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Control of Key Distribution Material Requirements (MDU) in Meeting the Demand for New Installations and Power Changes in Utility Companies

Oktavian Syaputra*, Nurhadi Nurhadi
Institut Teknologi Sepuluh Nopember, Indonesia
Email: oktaviansyaputra@gmail.com*

ABSTRACT

Inventory control in utility companies is crucial due to its potential to improve the achievement of sales revenue ratios in serving New Connection (PB) and Power Change (PD) requests. In inventory management, accurate demand planning is essential to minimize both excess and shortage of materials. The inaccuracy in calculating inventory parameters for Distribution Main Materials (MDU), especially for PB and PD, is primarily due to the lack of consideration for demand uncertainty, often resulting in stockouts or overstock. This study aims to optimize inventory management and minimize MDU inventory costs based on the company's inventory policy by classifying MDU according to criticality levels ABA, ABB, and ABC. Short-term forecasting is conducted using exponential smoothing or double exponential smoothing, selecting the method with the smallest forecasting error. Inventory parameters are calculated using the Continuous Review (s,S) and Periodic Review (R,s,S) methods, compared against the company's current condition, and the most optimal policy is selected under stochastic demand conditions. After selecting the best parameters among the three policies, total inventory cost and Service Level per MDU are calculated using Material Requirement Planning (MRP) simulation. By applying inventory policy parameters using the Periodic Review method (R,s,S), the total inventory cost and Service Level for each MDU classification (ABA, ABB, ABC) vary, with an average inventory cost of IDR 76 billion for ABA, IDR 3.6 billion for ABB, and IDR 844 million for ABC, and a Service Level of 98%. This allows the company to achieve inventory cost savings of up to 70% within 36 months compared to the current condition.

Keywords: Inventory Control, Time Series Forecasting, Continuous Review, Periodic Review

INTRODUCTION

In every business activity, the existence of inventory plays a very important role, whether in the form of raw materials, spare parts, semi-finished materials, or finished goods to support the company's operational activities. The high growth of businesses and industries after Covid-19 in 2019 resulted in a surge in applications for new installations and changes in electrical power. This requires utility companies to increase material inventory to meet customer needs. Materials in the electrical field generally consist of transformers, cables, poles, LV boards, kWh meters, MCBs, Lightning Arresters, and Fuse Cut-Outs.

One reason why inventory must exist is that goods cannot be obtained instantly but must go through several stages of the process that take time to complete (Alam et al., 2024; Baek, 2024; Jalili Marand et al., 2019; Oladele et al., 2021; Pasaribu, 2021; San-José et al., 2022). Calculating the amount of inventory that must be available and determining when orders should be placed is important in inventory management, especially when there is uncertainty in the business processes being run. Pujawan (2017) stated that if the company operates under conditions of uncertainty, then the reorder time must consider two aspects, namely safety stock and lead time. Safety stock is used as anticipation of shortages of goods, and with lead time, it is necessary to consider the reorder timing to ensure the availability of goods (Boonsthonsatit S., 2015; Choi, 2020; Gurtu & Johny, 2021; Itang et al., 2022; Saini et al., 2023).

According to Waters (2004), inventory management in a company is related to stock, encompassing policies, activities, and procedures to ensure the right quantity of each item at all times (Annie Rose Nirmala et al., 2022; Bartoszewicz & Latosiński, 2019; Feng et al., 2015; Ganesh et al., 2020; Pandya & Thakkar, 2016). This ensures that the existing inventory can meet the Service Level, be effective in utilization, and efficient in terms of cost. When modeling the inventory system as stochastic with the Continuous Review system approach, three things must be decided: the safety stock value, reorder point, and order quantity. All three must be optimized so that the costs incurred by the company can be minimized, and the two impacts of uncertainty due to demand quantity and lead time—inventory shortages or excess inventory—can be avoided.

PT PLN, as a utility company providing electricity services in Indonesia, is given the prerogative by the government to implement electricity connections to all provinces in Indonesia. From the business and industry side, this represents the company's potential to provide services and opportunities to increase electricity sales in accordance with the Company's Work Plan and Budget (RKAP) for 2024 of 300 TWh. PT PLN Distribution Main Unit (UID) Riau and Riau Islands up to 2023 continues to experience an increase in demand for New Installs (PB) and Power Changes (PD) for Business (B) and Industrial (I) tariffs. Pasang Baru (PB) is the activity of submitting a request to become a PLN customer at a certain tariff, while Changing Power (PD) is the activity of submitting a request to change the type of tariff or power (up or down) that has already been connected.

Table 1. Number of tariff B and I customers in 2020 – 2023

No	Year	Number of Subscribers per Tariff			
		B	% Increase	I	% Increase
1	2020	169.660		529	
2	2021	185.301	8,4%	633	16,4%.
3	2022	348.235	46,7%	861	26,4%
4	2023	354.257	1,69%	1.021	15,67%.

Source : Centralized Customer Service Application (AP2T)

It can be seen in the table above that there is a significant increase in the number of customers in both Tariff B and I. In 2021, the increase in the number of customers in Tariff B was 8.4% and Tariff I was 16.4%. Meanwhile, in 2022 there was an increase in the number of customers on Tariff B by 46.7% and Tariff I by 26.4% and in 2023 by an increase in the number of customers on Tariff B by 1.69% and Tariff I by 15.67%. There was an extraordinary surge in the number of B tariff customers in 2022 due to the end of the Covid 19 Pandemic which made the business world reopen and caused a very significant increase in customers at B tariff in 2022.

With the high demand for PB and PD, this results in a high demand for materials used to serve customers. Business and industrial growth after Covid 19 occurred in all provinces in

Indonesia. Limited material inventory in the company resulted in delays to the cancellation of new installations and power changes in meeting high demand.

Every business activity of a utility company is given a target set in the *Key Performance Indicator* (KPI), one of which is the customer's perspective for sales *points*. This target *is inline* with the RKAP of 300 TWh in 2024. Based on the realization of PB and PD tariff demand services in 2023, it is known that the average *monthly Service Level* achievement is 87.%, where the highest achievement during 2023 occurred in April at 98.94% and the lowest in May at 74.13% as seen in Figure 1.

