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Safety Stock and Reorder Point System for RF Media Stock Optimization

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Abstract.
Purpose: This study develops a web-based inventory management system by applying the Safety Stock and Reorder Point (ROP) methods to address inventory issues at RF Media small and medium enterprises (SMEs) in the printing sector. The system aims to improve operational efficiency and reduce the risk of stockouts, which frequently occur in SMEs due to their reliance on manual inventory processes.
Methods: This study develops a web-based inventory management system by applying the Safety Stock and Reorder Point (ROP) methods to address inventory issues at RF Media small and medium enterprises (SMEs) in the printing sector. The system aims to improve operational efficiency and reduce the risk of stockouts, which frequently occur in SMEs due to their reliance on manual inventory processes.
Result: The simulation showed a 21.38% increase in operational efficiency and a 16.10% reduction in the risk of stockouts. The system ensures complete inventory visibility, facilitates faster decision-making, and minimizes manual errors. Usability testing revealed high user satisfaction regarding interface clarity, ease of use, and quick access to inventory information.
Novelty: This study introduces an innovative integration of the Safety Stock and ROP methods into a lightweight, cost-effective web-based system specifically designed for SMEs. Inventory digitization plays a critical role in enhancing competitiveness. This system offers a practical and scalable solution for efficient inventory management in SMEs environments with limited resources.

Keywords: Inventory management, RF media, Reorder point, Safety stock, Web-based system
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INTRODUCTION

Inventory management is a critical component of supply chain operations, directly affecting business efficiency and profitability. By determining the optimal number and timing of orders, companies can maintain adequate inventory levels to support production activities, sales, and business profitability. By determining the optimal number and time of orders, companies can maintain sufficient inventory levels to support production, sales, distribution activities, minimize costs, and maximize customer satisfaction [1]. Effective inventory management ensures the availability of goods, reduces stock-outs risk, and optimizes operational processes. However, many organizations, especially small and medium enterprises (SMEs), experience difficulty managing inventory efficiently due to reliance on manual processes and limited technology integration [2].

Several studies have examined various methodologies to improve inventory management systems. One example is applying the Economic Order Quantity (EOQ) model, which has been widely adopted to determine the optimal order quantity, balancing storage and ordering costs[3][4]. In addition, integrating technology-based inventory systems has been emphasized to improve supply chain visibility and operational efficiency [5][6]. Recent advancements include the development of Safety Stock and Reorder Point (ROP), which utilize historical demand and variability data to reduce out-of-stock [7]. In addition, web-based inventory management systems have significantly improved operational efficiency and accuracy by reducing manual errors and enabling real-time data tracking [8].

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Existing research generally focuses on large enterprises with strong infrastructure, leaving gaps in solutions designed for SMEs with limited resources [9]. Research often does not address the challenges SMEs face in implementing technology, especially on web-based platforms that are customizable and easy to use for small organizations. A significant gap in the literature is the lack of integration of web-based systems that incorporate safety stock and ROP so that SMEs can adapt and use them efficiently. Previous research has not specifically addressed how the proposed web-based system can address SMEs' unique operational challenges and reduce dependency on expensive cloud infrastructure. In addition, some studies focus on large enterprises or prototype technologies that are difficult to implement for SMEs with limited resources [10].

Analyzing previous research, most of it focuses on cloud-based systems or complex infrastructures, not suited to the needs of smaller and more dynamic SMEs. For example, while research explores the use of Vendor Managed Inventory (VMI) for large enterprises, the system proposed in this research will differ from existing inventory management systems by prioritizing a web-based platform surrounded by mobile platforms, providing ease of access and reducing operational costs that are often a challenge for SMEs. The proposed solution also differs from existing systems, as it does not rely on an expensive cloud, but instead uses a web-based platform supported by a mobile platform, which is more affordable and accessible, allowing real-time access for SME managers and owners to monitor their inventory anywhere and anytime [10].

