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Design and Construction of a Web-Based Inventory Management Information System Using the Safety Stock and Economic Order Quantity (EOQ) Methods

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Abstract – **Effective inventory management is essential to maintain stock availability and control inventory costs in distribution companies. PT Panasonic Gobel Indonesia, Medan Branch, still faces challenges due to non-integrated inventory recording, resulting in data inconsistencies, reporting delays, and difficulties in determining optimal order quantities. These issues increase the risk of stock shortages and excess inventory, highlighting the need for an integrated inventory management information system. This study aims to design and develop a web-based inventory management system using the Safety Stock and Economic Order Quantity (EOQ) methods. The research applies a Research and Development (R&D) approach with the Waterfall model, covering requirement analysis, system design, implementation, and testing stages. Data were collected through observation, interviews, and literature review. The system was developed using PHP with the Laravel framework, a MySQL database, and UML. Model validation was conducted by comparing system calculation results with manual theoretical calculations, while verification was performed through functional and user acceptance testing. The results show that the system can accurately record inventory data, monitor stock levels in real time, and automatically calculate EOQ and safety stock, thereby supporting efficient and optimal inventory control.**

Keywords - *Economic Order Quantity (EOQ); Inventory Control; Inventory Management Information System; Safety Stock; Web-Based System;*

INTRODUCTION

Amidst rapid global change, the industrial and retail sectors face significant challenges and opportunities in maintaining efficiency and competitiveness. One key to addressing these challenges is through strengthened operational management supported by the use of technology [1] To create efficiency in inventory management, an internal control system is required, encompassing structured procedures for managing inventory. An internal control system is a procedure for designing company objectives to prevent risks that may arise in operations [2].

PT. Panasonic Gobel Indonesia is a company engaged in the sales and marketing of electronic goods for the needs of the public and businesses [3]. In its daily operations, the company handles intensive merchandise transactions, both receiving goods from its headquarters and shipping them to consumers or partners. However, the inventory recording and management process is still not fully integrated. As a result, issues often arise, such as inconsistencies in stock data, delayed reporting, and a lack of transparency in the flow of incoming and outgoing goods.

These problems have a direct impact on the effectiveness of inventory management, and can even cause significant losses if not addressed immediately [4]. Efficient and effective inventory management requires the implementation of an optimal information system. An optimal inventory management system aims to ensure timely availability of goods according to demand, while

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minimizing the risk of overstocking, understocking, and unnecessary operational costs[5]. Companies need to be able to determine the correct order quantity and maintain adequate safety stock. The methods used in this study are Economic Order Quantity (EOQ) and Safety Stock. The Economic Order Quantity (EOQ) model is an inventory control technique that minimizes the total cost of ordering and holding[6]. The purpose of EOQ (Economic Order Quantity) is to determine the economic quantity for each order, thereby minimizing total inventory costs [7]. Meanwhile, safety stock is a reserve stock of inventory that aims to reduce the risk of inventory shortages. The presence of safety stock helps avoid losses that can occur when inventory runs out. Safety stock is used to determine the minimum amount of stock that must be available to anticipate sudden demand or delays in delivery [8].

The method used to build this system involves the Economic Order Quantity (EOQ) and Safety Stock methods. The Economic Order Quantity (EOQ) method is a technique in inventory through considering ordering costs and holding costs [9]. If the total storage and ordering costs can be minimized, it will obtain results with an optimal order quantity. The EOQ model is a model in inventory control methods that can determine the optimum quantity for each raw material order and data on storage costs and ordering costs [10]. The EOQ method is often used by businesses, both small- and large-scale businesses [11]. Meanwhile, the safety stock method is a method that aims to determine how much stock is needed during the grace period to meet the large demand [12]. Safety stock, or rescue, is additional inventory held to protect or guard against the possibility of material shortages [13].

This research aims to develop an integrated web-based inventory information system capable of calculating EOQ and safety stock automatically, monitoring the availability of goods in real-time, and supporting more accurate and efficient decision-making in inventory management.

METHOD

This research uses the Research and Development (R&D) method, a method aimed at producing a product and testing its effectiveness. The products developed are not always physical objects or hardware such as books, stationery, or learning media, but can also be software designed to support specific processes.