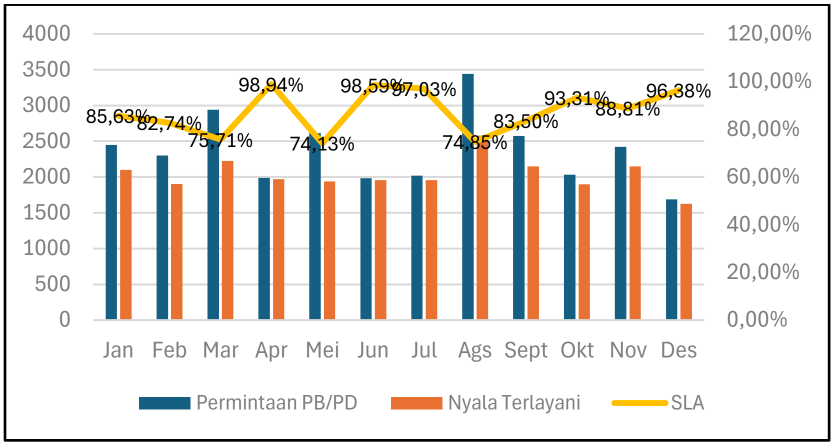

Figure 1. *Service Level* PD and PD services tariff B and I in 2023

(AP2T, 2024; data obtained from the processing of the Centralized Customer Service Application (AP2T), 2024)

If we dissect more deeply the achievement of SLAs with the lowest 3 (three) ranks, namely March (75.71%), May (74.13%) and August (74.85%) where some of the causes of customer disconnection can be caused by several indicators such as the customer's SLO not yet existing, MDU that is not yet available and so on, we can see in table 1.

Table 2. Causes of Customers Not Being Served for Tariff B and I in March, May and August 2023

No	Cause of Not Being Served	March 1 Phase	March 3 Phase	March Total	May 1 Phase	May 3 Phase	May Total	August 1 Phase	August 3 Phase	August Total	Average
1	Installation Building Not Completed	17	14	31	24	5	29	34	3	37	32
2	Applicant Data Not Valid	9	8	17	13	3	16	19	2	21	18
3	EX P2TL or PRR	72	58	130	102	21	123	146	12	158	137
4	Geographical Conditions	34	28	62	49	10	59	70	6	75	65
5	MDU Not Available	128	103	231	181	38	219	260	21	281	244
6	Address Not Found	9	7	16	12	3	15	18	1	19	17
7	Land Issues	45	36	81	63	13	76	91	7	98	

Source : Centralized Customer Service Application (AP2T)

Some of the conditions that cause customers not to be served at tariffs B and I in March, May and August 2023 can be seen in table 2, where the condition of address not being met is the lowest cause of customers not being served with an average of 17 customers. Meanwhile, the condition of MDU is not available is the cause of customers not being served with an average of 244 customers.

Materials are needed to support the operational activities of PB and PD service products in order to serve customers. Primary distribution materials (MDUs) and non-primary distribution materials (non-MDUs) are the two categories of materials used in PB and PD. The main distribution material is the main material used in the distribution unit, while the non-main distribution material is the material used as a complement or accessory for the activities of the distribution unit.

There are 16 categories of MDUs managed by the Supply Chain Management (SCM) Division of PLN Head Office where each category consists of several types according to the *detailed* specifications of the MDU which amounts to approximately 134 materials. The mechanism for requesting MDU needs is carried out in stages, namely from the Implementing Unit at any time can submit a request to the Main Unit, but the Main Unit will forward the request for MDU to the manufacturer on a scheduled basis once a month with the issuance of a Goods Order Letter (SPB). In SPB, the period of material fulfillment has been determined, each material has a different time, for example for kWh meter 1 phasa, the SPB period is 45 calendar days from the date of SPB issuance, MCB 1 phasa has a period of 30 calendar days from the date of SPB and so on.

The company has established a material inventory policy but the service implementation unit (UP3) has not fully done so that inventory management is not managed properly. Inventory control facilities have not been used optimally, such as classification per material, determination of *safety stock* and *reorder points* for each material.

The company's inability to serve PB and PD requests can be seen from the fact that there is still a waiting list every month. What is meant by a waiting list is a request for customers or prospective customers who have made PB or PD payments in the current month but have not been able to be served until the Service Quality Level (TMP) deadline. This can be caused by several things, for example, the installation at the customer is not ready, the customer's Certificate of Operational Suitability (SLO) does not yet exist, geographical conditions that do not allow for connection, and others. In 2023, there is a total waiting list for tariffs B and I of 20.25% of the total customer requests that must be served for 1 year with the results of the evaluation of the causes of tariff B and I customer waiting lists as shown in Figure 2 below:

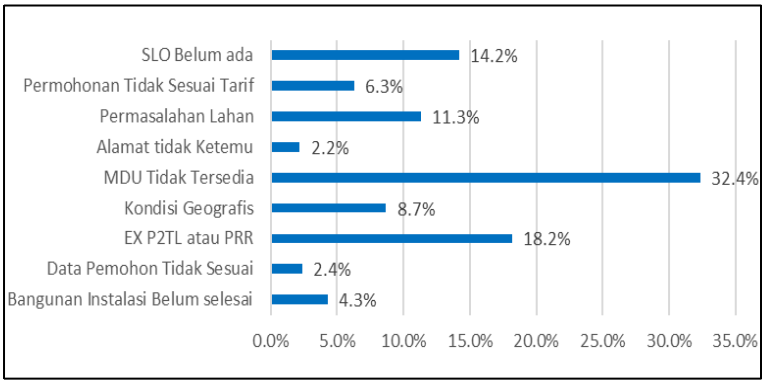

Figure 2. Causes of Tariff B and I Waitlists in 2023
(AP2T, 2024; data obtained from the processing of the Centralized Customer Service Application (AP2T), 2024)

From Figure 2, it is known that the highest cause of waiting lists is the unavailable MDU 32.4% and the lowest is the address not found (ATK) 2.2%. Then an evaluation was carried out on the cause of MDU not being available to serve PB and PD tariff B and I obtained the results as shown in Figure 4 below:

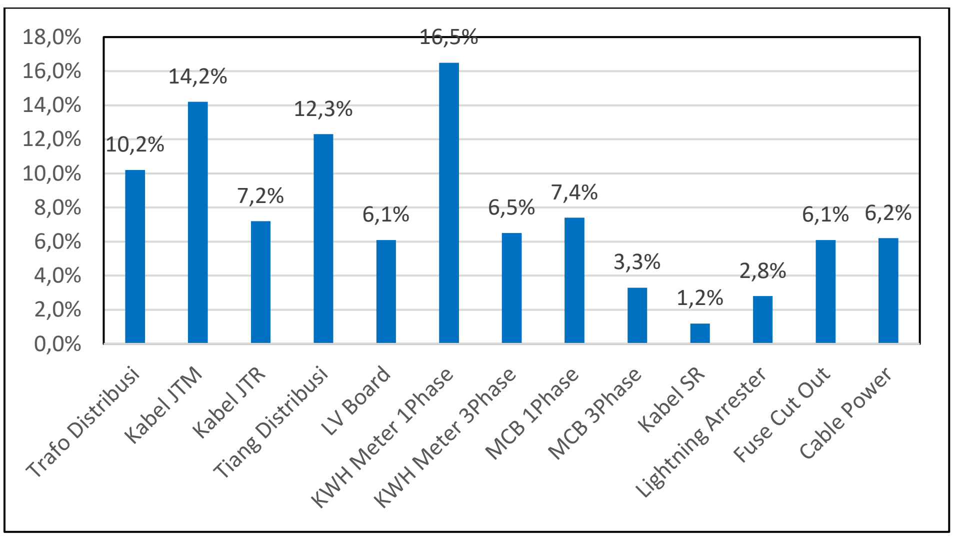

Figure 4. Main Distribution Materials (MDUs) are not available for Business and Industrial rates in 2023
(AP2T, 2024; data obtained from the processing of the Centralized Customer Service Application (AP2T), 2024)

From Figure 4, it is known that the dominance of MDU unavailability is in the *KWH Meter 1 Phase* category at 16.5%. There are various types of PB and PD inline service products with many variations of MDU needed. Service delays occur due to the unavailability of MDUs, which means that not all MDUs for the proposed type of power tariff are fully available; perhaps only 1 or 2 MDUs are unavailable. To understand the extent of the GAP between *demand* and *material stock* per month, analysis is necessary.

For example, for the MDU *kWh meter 1 Phase*, *demand* and *stock* data from 2023 show that every month the *Service Level* does not reach 100%. The *highest Service Level* occurred in June at 99.4%, and the lowest in August at 75.3%. The unmet demand for PB and PD tariffs B and

I due to unavailable MDUs causes the company to experience an average revenue delay of around 20%-25% of total monthly revenue. Additionally, when MDU stock is unavailable, the Implementing Unit transfers MDU stock between Units, resulting in operational costs for transportation services averaging around 2% of operational expenses per month. These factors cause the company's operational activities to run ineffectively and inefficiently.

The above conditions indicate that planning and management of MDU inventory are still not properly controlled due to material unavailability (*stockout*). However, on the other hand, PLN UID Riau and Riau Islands also often experience material overload (*overstock*) for *intermittent* materials. Materials are classified as *intermittent* if demand is not consistent over time or are considered *slow moving*. The issues of *stockout* and *overstock* result in ineffective inventory management, causing high inventory costs. Current MDU needs planning uses simple calculations to determine *reorder points* and *safety stocks* without accounting for uncertainties in demand. The calculation is based on the realized usage of MDU PB and PD over an average of three months, plus the previous month's waiting list and possible additional customers. Moreover, the waiting list that cannot be served due to MDU unavailability—sometimes only one or two MDUs—should also be considered.

Therefore, the first stage of this research is to determine the MDU requirements for PB and PD requests under Business (B) and Industrial (I) tariffs, by converting them into MDU needs based on *the Bill of Material Quantity* according to PLN standards. Then, to assess the level of criticality, availability, and usage of MDUs, they are classified following the company's inventory policy. Short-term forecasting of MDU PB and PD needs for power tariffs B and I will be conducted by analyzing the characteristics of fluctuating tariff demands B and I, as shown in Figure 1.5 below. Forecasting calculations will be performed using *the exponential smoothing* method and *double exponential smoothing* to accommodate the *trend* in the data. The accuracy of these forecasting methods will be evaluated by calculating *the Mean Absolute Deviation* (MAD) and *Mean Square Error* (MSE). The α value is determined within the range of 0 to 1 using a solver in MS Excel to expedite the search for α. For the *double exponential smoothing* method, it is similar to *exponential smoothing* but with an additional smoothing constant β, so there are two smoothing constants, α and β. The method that yields the smallest error values will be selected for forecasting MDU needs.

Inventory parameters will be calculated based on the forecast results. The inventory parameters for the current condition will be calculated and compared with those derived from *the Continuous Review* (s,S) method for *fast moving materials* and *Periodic Review* (R,s,S) for *slow moving* materials. The rationale for selecting these methods stems from differing policies between the Implementing Unit and the Main Unit. The Implementing Unit can request MDUs at any time according to its needs when stock falls below a threshold (*Continuous Review*), whereas the Main Unit places MDU orders on a periodic, scheduled basis — once per month (*Periodic Review*). To determine total inventory costs and *Service Level* for MDU, calculations will use *lot sizing* Material Requirement Planning (MRP) based on the three inventory parameters.

This research is considered superior to previous studies because it combines both the *exponential smoothing* and *double exponential smoothing* methods as the initial step in forecasting MDU needs. This approach improves prediction accuracy, especially when datasets exhibit fluctuations involving changes in historical patterns and future trends. Furthermore, the combination adapts well to various data types, whether *stationary* or trending. By comparing inventory parameter conditions — current, *the Continuous Review* (s,S), and *Periodic Review* (R,s,S) — total inventory costs and *MDU Service Level* can be calculated using *lot sizing* MRP. The smallest total cost and highest *Service Level* will then be selected as the most optimal forecasting outcome.

The problem addressed in this study is that the MDU inventory policy is suboptimal due to inaccuracies in forecasting and material classification, resulting in high inventory costs and low service levels. The study aims to determine appropriate inventory policy parameters based on material classification and demand characteristics, select the most accurate forecasting method, and evaluate the most effective inventory policy by comparing existing methods — the current policy, *Continuous Review* (s,S), and *Periodic Review* (R,s,S). It also aims to identify forecasting methods that provide more accurate estimates of material requirements and the best inventory methods that reduce costs while improving Service Levels.

The benefits of this research are expected to help companies manage MDU inventory better by optimizing MDU classes and inventory performance to reduce stockout risks while minimizing inventory costs. This will help achieve optimal Service Levels for PB and PD services at Business and Industrial rates. The scope of this study includes PB and PD demand data from 2021 to 2023 with tariffs B and I for powers up to 197 kVA at PLN Riau and Riau Islands Distribution Main Unit. The study focuses on managing MDU inventory except for concrete and steel poles. It assumes non-constant demand and constant lead times, with a policy of preventing stockouts.

RESEARCH METHOD

This study used a quantitative approach to optimize the inventory management of Main Distribution Materials (MDU) in power companies, focusing on business and industrial tariff customers. The methodology involved collecting historical data on New Installation (PB) and Power Change (PD) requests from 2021 to 2023, converting demand into MDU requirements, and classifying materials based on Board of Directors Decree No. 717.K by criticality (A-C), availability (A-C), and usage (A-D) categories. Needs forecasting was then conducted, with accuracy evaluated using MAD, MSE, MAPE, and RMSE. Inventory parameters were calculated by comparing two methods: Continuous Review (s,S) for the implementing unit and Periodic Review (R,s,S) for the parent unit. Finally, Material Requirement Planning (MRP) simulation was performed to determine total inventory cost and optimal service level.