This research gap aims to develop a web-based inventory management system that integrates Safety stock and Reorder point (ROP) methods to improve operational efficiency at RF Media, a small-scale printing company. Specific objectives of this research include the development of an automated system capable of calculating Safety stock and Reorder point (ROP) using daily data demand, standard deviation, and lead time, conducting an evaluation of potential negative impacts that may affect operational efficiency through comprehensive long-term simulations and providing an adaptable and scalable solution that enables SMEs to improve inventory management through digitalization, thereby increasing their competitiveness.
The proposed system's main advantages lie in its ease of implementation, affordable cost, and application of technology that is highly appropriate for Small and Medium Enterprises (SMEs). One key advantage is the system's ability to digitize and automate inventory management, thereby creating better efficiency and effectiveness, especially for small companies. Processes that previously relied on manual adjustments and stock monitoring can now be automated.

This study aims to supplement existing knowledge by providing practical technology-based solutions that are in line with SMEs needs. In addition, it emphasizes the significance of digitalization in inventory management in improving company efficiency and operations.

METHODS

This research uses two main methods to manage inventory efficiently, namely Safety Stock and Reorder Point (ROP)[11]. Safety Stock aims to anticipate fluctuations in demand or delays in the delivery of goods. This method ensures that stock remains available despite sudden spikes in demand or delays in delivery [12]. Meanwhile, ROP determines the reorder point, which is the minimum stock limit indicating the need to place a reorder. Combining these two methods helps ensure that inventory is maintained at an optimal level, avoiding shortages that can disrupt operations, as well as preventing waste due to excess stock [13]. The Safety Stock and ROP methods are particularly relevant for Small and Medium Enterprises (SMEs). SMEs often face challenges managing inventory due to limited resources and threats to demand or delivery times. Applying these two methods allows SMEs to manage inventory more efficiently, reduce stock-out risk, and avoid overstocking that can lead to waste [14]. Therefore, Safety Stock and ROP are very useful for SMEs in ensuring that stock remains available on time and in sufficient quantity, which ultimately supports smooth operations and improves customer satisfaction [15].

Safety stock (SS)

Safety Stock is a reserve stock designed to anticipate fluctuations in demand or delays in the delivery of goods [2]. This method ensures sufficient stock is available during lead times, even in unexpected demand [16]. The formula used to calculate Safety Stock is as follows:

$$SS = Z \times \sigma d \times \sqrt{L} \quad (1)$$

Where Z is the Z value at the 95% confidence level (Z = 1.645), σd is the standard deviation of daily demand, and L is the lead time.

Reorder point (ROP)

Reorder Point is the minimum inventory level that serves as an indicator for reordering goods [4]. This method ensures that stock remains available until new goods arrive, thus avoiding stock shortages [17]. The formula used to calculate ROP is as follows:

$$ROP = (\overline{D} \times L) + SS \quad (2)$$

Where $\overline{D}$ is the average daily demand, L is the lead time, and SS is the Safety Stock calculated using formula (1).

Data collection and evaluation procedures

The data collection process began by collecting daily demand data ((D_i) from the store's transactions over the past three months using a cashier app that records each transaction in real-time. This ensures the accuracy of the recorded data and provides live monitoring of transactions, which is crucial in handling rapid fluctuations in demand. This data is then verified with delivery reports from suppliers to ensure that the recorded demand data matches the deliveries made. This verification is necessary to avoid data errors that may affect further calculations. After that, the demand variation is calculated to obtain the standard deviation (σd) of daily demand, which describes the level of demand fluctuation and is an essential parameter in the calculation of Safety Stock.

The collected data calculates Safety Stock and ROP (Reorder Point). The Safety Stock calculation involves σd, lead time (L), and a Z value at the 95% confidence level (Z =1.645), ensuring sufficient stock during the waiting time or lead time. The results of the Safety Stock calculation are used together with the average daily demand ($\overline{D}$) to calculate the ROP, which is the point at which a reorder should be placed to avoid stock-outs. This rigorous data collection and verification process is essential to optimize inventory management and ensure the timely availability of goods, so that operations continue to run smoothly and customers remain satisfied.