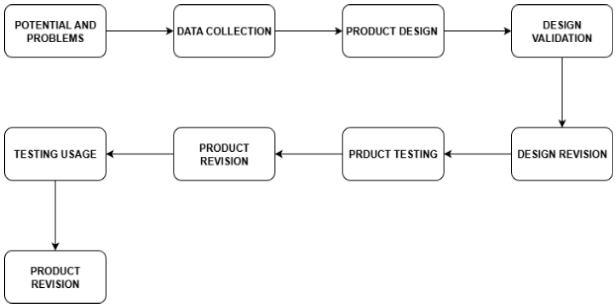

Figure 1. R&D Stages

Figure 1 illustrates the Research and Development (R&D) stages applied in this study for developing the inventory management information system. These stages include problem identification, data collection, system design, design validation, testing, and implementation to ensure that the developed system meets user requirements and research objectives. The R&D stages are explained as follows:

1. Potential and Problems
   The initial step in this research was to identify problems occurring in the inventory management process at PT Panasonic Gobel Indonesia, Medan Branch.
2. Information Collection
   After identifying the problems, the researcher gathered various relevant information.
3. Product Design
   The next stage is designing a web-based information system that meets the company's inventory management needs.
4. Design Validation
   Before entering the development phase, the system design is first validated to ensure it meets user needs and accurately applies Safety Stock and Economic Order Quantity (EOQ) calculations.
5. Design Revision
   Based on the validation results, revisions were made to the design of the inventory management information system.
6. Product Testing
   After the system is developed, initial testing is conducted to ensure that all features are working properly.
7. Product Revision
   From the initial trial results, several deficiencies were discovered, such as inconsistencies in stock recording and errors in the logic for calculating Safety Stock and Economic Order Quantity (EOQ).

8. Testing Usage
   After the revisions were made, the system was retested with the involvement of end users, namely warehouse staff.
9. Product Revision
   Based on the results of further testing and user feedback, several minor improvements were made to improve system stability and usability.

Economic Order Quantity (EOQ)

EOQ, or economic order quantity, is a form of inventory management that is useful for determining the quantity or amount of inventory to order to minimize a company's holding and ordering costs. Furthermore, EOQ can help address issues related to uncertainty through safety stock[14].

Economic order quantity (EOQ) is one of the oldest and most widely recognized inventory control techniques[15]. It answers two important questions: when to order and how much to order[16] . The EOQ formula is [17]:

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

Where,
D = Annual Demand
S = Order Cost
H = Holding Cost Per Unit

Safety Stocks

Safety stock is additional inventory maintained as a reserve to protect a company from uncertainty in demand or order timing[18]. The function of this safety stock is to avoid errors in estimating demand during the lead time. The value of this safety stock depends on the uncertainty of supply and demand. Under normal circumstances, this supply uncertainty can be initiated by the standard deviation of the supplier's lead time, which is the time between ordering raw materials and receiving them [19].

A company's production process will halt if inventory is insufficient to meet market demand, causing consumers to switch to competitors' products. The safety stock of a product can be calculated using the following formula[20]:

$$Safety\ stock = (\text{PM} - \text{PR}) \times \text{LT} \quad (2)$$

Where,
PM = Maximum Sales
PR = Average Sales
LT = Lead Time (Day)

RESULTS AND DISCUSSIONS

Data Collection

Data collection carried out in this research uses observation, interviews, and literature studies to obtain the desired data.

Table 1 presents the product data used as input for the inventory analysis, including holding cost, ordering cost, annual demand, maximum daily demand, average daily demand, and lead time. These parameters are essential for calculating the Economic Order Quantity (EOQ) and Safety Stock values in the proposed inventory management system.

Table 1. Data Product

Product Code	Product Name	Holding Cost Per Unit	Order Cost	Annual Demand	Maximum Daily Demand	PAverage Daily Demand	Lead Time
PAN-BAT-001	Batre AA Alkaline Panasonic 1.5V	IDR 226.667	IDR 650.000	6000	500	20	7 Days
PAN-BAT-002	Batre AAA Alkaline Panasonic 1.5V	IDR 45.000	IDR 600.000	4200	350	14	7 Days
PAN-BAT-003	Batre 9V Alkaline Panasonic	IDR 489.796	IDR 480.000	1200	100	4	10 Days
PAN-BAT-004	Batre CR2032 Button Cell	IDR 41.633	IDR 420.000	1800	150	6	14 Days
RF-PN-3456	Panasonic NR-BB361SS (2Pintu)	IDR 165.000	IDR 105.000	120	10	0,4	14 Days