Table 2. Stages of Research Methodology

No	Stages	Main Activities	Output
1	Early Stages	Current performance analysis and literature review	Identify research problems and scenarios
2	Data Collection	Data collection of PB/PD requests, Bill of Quantity, SPB, lead time, prices, and fees	Complete database for analysis

No	Stages	Main Activities	Output
3	Data Processing	Demand breakdown, conversion to MDU requirements, material classification	Analysis-ready structured data
4	Forecasting	Normality test, forecasting method selection, accuracy evaluation	The best forecasting models
5	Parameter Calculation	Analysis of existing conditions, Continuous Review, Periodic Review	Parameters of Optimal
6	MRP Simulation	Material Requirement Planning for both methods	Total cost and service level
7	Analysis & Conclusion	Comparison of results, recommendations, conclusions	Optimal inventory strategy

The table showed seven stages of systematic research methodology, from problem identification to providing recommendations. Each stage involved specific activities that produced outputs serving as inputs for the next stage. Key stages included classifying materials into three categories (criticality, availability, usage), comparing two inventory control methods (Continuous vs. Periodic Review), and conducting MRP simulations to determine the most cost-effective inventory strategy with the optimal service level for the power company's distribution materials.

This section presented an overview of the company's condition, data collection results, and data processing stages. The process began by converting PB and PD requests into MDU needs, followed by classifying MDUs according to the company's inventory policy. MDU needs were then forecasted using appropriate methods, inventory parameters were calculated, and Material Requirement Planning simulations were performed to analyze total inventory costs and MDU service levels.

RESULTS AND DISCUSSION

Analysis of the Existing Conditions of Inventory Control

The company has not optimally met the demand of PB and PD business and industrial tariffs for MDU inventory control. This is shown by the fact that the inventory policy regulated by PLN Head Office has not been implemented. Each unit must implement the policy by adjusting their own conditions. Due to inconsistent inventory control, which often leads to *stockouts*, MDU classification has not been performed to determine the category of fast, medium, or slow-moving MDUs.

This can be caused by many things, such as limited human resources in terms of planning and logistics or the ineffective utilization of inventory application systems that have been used by the company. In addition, it is worth noting that there is a difference in the booking period required for MDU between UP3 and UID. This is because the Implementation Unit makes an order when the MDU in the warehouse is exhausted or almost exhausted without considering the order *review interval*.

For MDU PB and PD business and industrial rates, the suggested parameters will help the company manage inventory. Organizing according to the classification of MDUs according to the company's inventory policy No.717.K will make it easier for companies to determine the level of service of each MDU. Knowing the types of MDU usage patterns and more appropriate control strategies will make it easier for management to make decisions about inventory at the most cost-efficient.

Analysis of the Conversion of PB and PD Requests into MDU Needs

To make it easier to calculate the MDU needs for the power group in the range, PB and PD demand data are elaborated specifically for each power group. After elaborating, the results were obtained for the B-1 power group 450 VA to 6,600 VA there were 8 power groups and for the B3 power group > 6,600 there were 17 power groups, data was obtained from the previous six power groups to twenty-five business and industrial tariff power groups.

Data was collected thoroughly for power groups that did not have records of previous PB and PD requests. The results include sixteen types of MDUs that are frequently used to meet PB and PD business and industrial tariff demands, four MDUs for 1 phase customer requirements, six MDUs for 3 phase customer requirements, and six MDUs for Low Voltage Network (JTR) expansion needs, as shown in Figure 5.

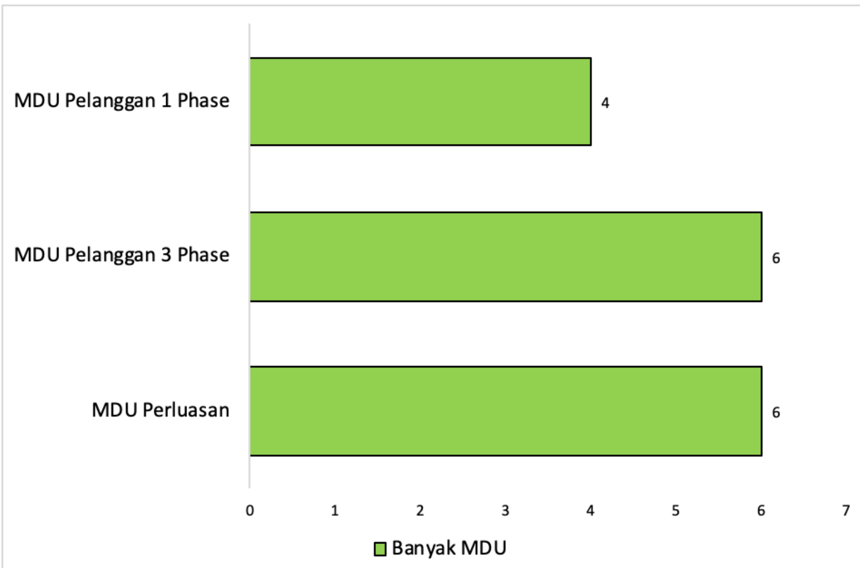

Figure 5. Composition of MDU PB and PD Business and Industrial Tariffs

Classification of MDUs by Company Inventory Policy

According to the company's inventory policy, there are 16 MDUs that are the object of research, each with a different class. In the availability category, all MDUs are included in the critical level because PB and PD business processes cannot take place if they are not available. For the availability category, availability is based on the time of provision of MDUs as seen from the lead time, for the 16 MDUs are included in level B which means that the *medium lead time* is between 30-90 calendar days in accordance with the Unit Price Contract (KHS).

The recapitulation of the results of the MDU classification used for PB and PD business and industrial rates based on the company's inventory policy obtained the results of 7 (44%) MDUs included in the MDU ABA class, 4 (25%) MDUs included in the ABB class and 5 (31%) MDUs included in the ABC class as seen in Figure 6.