System design and implementation

This web-based system is designed to automate stock counting and management with two main modules. The Stores module collects stock in real-time and provides notifications when stock reaches a specified minimum level. When the stock reaches the limit, the system will send notifications to stores to reorder as needed, ensuring timely reordering and avoiding stock shortages. The Warehouse module receives reorder notifications from stores, records the delivery of goods to stores, and provides efficient data integration between stores and warehouses. These two modules work synergistically to optimize inventory management, reduce waste, and improve operational efficiency throughout the system. A flowchart illustrating these key processes can be seen in the following figure, which displays the steps in the web-based system.

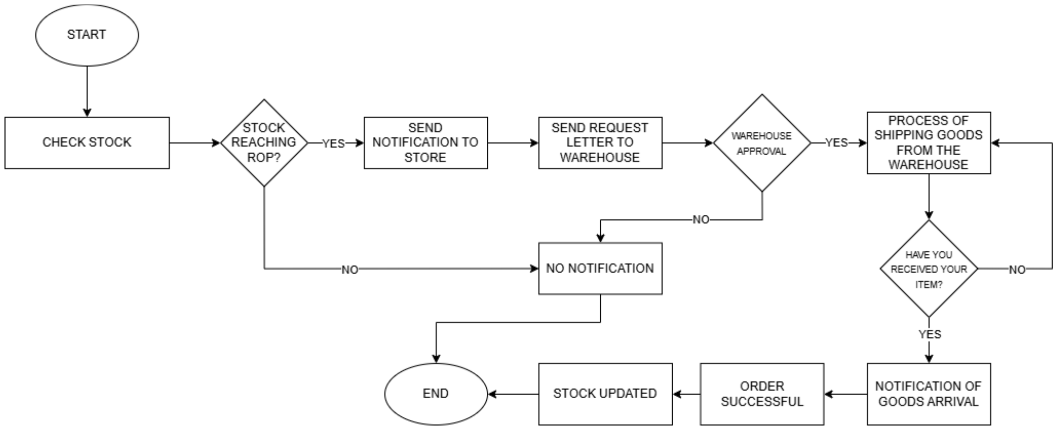

Figure 1. System flow chart

The System Flowchart describes in detail the steps in inventory management, starting from stock checking, where the store module verifies whether the stock reaches the Reorder Point (ROP). If the stock reaches the ROP, a notification and demand letter will be sent to the store and warehouse to process the reorder. The warehouse module then verifies the request and ships the goods to the store, followed by a stock update once the goods arrive and the order is deemed successful. The system provides complete visibility and control over inventory management, which reduces the risk of stock shortages and improves operational efficiency. This research adapts the traditional Safety Stock and ROP methods by integrating them into a web-based system that provides real-time data processing and notifications. The main innovation in this research is to use the cashier application to collect data in real-time and automatically calculate Safety Stock and ROP, which ensures more efficient inventory management and responsiveness to changes in market demand.

RESULTS AND DISCUSSIONS

After applying the Safety Stock and Reorder Point (ROP) calculation methods using historical daily demand and lead time data, the next step is to analyze the implementation of the calculation results. The main objective of this analysis is to evaluate the effectiveness of the designed web-based system in improving stock management efficiency at RF Media. The results show that this approach enables more structured stock management, minimizes the risk of stock shortages, and reduces operational costs caused by excess stock.

Implementation of safety stock (SS) and reorder point (ROP) calculation

To calculate Safety Stock (SS) and Reorder Point (ROP) for each item in RF Media, the average daily demand ($\overline{D}$) and standard deviation of daily demand (σd) are determined. The calculation is based on the sales data given in Table 1 using a 95% confidence level (Z = 1.64) and a lead time (L) of 1 day.

Table 1. Sales Data for Safety Stock and ROP Calculation

Code	Item	Daily Demand (D_i)							Lead Time (L)
RF001	Rf - A4 Rim	2	1	0	1	2	2	2	1
RF002	Rf - F4 Rim	2	6	2	2	2	2	2	1
RF003	Kertas Folio	2	2	2	5	2	5	2	1
RF004	A4 Stiker	2	10	5	2	5	2	2	1
RF005	Art Paper	5	2	2	5	2	2	2	1

Table 1 shows the sales data used as the basis for calculating the average daily demand and standard deviation, which is then applied in the calculation of Safety Stock and Reorder Point as follows:

Average daily demand ($\overline{D}$) :

$$\overline{D} = \frac{2 + 10 + 1 + 2 + 2 + 2 + 2}{7} = 3$$

Standard deviation of daily demand (σd) :

$$\sigma d = \sqrt{\frac{\sum (x_i - \overline{D})^2}{N - 1}}$$

$$\sigma d = \sqrt{\frac{(2-3)^2 + (10-3)^2 + (1-3)^2 + (2-3)^2 + (2-3)^2 + (2-3)^2 + (2-3)^2}{7 - 1}}$$

$$\sigma d = \sqrt{\frac{1 + 49 + 4 + 1 + 1 + 1 + 1}{6}}$$

$$\sigma d = \sqrt{\frac{58}{6}} \quad \sigma = \sqrt{9.67} \quad \sigma = 3.11$$

Safety stock (SS) :
$SS = Z \times \sigma d \times \sqrt{L}$
$SS = 1.64 \times 3.11 \times \sqrt{1}$
$SS = 5.10$ = 5 units

Reorder point (ROP) :
$ROP = (\overline{D} \times L) + SS$
$ROP = (3 \times 1) + 5.10$
$ROP = 8.10$ = 8 units

The calculation for item RF001 (A4 Rim) results in a Safety Stock of 5 units and a Reorder Point of 8 units. However, items with higher demand fluctuations, such as RF004 (A4 Stickers), require more careful stock management due to higher standard deviations.

Comparative analysis of inventory management systems

This research adopts the Safety Stock and Reorder Point (ROP) methods for web-based inventory management. The results showed a 21.38% decrease in the risk of stock shortages and a 16.10% increase in operational efficiency. Implementing this system is proven to improve stock management and reduce waste. Compared to previous research, as described by Ghasemi et al. [18], RFID-based systems and more complex inventory management are more widely implemented in large companies. Previous research has also discussed Vendor Managed Inventory (VMI) systems for inventory management on a large scale, as described by Saha & Rathore [10]. While effective, these systems are often difficult to implement in smaller companies with limited resources and strong technology infrastructure.

This research focuses on the problems faced by Small and Medium Enterprises (SMEs) that do not have a strong technological infrastructure. Therefore, the system developed is more relevant and affordable for SMEs such as RF Media. The system is in contrast to more complex solutions, which are difficult to implement and expensive, as expressed by Alam et al. [5]. The web-based system is easy to use as it automates Safety Stock and ROP calculations using real-time daily data and provides automatic notifications. This reduces manual errors and improves response to dynamic changes in market demand. The system is also easier to implement than more complex systems, as described by Saha & Rathore [10]. The implementation of this web-based system speeds up the decision-making process and reduces reliance on workers for administrative tasks, as emphasized by Ghasemi et al. [18]. This research addresses some of the shortcomings in previous studies by developing a platform that is easy to use and accessible to SMEs with limited resources, which is in line with the findings of Alam et al. [5]. This comparison confirms that the innovation in this study has significant advantages in terms of scalability, ease of use, and cost-effectiveness for SMEs.

The limitations of this study include several aspects, such as the limited scalability of the system to SMEs with limited resources. Challenges also arise in adapting the system for other types of industries or products that have specific needs in inventory management. Data security is a concern, as using a web-based system increases risks related to hacking or information leakage. In addition, the level of technology adoption by users, especially in SMEs that are more conservative towards new technologies, may affect the effectiveness of the system. This study is also limited to daily data for Safety Stock and ROP calculations, which may not fully cover seasonal fluctuations or other unexpected events. These limitations mean that the implementation of the system may be less than optimal in the face of dynamic market conditions, as well as reliance on historical data that may not be entirely reliable.

The scalability potential of the system is enormous, especially in its application across various SMEs in different industry sectors. The system can be customized to the needs of each sector. The development of real-time features and integration with other systems, such as Enterprise Resource Planning (ERP) and supplier management systems, can expand the functionality of the system. Integration with Internet of Things (IoT) and RFID technology for automatically tracking goods can improve inventory management efficiency and accuracy. Utilization of Big Data for more accurate demand trend analysis and better prediction, as well as the development of mobile applications to increase user flexibility and responsiveness, can also expand the functionality of the system. Expansion into international markets is possible as the system is designed to be easily adapted and used in different countries, with SMEs facing similar challenges.