Product Code	Product Name	Holding Cost Per Unit	Order Cost	Annual Demand	Maximum Daily Demand	PAverage Daily Demand	Lead Time
RF-PN-3478	Panasonic NR-BT410 (Twin Cooling)	IDR 186.000	IDR 122.000	72	6	0,24	21 Days
TV-PG-001	Panasonic LED 32" HD (Model A32)	IDR 112.500	IDR 1.550.000	240	20	0,8	7 Days
TV-PG-002	Panasonic LED 32" Smart (Model S32)	IDR 131.765	IDR 1.320.000	180	15	0,6	10 Days
KPF-FEL402	Stand Fan FEL402 (16")	IDR 112.500	IDR 615	180	15	0,6	14 Days
KPF-FEP4022	Stand Fan FEP4022W	IDR 131.765	IDR 517	96	8	0,32	14 Days

Economic Order Quantity (EOQ)

The Economic Order Quantity (EOQ) calculation was performed to determine the optimal order quantity that minimizes the total inventory cost, which consists of ordering costs and holding costs (Formula 1). The EOQ value for each product was calculated using the standard EOQ formula, which considers annual demand, ordering cost, and holding cost per unit. The detailed calculation results for selected products are presented to illustrate the application of the EOQ method. The results indicate that each product has a different optimal order quantity depending on its demand level and cost structure. By applying the EOQ method, the company can place orders in economically optimal quantities, thereby reducing unnecessary inventory costs and improving overall inventory efficiency.

1. Batre AA Alkaline Panasonic 1.5V

$$\sqrt{\frac{2 * 6000 * 650.000}{226.667}} = \sqrt{\frac{7.800.000.000}{226.667}}$$
$$= \sqrt{34.401} = 185,50 = 186$$

2. Batre AAA Alkaline Panasonic 1.5V

$$\sqrt{\frac{2 * 4200 * 600.000}{45.000}} = \sqrt{\frac{5.040.000.000}{45.000}}$$
$$= \sqrt{112.000} = 334,66$$
$$= 335$$

3. Batre 9V Alkaline Panasonic

$$\sqrt{\frac{2 * 1200 * 480.000}{489.796}} = \sqrt{\frac{1.152.000.000}{489.796}}$$
$$= \sqrt{2352,47} = 48,50 = 49$$

4. Batre CR2032 Button Cell

$$\sqrt{\frac{2 * 1800 * 420.000}{41.633}} = \sqrt{\frac{1.152.000.000}{41.633}}$$
$$= \sqrt{36317,4} = 190,52$$
$$= 191$$

5. Panasonic NR-BB361SS (2Pintu)

$$\sqrt{\frac{2 * 120 * 105.000}{165.000}} = \sqrt{\frac{25.200.000}{165.000}}$$
$$= \sqrt{152,73} = 12,36 = 13$$
$$27,45 = 28$$

Safety Stocks

Safety stock calculations were conducted to determine the minimum buffer inventory required to anticipate demand variability and lead time uncertainty (Formula 2). The safety stock value was calculated using the difference between maximum demand and average demand multiplied by the lead time. This approach ensures that sufficient inventory is available during the replenishment period to prevent stockouts. The calculation results show that products with higher demand fluctuations and longer lead times require larger safety stock levels. The application of the safety stock method enables the company to maintain inventory stability and reduce the risk of inventory shortages during unexpected demand increases or delivery delays.

1. Batre AA Alkaline Panasonic 1.5V
   $Safety\ Stock = (500 - 20) * 7 = 3360$
2. Batre AAA Alkaline Panasonic 1.5V
   $Safety\ Stock = (350 - 14) * 7 = 2352$
3. Batre 9V Alkaline Panasonic
   $Safety\ Stock = (100 - 4) * 10 = 960$
4. Batre CR2032 Button Cell
   $Safety\ Stock = (150 - 6) * 14 = 2016$