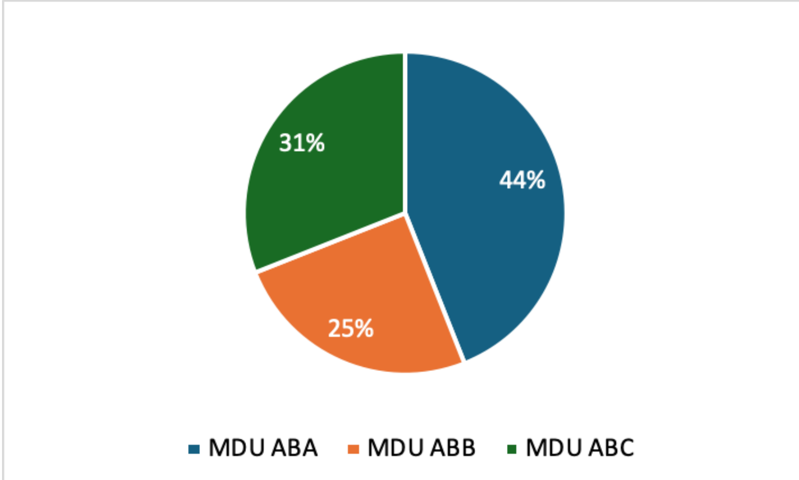

Figure 6. Results of the Classification of MDU for PB and PD Tariff Rates B and I

Of the 7 MDUs in the ABA class, 4 MDUs are used to serve customers in 3 languages, 3 MDUs to serve network expansion customers. Furthermore, 4 ABB class MDUs consist of 2 MDUs to serve 1 phase customers, 1 MDU to serve 3 phase customers and 1 MDU to serve network expansion customers and 5 ABC class MDUs consisting of 2 MDUs to serve 1 phase customers, 1 MDU to serve 3 phase customers and 2 MDU to serve network expansion customers.

MDU Needs Forecasting Analysis

From the results of the data testing, it is known that the normally distributed data is evidenced by the normality test using *the Q-Q plot* visually. Then forecasting is carried out using 2 different methods, namely *exponential smoothing* and *double exponential smoothing*. Selecting the optimal α smoothing constant in both methods will minimize the *error value*. The result of the calculation using the exponential smoothing method, the value α 0.7 while for the double exponential smoothing method with a value of $\beta = 0.35$, a α value of 0.65 was obtained. The forecasting results of the two methods can be seen in Figure 5.3 as an example is the forecasting of MDU- 3260027 in a year.

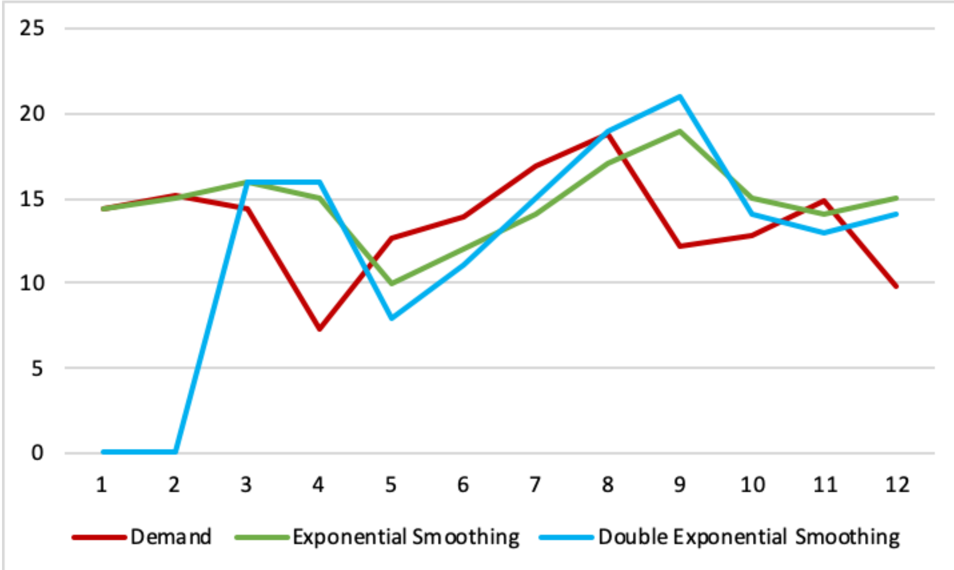

Figure 7. MDU- Needs Forecasting Results-3260027

From Figure 7, we can see that *demand* fluctuates quite sharply, especially in the third to fifth months, as well as in the eighth to ninth months, while the *exponential smoothing* method provides smoother predictions and slower to respond to drastic changes, unlike the *double exponential smoothing* method which provides results that are more responsive to trend changes, it can be seen that the sharper garus follows the ups and downs of demand, but it is necessary to be aware of *demand* that fluctuates sharply that occurs only for a moment. We can conclude that *the exponential smoothing* method can be an option in forecasting the data because it aims to stabilize the prediction against fluctuations where demand is not too much of a trend.

To test the accuracy value of the forecasting results of the two methods used, *the error calculation* was calculated with 4 parameters MAD, MSE, MAPE and RMSE. From the calculation results, the results were obtained that the values of MAD, MSE, MAPE and RMSE of *the exponential smoothing* method were lower than the results using *the double exponential smoothing* method as seen in Figure 8.

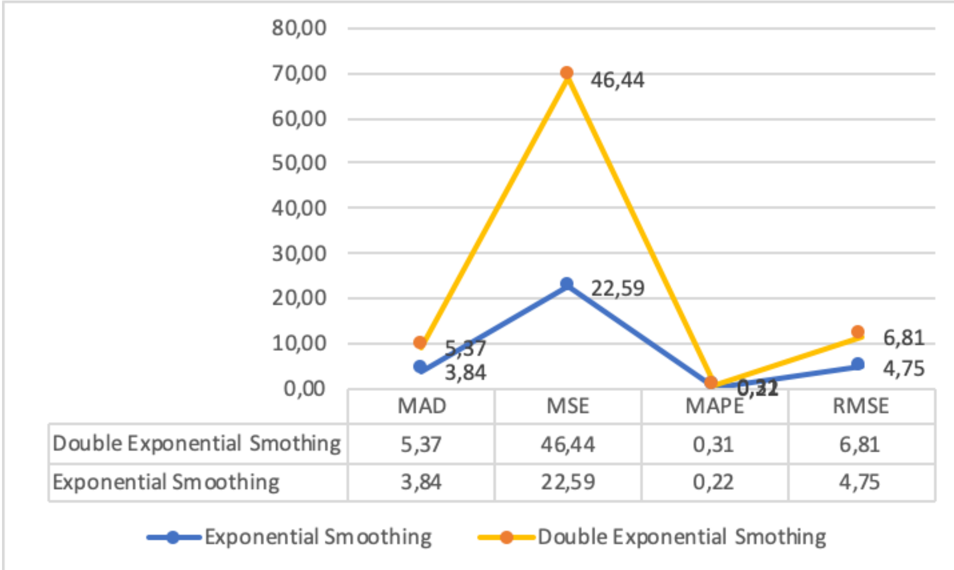

Figure 8. Comparison of Errors on MDU- 3260027

In this study, the forecasting used to forecast the need for MDU using *exponential smoothing* was chosen, because the values of MAD, MSE, MAPE and RMSE were smaller than the *double exponential smoothing method*.