Usability testing results

Usability testing is an assessment method to evaluate how users can use a product or system effectively, efficiently, and satisfactorily. The main goal is to identify user problems and difficulties using the product or system [19]. This test follows the ISO 9126 standard, which assesses software quality, including usability aspects such as clarity, ease of learning, operability, and attractiveness in user interaction with the system [20].

Table 2 Characteristic ISO 9126

Sub-Characteristics	Question	Code
Understandability	• Do you feel you can learn how to use the system quickly?	Q1
	• How easy is the system for new users to learn?	Q2
Learnability	• Do you find the system easy to use after learning it?	Q3
	• Do you feel this system needs help from others to operate it properly?	Q4
Operability	• How attractive is the interface design of this system?	Q5
	• Is the appearance of this system comfortable to use for long periods of time?	Q6
Attractiveness	• Do all the features in the system function properly as you expected?	Q7
	• Are you satisfied with the experience of using this system?	Q8
Fungsionalitas	• Do you feel you can learn how to use the system quickly?	Q9
	• How easy is the system for new users to learn?	Q10

Table 2 contains 10 statements from the ISO 9126 questionnaire that must be answered by respondents using a Likert scale with the options “Strongly Disagree”, “Disagree”, “Neutral”, ‘Agree’, and “Strongly Agree”. Respondents were measured using a Likert scale. The results of Likert scale measurements based on ISO 9126 can be seen in Table 3.

Table 3 Calculation of ISO 9126

Q	Characteristic					Total Value	Score Min	Score Max	Percentage (Total/max)
	SD	D	N	A	SA				
Q1	0	0	5	12	8	103	1	5	82,4%
Q2	7	9	3	4	2	90	1	5	72%
Q3	0	0	7	9	9	102	1	5	81,6%
Q4	0	1	6	8	10	102	1	5	81,6%
Q5	0	0	2	10	13	111	1	5	88,8%
Q6	4	11	6	2	2	88	1	5	70,4%
Q7	0	0	3	13	9	106	1	5	84,8%
Q8	0	0	4	9	12	108	1	5	86,4%
Q9	0	0	4	10	11	107	1	5	85,6%
Q10	0	0	3	12	10	107	1	5	85,6%

Based on the results of the ISO 9126 questionnaire using a Likert scale, the Understandability characteristic obtained the most significant value with a percentage of 83%, indicating that the majority of respondents felt the system or product tested was easy to understand and use. In contrast, the Learnability characteristic recorded the lowest score with a percentage of 73%, indicating that the initial learning aspect of the system still requires improvement to make it easier for new users to adapt. Overall, although most characteristics show a high level of satisfaction, some aspects, especially in terms of learning, need to be improved to optimize the user experience, as can be seen in Figure 1, which summarizes the recapitulation of the assessment based on ISO 9126.

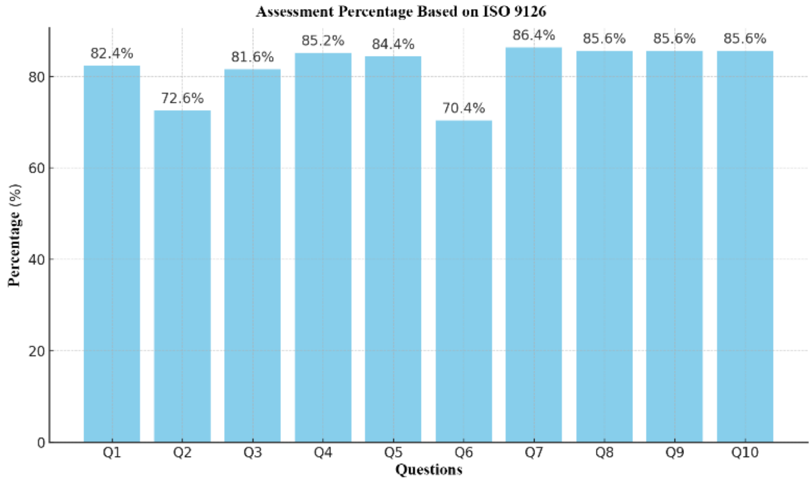

Figure 2 Results with ISO 9126

Following on from the previous evaluation, Table 2 presents the results of an assessment of the effectiveness of stock tracking based on several relevant evaluation metrics.