Table 2. Data Result

Product Code	Product Name	EOQ	Safety Stock	CONDITION
PAN-BAT-001	Batre AA Alkaline Panasonic 1.5V	186	3360	SAFE
PAN-BAT-002	Batre AAA Alkaline Panasonic 1.5V	335	2352	SAFE
PAN-BAT-003	Batre 9V Alkaline Panasonic	49	960	SAFE
PAN-BAT-004	Batre CR2032 Button Cell	191	2016	SAFE
RF-PN-3456	Panasonic NR-BB361SS (2Pintu)	13	135	NEED TO RESTOCK
RF-PN-3478	Panasonic NR-BT410 (Twin Cooling)	10	121	NEED TO RESTOCK
TV-PG-001	Panasonic LED 32" HD (Model A32)	82	135	NEED TO RESTOCK
TV-PG-002	Panasonic LED 32" Smart (Model S32)	61	144	NEED TO RESTOCK
KPF-FEL402	Stand Fan FEL402 (16")	2	202	NEED TO RESTOCK
KPF-FEP4022	Stand Fan FEP4022W	1	108	NEED TO RESTOCK

5. Panasonic NR-BB361SS (2Pintu)
$$Safety\ Stock = (10 - 0{,}4) * 14 = 135$$

Final Results
After the calculations were carried out, the following results were obtained. In this study, inventory status is determined by comparing the current stock level with the calculated Safety Stock value. An item is classified as *Safe* when the current stock is greater than or equal to the Safety Stock, indicating that inventory levels are sufficient to accommodate demand variability and lead time uncertainty without requiring immediate replenishment. Conversely, an item is classified as *Need Restock* when the current stock level falls below the Safety Stock, signaling a potential risk of stockout. In this condition, inventory replenishment is recommended, and the order quantity is determined using the Economic Order Quantity (EOQ) method to ensure cost-efficient inventory control.

Table 2 shows the results of the EOQ and Safety Stock calculations for each product. The inventory condition is determined by comparing the current stock level with the calculated Safety Stock value to classify items as either safe or requiring restocking.

Product Design

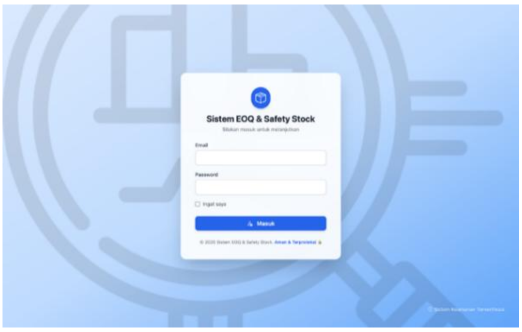

Figure 2. Login Interface

Figure 2 shows the login interface of the EOQ and Safety Stock system. This interface functions as a user authentication mechanism to ensure that only authorized users can access the system and manage inventory data securely.

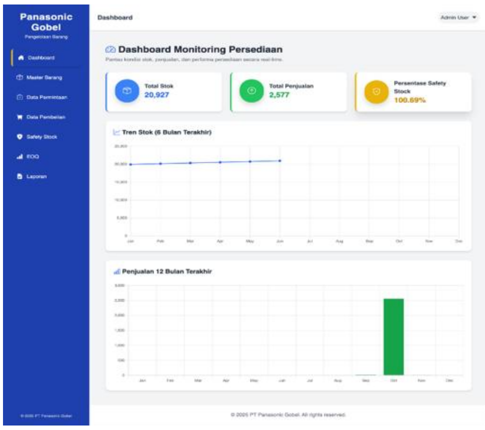

Figure 3. Dashboard Interface

Figure 3 presents the dashboard interface, which provides an overview of inventory conditions in real time. The dashboard displays key information such as total stock, sales activity, and safety stock indicators, supporting effective monitoring and decision-making.