Analysis of Inventory Parameter Calculation

From the results of the calculation of inventory parameters with 3 methods, namely the current condition method (s,S), *the Continuous Review* method (s,S) and *the Periodic Review* method (R,s,S), the results obtained that *the minimum stock* parameter value (s) and *maximum stock* (S) for the *Continuous Review* method has the highest value between the two methods, for example for MDU 2190224.

Table 3. Comparison of the minimum (s) and maximum (S) values of the MDU 2190224

MDU 2190224 - MTR; kWH E-PR; 1P; 230V; 5-60A; 1; 2W		
Method	**s**	**S**
Existing (s,S)	455	2.065
Continuous Review (s,S)	2.287	4.574
Periodic Review (R,s,S)	587	1.666

From Table 3, it is known that the current condition inventory parameter (s,S) is the lowest than the *Continuous Review* (s,S) and *Periodic Review* (R,s,S) methods because the calculation of minimum and maximum values is only based on *safety stock* and *reorder points*. As for the *Periodic Review* (R,s,S) method, it is between the other two methods for *minimum stock* and the lowest for maximum *stock*, this is due to the combination of *the review* time interval and the reorder point *value* that is maintained to place an order for MDU so that the combination of these two conditions can optimize *stock* material. And for the *Continuous Review* (s,S) method, it has the highest minimum inventory value among the other two methods due to the considerable variability of *lead time* while the *periodic review method* does not take into account the variability of *lead time*, only the variability of demand during *the review period* and *lead time*. The difference in inventory parameters will affect the inventory costs that must be incurred by the company and the fulfillment of *the MDU's* Service Level.

Comparative Analysis of the Implementation of Inventory Control Policy

From the calculation of inventory parameters using these 3 methods, *Material Requirment Planning* (MRP) calculations are carried out for each MDU per month to find out the total cost of inventory and *its Service Level*. The total inventory cost is the sum of the purchase cost, order cost, storage cost and *stockout* cost per MDU. Purchase cost is a cost incurred when making a purchase which is calculated from the number of MDUs ordered multiplied by the unit price of MDU. Booking fees are fees incurred each time a company places an order. Storage costs are costs incurred due to the storage of the MDU such as capital costs, financial costs, taxes and others where in this study the total is 26%, and *stockout* costs are *back order costs* that must be incurred by the company. The calculation of *stockout* costs is calculated by looking at the highest price of materials at the market place to meet the demand of PB and PD including material costs, shipping costs and insurance costs so that the *stockout* price is obtained if the materials needed for PB and PD are not available beyond *the Service Level* that has been set by the company. The average total inventory cost and average *service level* per month of each MDU class based on the company's inventory policy are decisive in decision-making. The following is a comparison of the total cost of inventory and *Service Levels* of the three policies as seen in Table 4.

Table 4. Recapitulation of Inventory Cost Calculation Results and *Service Level*

MDU Class	Material Number	Existing Condition (s,S)		Continuous Review (S,S)		*Periodic Review* (R,s,S)	
		Inventory Cost	SL	Inventory Cost	SL	Inventory Cost	SL
ABA	3110038	945.834.388.510	77%	277.040.642.446	95%	52.487.803.472	97%
FIG	3110025	86.212.748.290	76%	33.155.507.979	93%	7.233.654.722	97%
ABC	3250012	1.621.129.423	89%	1.484.176.272	100%	1.280.259.339	97%
Sum		1.033.668.266.223	80%	311.680.326.698	96%	61.001.717.533	97%

From Table 4, it is known that the total inventory cost of the *Periodic Review* (R,s,S) method is lower for all classes of MDU compared to the other 2 methods. The achievement of *the highest level* of the MDU class is in the *Periodic Review method* and the lowest in the current condition (s,S). In total the overall inventory cost for the 3 classes of MDU (ABA, ABB, ABC), the lowest order is in the *Periodic Review* method (R,s,S), the second *is the Continuous Review* method (S,S) and the highest is the current condition (s,S). In order to clarify the comparison of inventory costs and *Service Levels* of the three methods in each MDU class, 1 MDU per class is taken which is considered the most critical of each classification so that it can represent the overall condition with data as shown in Table 4. For more details, we will discuss per ABC classification related to total inventory cost and *Service Level*.

Total Cost of Inventory and *Service Level* in MDU ABA Class

A comparison of the total cost of inventory and *Service Level* of the three method parameters for the MDU ABA class can be seen in Figure 9 for example is MDU 3110038.

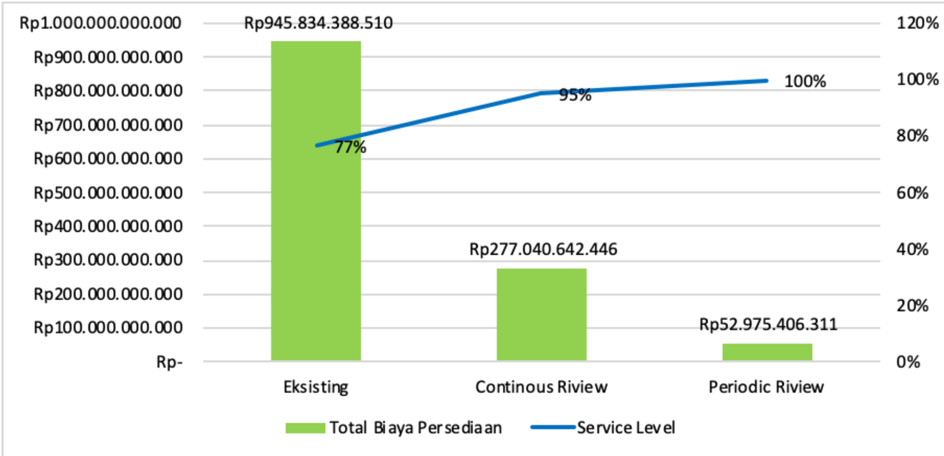

Figure 9. Comparison of Total Inventory Costs and *Service Level* MDU ABA Class

From Figure 9, it can be seen that the total inventory cost for the MDU ABA class, the current condition (s,S) reaches IDR 945 billion with *a Service Level* of 77%, while for *the Continuous Review* (s,S) method, the total inventory cost is IDR 277 billion with *a Service Level* of 95% and for the *Periodic Review (*R,s,S) method with a total inventory cost of IDR 52 billion with *a Service Level* of 97%. The highest inventory costs with the *highest Service Level* are in the *Periodic Review* (R,s,S) method. The opposite happens in the current condition, where the total cost of inventory is high with *the lowest Service Level*. This can happen because the component of inventory costs that is quite significant affects is that PB and PD demand is often not served due to material *stockouts*.

