ANN
7	3250055	191.31	47%	142.37	17%	ANN
8	3250057	126.20	123%	26.18	12%	ANN
9	3250168	200.29	73%	154.89	14%	ANN
10	3250131			0.33	6%	ANN
11	3250169			0.23	1%	ANN
12	2190218	9.01	22%	3.12	7%	ANN
13	2190252	37.62	45%	23.92	13%	ANN
14	3250022	16.18	50%	6.40	10%	ANN
15	3250024	18.85	31%	12.77	14%	ANN
16	3250021	14.81	52%	14.13	16%	ANN

No.	Material Number	ARIMA		ANN		Chosen Forecast Method
		RSME	MAPE	RSME	MAPE	
17	3250025	6.13	35%	3.85	11%	ANN
18	3250027	4.09	44%	6.10	72%	ARIMA
19	3250029	4.79	36%	1.23	29%	ANN
20	3250032			1.22	41%	ANN

Table 5 shows the final forecasting result of kWh Meters and MCBs for the next 12 months, based on the chosen forecast method.

Table 5. kWh Meters and MCBs forecasting result

No.	Material Number	2021											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**2190222**	416	380	347	237	130	73	10	0	0	0	0	0
2	**2190224**	3,296	2,207	3,009	2,914	2,052	1,785	3,069	3,661	3,651	3,236	3,419	3,163
3	**3250047**	479	377	424	490	459	392	476	382	390	422	444	450
4	**3250049**	1,719	1,414	1,403	1,504	1,208	1,179	1,708	1,734	1,846	1,689	1,833	1,593
5	**3250051**	720	442	739	745	666	711	1,000	1,152	1,188	1,058	1,182	1,081
6	**3250053**	557	488	319	261	214	235	481	773	777	403	460	324
7	**3250055**	373	299	355	349	239	282	651	869	884	736	716	631
8	**3250057**	148	75	126	106	112	88	241	350	492	196	181	134
9	**3250168**	259	163	198	204	144	137	543	689	757	611	559	605
10	**3250131**	0	0	0	0	0	0	0	1	4	0	1	1
11	**3250169**	0	0	0	0	0	0	0	0	1	0	0	0
12	**2190218**	26	35	40	25	21	33	31	46	38	42	35	34
13	**2190252**	50	42	82	100	82	119	114	120	119	120	120	116
14	**3250022**	23	31	38	60	33	78	73	80	87	77	78	71
15	**3250024**	26	23	48	49	47	54	72	64	83	82	66	66
16	**3250021**	13	19	38	37	32	57	50	60	66	62	58	56
17	**3250025**	13	16	10	11	20	16	13	20	28	26	27	25
18	**3250027**	5	9	17	10	15	18	12	11	17	17	20	20
19	**3250029**	3	3	6	7	6	3	7	4	6	5	8	8
20	**3250032**	1	1	1	0	0	0	0	0	2	0	0	2

The lot size calculation is then carried out using the existing method, EOQ, and POQ. The existing method of lot size calculation only pays attention to the average value of the material used every month and determines orders based on safety stock (SS). If the inventory value has reached SS, an order will be placed. Meanwhile, the maximum order value is based on the reorder point (s) value. The calculation uses the following equation.

$$SS = \frac{\overline{D} \times L}{2} \qquad (1)$$

$$s = (\overline{D} \times L) + SS \qquad (2)$$

$\overline{D}$ = average demand
L = lead time

Meanwhile, EOQ and POQ will be calculated with,

$$EOQ = \frac{\sqrt{2 \times R_c \times D}}{H_c} \quad (3)$$

$$POQ = \frac{EOQ}{\overline{D}} \quad (4)$$

where,
R_c = order cost
D = total demand
H_c = holding cost

Based on these equations, the value of each lot size obtained is shown in Table 6.

Table 6. Lot size calculation results

No.	Material Number	Average Demand/ Year	Demand/ Year (D)	Existing		EOQ	POQ	
				s	SS	Q_{EOQ}	Order Period	Q_{POQ}
1	**2190222**	133	1.593	199	66	252	2.0	796
2	**2190224**	2,955	35,463	4,433	1,478	1,036	0.4	101,163
3	**3250047**	432	5,184	648	216	1,114	3.0	1,728
4	**3250049**	1,569	18,830	2,354	785	2,122	1.0	18,830
5	**3250051**	890	10,684	1,335	445	1,599	2.0	5,342
6	**3250053**	441	5,291	661	220	959	2.0	2,646
7	**3250055**	532	6,386	798	266	1,264	2.0	3,193
8	**3250057**	188	2,251	281	94	748	4.0	563
9	**3250168**	406	4,869	609	203	1,079	3.0	1,623
10	**3250131**	1	8	1	0	43	68.0	0
11	**3250169**	0	1	0	0	15	54.0	0
12	**2190218**	34	405	51	17	47	1.0	405
13	**2190252**	99	1,183	148	49	72	1.0	1,183
14	**3250022**	61	728	91	30	201	3.0	243
15	**3250024**	57	681	85	28	199	4,0	170
16	**3250021**	46	549	69	23	175	4.0	137
17	**3250025**	19	227	28	9	115	6.0	38
18	**3250027**	14	171	21	7	98	7.0	24
19	**3250029**	6	66	8	3	38	7.0	9
20	**3250032**	1	8	1	0	7	11.0	0