Table 4 Effectiveness of Stock Tracking

Evaluation Metrics	Question	Total Value	Percentage (Total/max
Ease of use	How easy is it to find information about stock availability in this system?	105	84%
Alerts	How effective is the system in providing alerts when stock is running low?	111	88,8%
Stock accuracy	How accurate is the system in monitoring and updating stock status in real-time?	106	84,8%
Data access	Can you easily access stock data and product transaction history in this system?	107	85,6%
System Response Time	How fast does the system process stock transactions and update inventory status in real time?	104	83,2%

Based on the evaluation results of the stock tracking system, most metrics showed good performance. Ease of access to stock information scored 84%, indicating that the system is relatively easy to use. Out-of-stock alerts are effective with a score of 88.8%, which helps users manage stock. Stock Accuracy reached 84.8%, indicating fairly accurate stock status updates in real-time. Data Access is also adequate with a score of 85.6%, making it easy for users to manage stock data and transaction history. However, the speed of transaction processing and stock updates is slightly lower, with a score of 83.2%, indicating the potential to improve the speed of the system. Overall, the stock tracking system is effective, but there is still room for improvement, especially in processing speed.

System implementation

The following are the results of the system implementation on the web page:

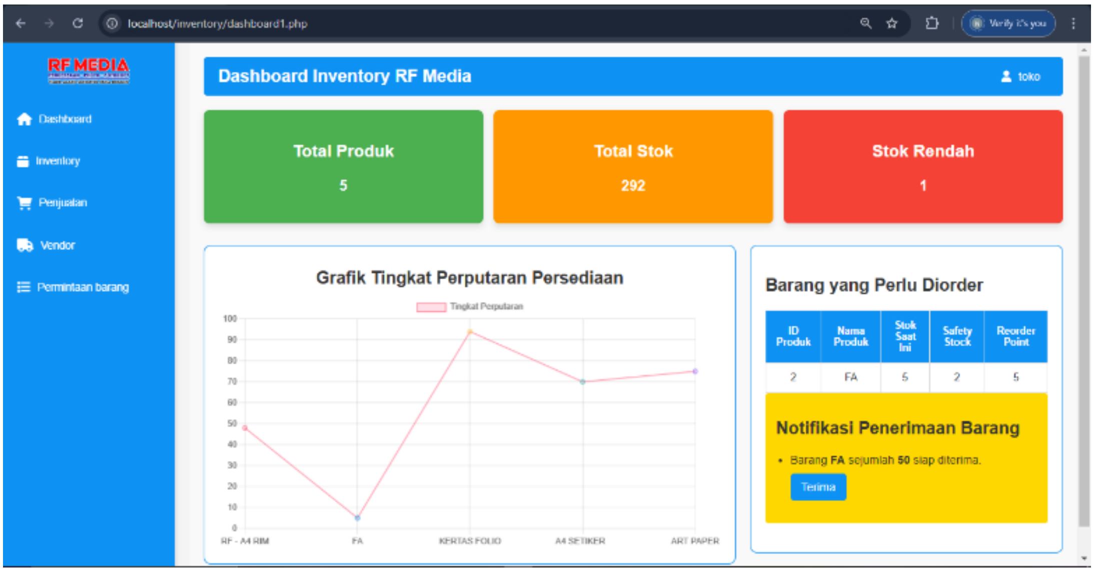

Figure 3. Inventory dashboard page

RF Media inventory dashboard view summarizes total products, stock, and low stock, as well as an inventory turnover graph depicting stock fluctuations. These graphs make it easy to identify trends and reorder needs. The table below the graph displays items that need to be ordered, along with stock details and reorder point (ROP). Goods receipt notifications make it easy to confirm re-stocking. The menu on the left gives access to the Inventory and Ordering Item pages, supporting efficient inventory management and quick decision making.