Total Inventory Cost and *Service Level* in ABB MDU Class

Comparison of the total inventory cost and *Service Level* of the three inventory parameters for ABB Class MDUs, Figure 10 as an example is the 3110025 MDU.

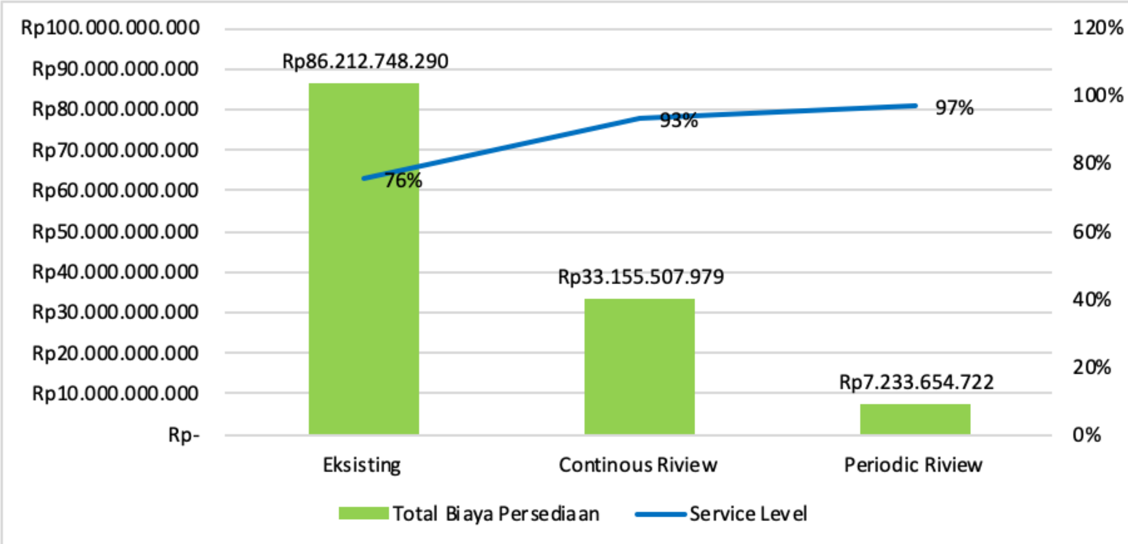

Figure 10. Comparison of Total Inventory Costs and *Service Level* ABB MDU Class

In the MDU ABB class, the total cost of *Periodic Review* (R,s,S) policy inventory is the smallest compared to the other 2 methods of IDR 7.2 billion with *the highest Service Level* achievement of 97%. Furthermore, the *contonous review* method (s,S) with the total inventory cost between the two methods is IDR 33.1 billion with the achievement *of 93% Service Level*. And for *the current method* (s,S), the highest total inventory cost is IDR 86.2 billion with the achievement of *73% Service Level*.

Total Inventory Cost and *Service Level* in MDU ABC Class

A comparison of the total cost of inventory and *Service Level* of the three policies for the MDU ABC class, Figure 11 as an example is MDU 3250012.

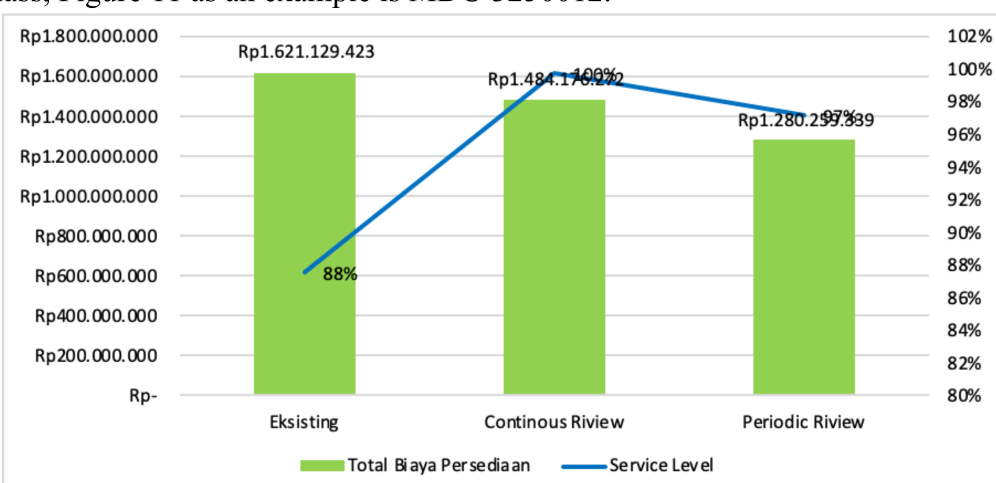

Figure 11. Comparison of Total Inventory Costs and *Service Level* MDU ABC Class

From Figure 11, it is known that the current condition provides *the lowest Service Level* of 88% than the other two methods with the highest total cost of Rp 1.6 Billion. Furthermore, the *Periodic Review* (R,s,S) method provides the lowest total inventory cost of Rp. 1.2 billion with the achievement of *97% Service Level*. In the comparison of the inventory cost component for the MDU ABA class, the highest cost in the current condition (s,S) is the stockout cost of Rp. 904 M, with a message frequency of 16 times and a stockout frequency of 11 times. The total inventory cost in existing conditions without taking into account stockout costs is Rp. 41.6 M. For the Continuous Review (s,S) method, the highest inventory cost is recorded at Rp. 64.5 M, while for the Periodic Review (R,s,S) method, the total inventory cost is Rp. 52 Billion with the highest Service Level of 100%. In the ABB MDU class, the highest stockout cost was recorded at Rp. 81 billion in existing conditions with a Service Level of 76%, but the Periodic Review (R,s,S) method produced the lowest total inventory cost of Rp. 7.2 billion with a Service Level of 97%. In the MDU ABC class, the stockout cost in the existing condition is Rp. 563 million, and for the Continuous Review (s,S) method, the total inventory cost reaches Rp. 1.4 billion without calculating stockout costs, while the Periodic Review (R,s,S) method shows the lowest inventory cost of Rp. 1.2 billion with a Service Level of 97%. Overall, the Periodic Review (R,s,S) method provided the best results in terms of cost and Service Level across all MDU classes tested..