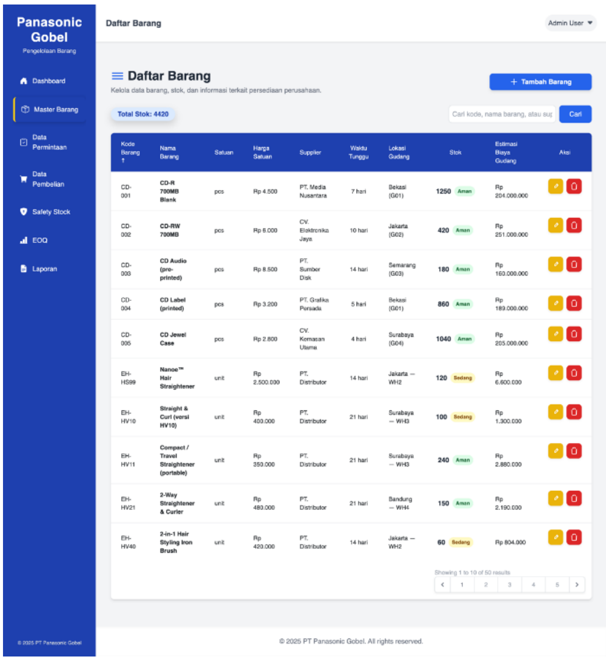

Figure 4. Product List Interface

Figure 4 depicts the product list interface used to manage inventory data. This page displays detailed product information, including item codes, product names, stock levels, lead time, and safety status, enabling efficient inventory control.

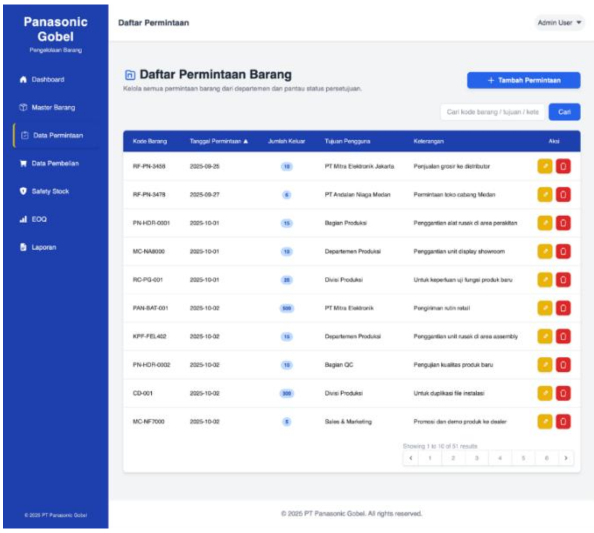

Figure 5. Item Request List Interface

Figure 5 shows the item request list interface, which is used to record and monitor product requests from departments or partners. This feature supports transparent and well-controlled inventory distribution processes.

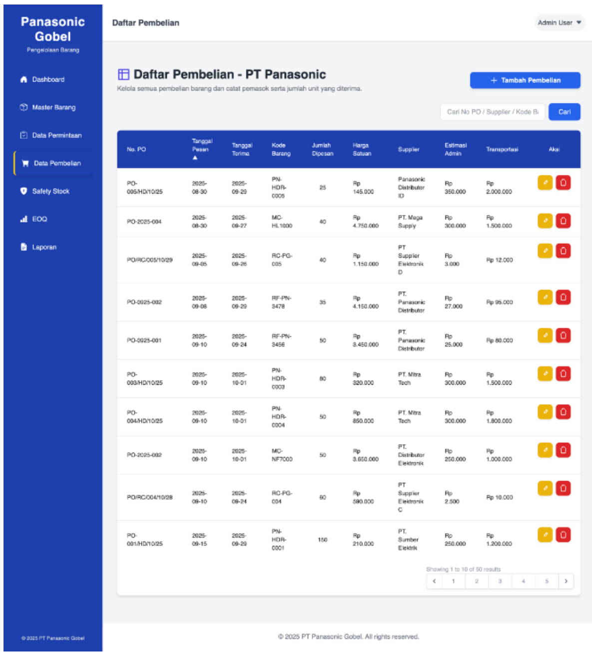

Figure 6. Purchase List Interface

Figure 6 illustrates the purchase list interface that records purchasing transactions with suppliers. This page provides information on purchase orders, quantities, prices, and associated costs, supporting systematic procurement management.