Based on the inventory costs for a year, lot-sizing using EOQ has the most efficient total cost with the highest average service level. However, when viewed based on inventory security, it is necessary to also pay attention to the minimum order limit. Lot-sizing using the existing method has an advantage because there is a clear lower limit, but it also has a weakness. If the demand in the following month exceeds the lower limit for repurchasing, while the inventory in the current month has not stated the amount to repurchase, the risk of stock-out in the following month will increase.

If EOQ is used as the lot size calculation, there is no lower limit for reordering. If it is known that the demand in the following month will not be fulfilled with inventory during the current month, purchase order can immediately be placed to minimize the risk of stock-out. Likewise for POQ, there is no limit on the minimum number of orders because the lot size is very dependent on the number of ordering periods specified in a year, although in general, it has the lowest cost with a high service level.

The selection of the best lot size cannot be seen as a whole using only one lot size calculation, because each material has each best calculation method when viewed from the total cost and service level produced. Table 7 shows the comparison between the most efficient costs to the calculation of the existing lot size. The comparison of total inventory costs with the average service level of each lot size is shown in Table 8.

Table 7. Comparison of inventory costs and service level lot sizing of each material type

No.	Material Number	Exixting Lot Size Inventory Cost	Chosen Lot Size Inventory Cost	Chosen Lot Size	Saving
1	2190222	$21,327.75	$20,059.81	POQ	6%
2	2190224	$715,650.69		Existing	0%
3	3250047	$11,714.26	$ 10,964.57	POQ	6%
4	3250049	$45,374.39	$39,139.17	POQ	14%
5	3250051	$25,713.93	$22,306.83	POQ	13%
6	3250053	$18,148.72	$15,246.37	POQ	16%
7	3250055	$19,505.48	$12,814.87	POQ	34%
8	3250057	$9,047.18	$4,776.27	POQ	47%
9	3250168	$11,574.42	$10,310.99	POQ	11%
10	3250131	$565.63	$175.25	EOQ	69%
11	3250169	$69.39	$108.75	EOQ	0%
12	2190218	$38,776.02	$36,510.11	POQ	6%
13	2190252	$123,387.38	$134,522.27	POQ	0%
14	3250022	$13,917.69	$6,708.01	POQ	52%
15	3250024	$8,703.44	$6,067.57	POQ	30%
16	3250021	$6,987.38	$5,137.82	POQ	26%
17	3250025	$2,928.42	$2,116.23	EOQ	19%
18	3250027	$2,997.15	$1,951.36	EOQ	33%
19	3250029	$2,607.58	$1,961.15	EOQ	23%
20	3250032	$972.35	$625.92	EOQ	36%
POQ Saving Average					20,01%
EOQ Saving Average					30,00%

Table 8. Comparison of inventory costs and service level lot sizing of each material type