Analysis of the Application of Orders Up to Level (S) Inventory Periodic Review

In the application of the determination of the value of S on the inventory of the method *Periodic Review* there are several conditions in the selection of the S value to get the most optimal booking value to reduce costs and obtain *Service Level* best. Conditions with *Variability* demand and need for *safety stock* This formula takes into account fluctuations in demand and the risk of running out *Stock* by adding components *safety stock* at *Order Up to Level* cause the value of S in this formula is quite high but gives a value *Service Level* highest. Further in the application *Order Up to Level* with the condition *Demand* per normal and stable period using the formula of the average demand and standard deviation of the demand and added *safety factor* which corresponds to values 1,2,3 and so on. An S value is obtained on *Order Up to Level* by replacing *safety factor* $S_{=k1}$have *Stock* the lowest inventory yet provides *Service Level* lowest at 89%. Next *safety factor* $S_{=k2}$have *Stock* higher inventory but provides *Service Level* that has not reached the target set by the company varies between 94% to 100% on average *Service Level* 97% and *safety factor* $S_{=k3}$ provides value *stock* optimal as well as *Service Level* which is high according to the needs of the company with the average *Service Level* 98%. With the most optimal S results and achievements *Service Level* best among all conditions, the policy formula with *safety factor* $S_{=k3}$is selected to specify the value of S on the *Periodic Review* (R,s,S).

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Analysis of the implementation of the inventory policy by selected methods

After discussing each component of the cost for each policy, starting from the current policy, *Continuous Review* (s,S) and *Periodic Review* (R,s,S) it is known that the importance of classifying MDU based on the MDU class that has been determined by the company so that there is no *stockout* so that the *Service Level* can be fulfilled by taking into account the minimum possible inventory costs. From table 5.5 and the explanation in the sub-chapter per cost component, it can be determined that the selected inventory policy method as a recommendation for companies in all classes of MDU ABA, ABB and ABC is the *Periodic Review* (R,s,S) method. The high level of usage for the MDU ABA class can still be satisfied with this *Periodic Review* (R,s,S) method, with the cost of inventory not too high and the achievement of *the Service Level* is still in the range of 97%, this method is still relevant to be implemented. If the target is to achieve 100% *MDU Service Level*, management can increase the number of orders up to the maximum point (S) as needed within the booking period. For ABB's MDU class, which has a medium usage rate, with a low inventory cost and provides a *Service Level* of 97%, this method is appropriate to apply compared to the current policy which does provide lower inventory costs but achieves a very low *Service Level* of 92%. And for MDU ABC classes with low usage rates and 97% *Service Level*, this method can provide optimal inventory costs. So if the *Periodic Review* (R,s,S) method is applied to each MDU class, savings can be simulated when compared to the current conditions as seen in Table 5. below:

Table 5. Calculation of Inventory Cost recapitulation and *Service Level* per MDU Class

MDU	Inventory Cost	SL	Inventory Cost	SL	Inventory Cost	SL
Class	Existing Condition (s,S)		Continuous Review (s,S)		Periodic Review (R,s,S)	
ABA	2.601.739.397.753	82%	1.113.256.734.760	97%	762.040.640.171	99%
FIG	15.946.637.856	87%	17.708.508.146	98%	14.683.492.689	99%
ABC	2.183.661.971	88%	2.065.614.879	99%	1.688.758.817	97%
Sum	2.619.869.697.580	84%	1.133.030.857.785	98%	778.412.891.677	98%

Cumulatively, if the *Periodic Review* (R,s,S) method is applied to all MDU classes, the savings can be simulated as follows:

$$\text{Cost Savings} = \text{x } 100\% \frac{\text{biaya kebijakan eksisting} - \text{biaya kebijakan } \textit{continuous review}}{\text{biaya kebijakan eksisting}}$$

$$= \text{x } 100\% = 70\% \frac{2.619.869.697.580 - 778.412.891.677}{2.619.869.697.580}$$

So if the *Periodic Review* (R,s,S) method is applied to the calculation of inventory parameters in all MDU classes, a saving of 70% from the current condition or Rp. 1,841,456,805,903 for 36 months with the achievement of *98% Service Level, which meets the provisions of the company's inventory policy.*

Managerial Implications

The managerial implications are described regarding things that can be used as suggestions to improve and improve the MDU inventory control business process, including the following:

1. Classify MDU in accordance with the Inventory Policy that has been regulated in the Decree of the Board of Directors of PT PLN according to the material designation either for new connection activities or for maintenance. This is very useful for determining the planning and control of the materials to be ordered.
2. Forecasting MDU needs based on MDU classes can be done by several methods according to the level of use of the MDU. The forecasting method with *the Exponential Smoothing* method can be used for MDUs that have a stable trend as in this study so that it produces simple and fast forecasting.
3. Determine and regularly evaluate MDU inventory policy parameters so that orders and material inventory are in accordance with needs so that at the minimum possible cost can meet Service *Level* desired by the company where *the Service Level* can be calculated how much percentage of material demand can be fulfilled directly without delay in meeting the needs of PB and PD.

CONCLUSION

Based on the results of the study, it can be concluded that material forecasting for MDU inventory policy can be carried out using the exponential smoothing method, because the demand trend is relatively stable and provides MAD and MSE values with the smallest errors compared to the double exponential smoothing method. Inventory parameters are measured by several factors such as safety stock, reorder point, and maximum inventory, which results in the Periodic Review (R,s,S) method as the method with the lowest total inventory cost and the highest Service Level. Simulations using MRP show that inventory policies based on forecasting and defined parameters can increase Service Levels and lower total inventory costs. The three scenarios tested—existing conditions, Continuous Review (s,S), and Periodic Review (R,s,S) methods—show that the use of methods that conform to the MDU (ABA, ABB, ABC) classification can provide total costs and service levels that suit the company's needs. For example, in the ABB class, the current policy provides the lowest inventory cost but the Service Level is poor, while the other two methods provide a high total inventory but achieve a Service Level of more than 95%, exceeding the company's target. The application of the Periodic Review (R,s,S) method can save up to IDR 1,841,456,805,903 or 70% for 36 months, meeting the company's criteria for low costs and high Service Level. Suggestions for further research include expanding the scope for power above 197 KVA, the development of short-term forecasting methods using techniques such as the Neural Network, Fuzzy, ARIMA, or Croston Method, as well as the application of Monte Carlo simulations to accommodate demand uncertainty and lead times. This research can also be expanded by evaluating the effect of inventory control on other KPIs such as customer connection speed and customer satisfaction levels, as well as developing a multi-echelon inventory optimization approach for more efficient and collaborative stock control.

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