Figure 4. Warehouse dashboard page

RF Media warehouse dashboard page provides a real-time summary of products, stock, and low stock, as well as graphs of inbound and outbound stock movements. The table on the right displays items that need to be reordered, complete with stock details and reorder points. The order notification feature allows the warehouse to receive item request letters from stores containing details of the required items. Once the requisition is verified, the warehouse can process it via the Receive button to ensure timely delivery. The navigation menu on the left provides easy access to the Item Management and Transactions pages, supporting efficient inventory management..

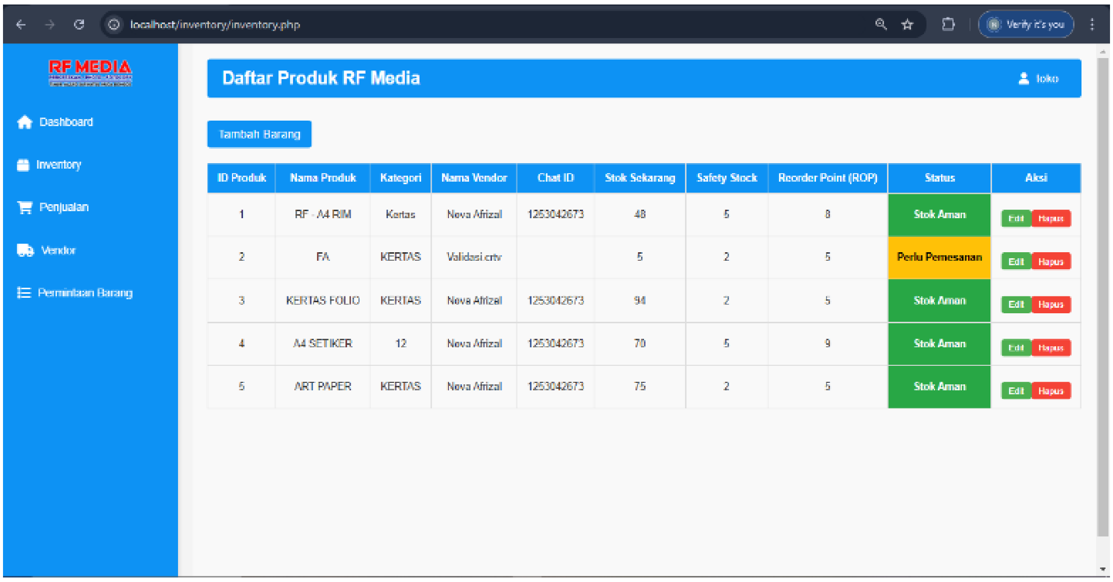

Figure 5. Inventory dashboard page

The Product List page in the RF Media Inventory system displays complete information about the products managed in the store, including Product ID, Product Name, Category, Vendor Name, and Chat ID to contact the Warehouse. The Stock column shows the amount of stock available, while Safety Stock and Reorder Point (ROP) help monitor minimum limits and reorder levels. Stock status is displayed with labels such as "Safe Stock", "Reorder Required", and "Very Low Stock". Users can also edit or delete data by using the buttons provided.

CONCLUSION

Based on the research conducted, implementing a technology-based inventory management system at RF Media that integrates the concepts of safety stock and reorder point shows significant results in improving inventory management efficiency. Simulation results for three months show an increase in operational efficiency of 21.38% and a decrease in the risk of stock shortages by 16.10%. The system enables real-time stock monitoring and automatic calculation of reorder needs, and reduces manual errors, ensuring the availability of goods according to customer needs. With reorder notification features and data integration between stores and warehouses, the system provides complete visibility into the supply chain, supporting faster and more accurate decision-making. The system also effectively reduces operational costs due to overstocking and improves customer satisfaction. In the future, integrating machine learning for demand forecasting, mobile support, and linking with the finance module can expand the effectiveness of this system, enabling more responsive stock management and more optimized cost management. This research makes an important contribution to SMEs, helping them reduce reliance on manual processes, improve operational efficiency, and save costs associated with inventory management, ultimately supporting smooth operations and business growth.

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