No.	Material Number	Material Name	Existing		EOQ		POQ		Choosen Quantity/Order (Unit)
			Inventory Cost	Service Level	Inventory Cost	Service Level	Inventory Cost	Service Level	
1	**2190222**	MTR;kWH ECOM;;1P;230V;5-40A MINMCB;1	$21,529.39	63%	$21,529.39	76%	$20,065.03	100%	796
2	**2190224**	MTR;kWH E-PR;;1P;230V;5-60A;1;;2W	$715,837.09	94%	$538,660.22	29%	$1,962,320.31	100%	1,478
3	**3250047**	MCB;230/400V;1P;2A;50Hz;MIN BOX	$11,717.31	96%	$12,131.86	100%	$10,967.43	100%	1,728
4	**3250049**	MCB;230/400V;1P;4A;50Hz;MIN BOX	$45,386.21	87%	$40,417.40	100%	$39,149.37	100%	18,830
5	**3250051**	MCB;230/400V;1P;6A;50Hz;MIN BOX	$25,720.63	93%	$24,012.36	100%	$22,312.64	100%	5,342
6	**3250053**	MCB;230/400V;1P;10A;50Hz;MIN BOX	$18,153.45	94%	$17,217.82	100%	$15,250.34	100%	2,646
7	**3250055**	MCB;230/400V;1P;16A;50Hz;MIN BOX	$19,510.56	91%	$16,140.84	100%	$12,818.21	100%	3,193
8	**3250057**	MCB;230/400V;1P;16A;50Hz;MIN BOX	$9,049.54	85%	$6,673.41	100%	$4,777.52	100%	563
9	**3250168**	MCB;230/400V;1P;25A;50Hz;MIN BOX	$11,577.44	99%	$11,851.77	100%	$10,313.68	100%	1,623
10	**3250131**	MCB;230/400V;1P;35A;50Hz;MIN BOX	$565.78	65%	$175.30	100%	$555.23	0%	43
11	**3250169**	MCB;230/400V;1P;50A;50Hz;MIN BOX	$69.40	0%	$108.78	100%	$69.40	0%	15
12	**2190218**	MTR;kWH E;;3P;230/400V;5-80A;1;;4W	$38,786.12	93%	$39,149.31	100%	$36,519.62	100%	405
13	**2190252**	MTR;kWH E-PR;;3P;230/400V;5-80A;1;;4W	$123,419.52	88%	$110,677.44	73%	$134,557.31	100%	1,183
14	**3250022**	MCB;380/440V;3P;10A;50Hz;	$13,921.31	87%	$7,480.48	100%	$6,709.76	100%	243
15	**3250024**	MCB;380/440V;3P;16A;50Hz;	$8,705.70	87%	$7,320.91	100%	$6,069.15	100%	170
16	**3250021**	MCB;380/400V;3P;20A;50Hz;	$6,989.20	94%	$6,773.13	100%	$5,139.16	100%	137
17	**3250025**	MCB;380/440V;3P;25A;50Hz;	$2,929.18	96%	$2,116.79	100%	$2,361.93	100%	115
18	**3250027**	MCB;380/440V;3P;35A;50Hz;	$2,997.93	93%	$1,951.87	100%	$2,013.65	100%	98
19	**3250029**	MCB;380/440V;3P;50A;50Hz;	$2,608.26	92%	$1,961.66	100%	$2,013,15	100%	38
20	**3250032**	MCB;380/440V;3P;63A;50Hz;MCCB	$972.60	0%	$626.09	100%	$972.60	0%	7
POQ Service Level Average						100%			
EOQ Service Level Average						100%			

5.2 Proposed Improvements

Forecasting accurate material demand would assist companies in determining strategies and the planning of material inventory in the warehouse. Errors at the forecasting stage will have an impact on planning errors in material inventory. If the forecasting error is too large, then the planned amount of material inventory will also have a significant error. Meanwhile, the process of ordering materials within the company cannot be done suddenly, and some contracts cover a certain period of time. In practice, changes in material requirements are rarely facilitated, because the amount of the budget ceiling has been locked based on the initial proposal. The procurement process is also carried out centrally with contracts and vendors appointed by the electrical holding company to serve all of Indonesia. Therefore, errors in the forecasting stage of material demand will have an impact until the end of the year in the next period. The proposed method for forecasting in this research is the ANN method, which is adaptive to changes in data patterns, can identify patterns in the historical data used, and can also study the relationship between data so that it will be more real according to conditions. However, the authors suggest that the ANN method is only used in the short term with evaluations every few times so that its accuracy can be monitored, especially in times of pandemic which can at any time affect requests from customers. Calculating and conducting routine evaluations of the kWh Meter and MCB material inventory should also be done so that the purchase of material inventory is following the needs, and hence at minimum cost, it can meet the service level set by the company. Moreover, the company should optimize the use of ERP in the material management function as a logistics control support system by activating features, such as safety stock, reorder points, and optimum order quantity, to simplify the planning and inventory control in real time and to be able to carry out regular stock updates.

6. Conclusion

Forecasting the short-term needs of the main distribution material in this research, especially the kWh meter and MCB, is carried out using the ARIMA and ANN methods. The forecasting results using the ANN method has smaller RMSE and MAPE values on average, i.e., 111.48 for RMSE and 21% MAPE. Meanwhile, the ARIMA method produces 153.0 for RMSE and 48% MAPE. Hence, the ANN method can be an alternative material forecasting to be applied in the company.

In terms of the cost-saving and service level produced, the results of the lot size calculation show that there are thirteen materials becoming more efficient, when using the POQ lot-sizing method, i.e., 2190222 (796 Unit/Order), 3250047 (1,728 Unit/Order), 3250049 (18,830 Unit/Order), 3250051 (5,342 Unit/Order), 3250053 (2,646 Unit/Order), 3250055 (3,193 Unit/Order), 3250057 (563 Unit/Order), 3250168 (1,623 Unit/Order), 2190218 (405 Unit/Order), 2190252 (1,183 Unit/Order), 3250022 (243 Unit/Order), 3250024 (170 Unit/Order), 3250021 (137 Unit/Order) with 20.01% saving average and 100% service level average. On the other hand, there are six materials becoming more efficient when using EOQ lot-sizing method, i.e., 3250131 (43 Unit/Order), 3250169 (15 Unit/Order), 3250025 (115 Unit/Order), 3250027 (98 Unit/Order), 3250029 (38 Unit/Order), 3250032 (7 Unit/Order) with 30.00% saving average and 100% service level average. However, material 2190224 (1,478 Unit/Order) is still more efficient when using the existing method. The result of the lot size calculation can become an option in determining the amount of material purchased by calculating the inventory in the MRP.

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