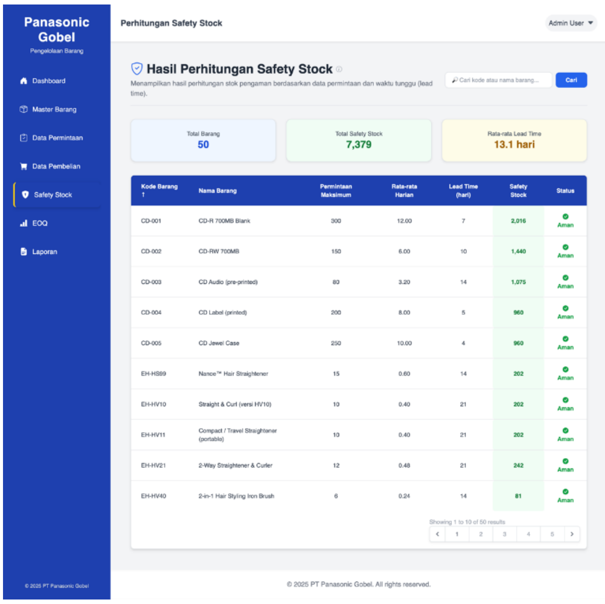

Figure 7. Safety Stock Interface

Figure 7 presents the safety stock interface displaying the results of safety stock calculations. This interface helps determine minimum inventory levels required to anticipate demand variability and lead time uncertainty.

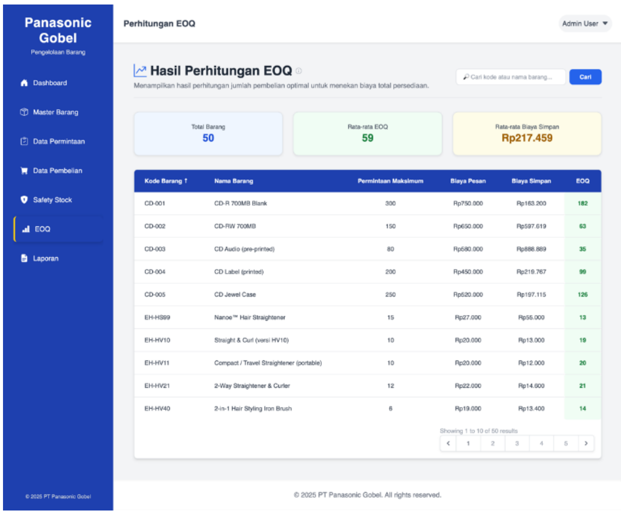

Figure 8. EOQ Interface

Figure 8 shows the Economic Order Quantity (EOQ) interface, which presents the optimal order quantities for each item. The EOQ results support cost-efficient inventory planning by minimizing ordering and holding costs.

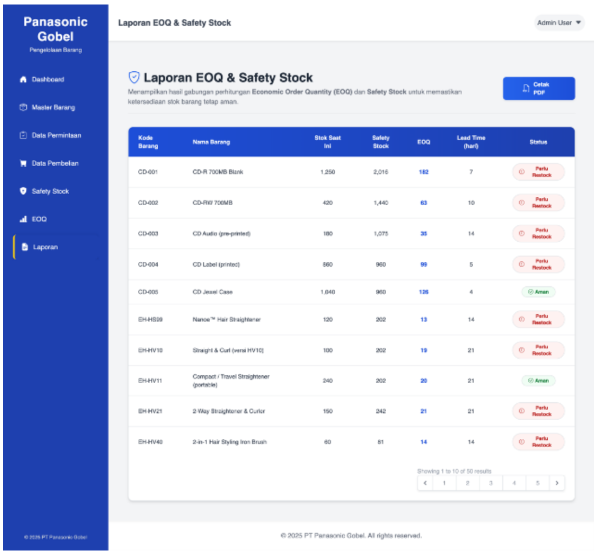

Figure 9. EOQ and Safety Restock Interface

Figure 9 illustrates the integration of EOQ and safety stock calculations with current inventory levels. This interface determines the inventory status, indicating whether items are in a safe condition or require restocking.

CONCLUSIONS

This study achieved its objective of designing and developing a web-based inventory management information system using the Safety Stock and Economic Order Quantity (EOQ) methods at PT Panasonic Gobel Indonesia, Medan Branch. The developed system successfully integrates inventory recording processes, including incoming and outgoing goods, into a centralized platform that improves data accuracy and enables real-time stock monitoring. In line with the research objectives, the implementation of the Safety Stock method enables the company to determine appropriate buffer stock levels to anticipate demand fluctuations and lead time uncertainties. Meanwhile, the application of the EOQ method provides accurate recommendations for optimal order quantities, supporting cost-efficient inventory control. The validation and verification processes confirm that the system's calculations and functionalities operate correctly and correspond with actual operational requirements. Overall, the developed system fulfills its intended purpose by supporting effective managerial decision-making, improving operational efficiency, and reducing the risk of stock shortages and excess inventory in inventory management.

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