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Web-Based Dental Inventory Management and Treatment Automation System

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Abstract *- Currently, inventory management for medical equipment and supplies at the dental clinic relies on conventional methods. This situation leads to various issues, such as stock data discrepancies, delayed updates, recording errors, and difficulties in displaying product availability dates and stock levels in real-time. Furthermore, the use of medical supplies during patient treatment is not directly linked to the inventory system, requiring stock reductions to be processed separately. To address these challenges, an automated, web-based inventory management information system was developed. The proposed system integrates dental treatment procedures using the Waterfall Software Development Life Cycle (SDLC) model and is built on the Laravel, Next.js, and MariaDB platforms. It incorporates the First-In-First-Out (FIFO) principle, a Bill of Materials (BOM) structure tailored to each treatment type, stock reduction alerts based on the Moving Average method, inventory monitoring, and multi-channel notifications via web interface, email, and WhatsApp. Notably, simulation results demonstrate that the automated BOM mechanism reduces the recording process from 5–25 steps to 1–3 steps and cuts processing time from 1–3 minutes to 5–15 seconds per treatment. User Acceptance Testing (UAT) yielded a score of 88.57% (categorized as "Very Good"), confirming the application's suitability for supporting inventory operations at the dental clinic.*

Keywords**:** *Bill of Materials; FIFO; Inventory Management; Inventory Depletion Alert; Web-Based System.*

1. INTRODUCTION

The Rapid advancements in information technology (IT) have significantly transformed the healthcare sector, enabling improvements in service quality, administrative processes, and operational efficiency. The implementation of web-based information systems has become increasingly vital for healthcare organizations to reduce administrative errors, enhance data accessibility, and support timely decision-making [1][2]. Through digital transformation, healthcare providers can manage operations more effectively while ensuring the accuracy and currency of information.

The quality and sustainability of healthcare services rely heavily on the availability and proper management of medical equipment and consumables. Inadequate inventory management can lead to stockouts, overstocking, inaccurate record-keeping, and the use of expired materials; these issues can negatively impact healthcare services and drive up operational costs [3][4]. Despite rapid technological advancements, many healthcare facilities still rely on manual recording methods or spreadsheet-based inventory management. These conventional approaches are prone to human error, delayed data updates, and limited real-time monitoring capabilities, ultimately resulting in discrepancies between recorded inventory data and actual stock levels [5][6]. A primary cause of these discrepancies is the failure to deduct stock immediately when medical materials are used during treatment procedures [5]. A similar situation exists in dental clinics, where the use of medical supplies is manually recorded in separate spreadsheets after treatment is completed; this leads to administrative delays, tracking difficulties, and inconsistencies in inventory records.

To address challenges in inventory management, various studies have examined the implementation of web-based automated inventory systems. Pasaribu [7], Utami et al. [8], and Yoraeni et al. [9] reported that web-

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based inventory systems enhance data centralization, transaction accuracy, and reporting efficiency, while simultaneously reducing inventory discrepancies. Furthermore, the First-In-First-Out (FIFO) method has been widely adopted to manage inventory turnover, particularly for materials with expiration dates. Hasanah et al. [10] and Atmojo et al. [11] demonstrated that FIFO effectively prioritizes the use of earlier-received inventory, thereby mitigating the risk of product expiration. Similar findings were reported by Selpiyana et al. [12], Zalukhu et al. [13], and Shinta et al. [14], indicating that integrating FIFO into inventory systems improves stock traceability, inventory accuracy, and the automation of stock turnover processes.

Another key concept in inventory automation is the *Bill of Materials* (BOM), which defines material requirements associated with specific operational activities. Originally developed for manufacturing environments [15][16], BOM has been successfully adapted to service industries. Kamal et al. [17] applied BOM to improve ingredient tracking in food service operations, while Sasikanth et al. [18] utilized it to automate material management within restaurant systems. By linking predefined material processes to operational procedures, the BOM enables automatic inventory reduction and minimizes manual record-keeping tasks. Furthermore, predictive inventory management and automated notification mechanisms have garnered increasing attention in recent years. George et al. [19], Abu Zwaida et al. [20], and Gonzatto Junior et al. [21] demonstrated that demand forecasting methods can improve inventory planning and reduce the risk of stock shortages. Similarly, Rhamadani et al. [22] and Surya et al. [23] showed that rule-based notification systems facilitate the early detection of critical inventory conditions and support faster responses from operational staff.

In this study, we designed and developed a web-based dental inventory and treatment automation management system specifically tailored for dental clinics. While previous research has demonstrated the effectiveness of web-based inventory system, including FIFO implementation, BOM-based material planning, demand forecasting, and rule-based notification mechanisms, these functionalities are typically implemented in isolation and rarely integrated into a single platform for dental healthcare services. Consequently, inventory monitoring and stock management processes are often fragmented and require significant manual intervention. To address this gap, the proposed system integrates automated inventory reduction linked to treatment actions via a Bill of Materials (BOM), batch-based stock rotation using the First-In-First-Out (FIFO) method, stock depletion alerts based on a 7-day moving average, and rule-based management of expired inventory into a unified workflow. Furthermore, the Laravel queue mechanism is utilized to automate the delivery of inventory notifications via the web interface, email, and WhatsApp channels using the Font API. The implementation of these integrated features is expected to enhance inventory accuracy, reduce administrative workloads, improve real-time inventory visibility, and facilitate more effective inventory management within dental healthcare services.

2. RESEARCH METHODOLOGY

This system was developed using the Waterfall model of the Software Development Life Cycle (SDLC) [7][12], comprising the stages of requirements gathering, system analysis, system design, requirements verification, implementation, and testing. During the requirements gathering stage, discussions were held with the owner of a dental clinic in Tangerang to identify existing inventory workflows and operational challenges. The clinic utilized separate, non-integrated Microsoft Excel spreadsheets for inventory recording, resulting in a time-consuming process and limited real-time monitoring capabilities regarding stock inflow and outflow. These findings informed the determination of system requirements, which included integrated inventory management, batch-based stock tracking, automatic stock updates, material usage recording based on treatment type, inventory notifications, and expiration date monitoring.

In the system analysis stage, the identified requirements were translated into functional requirements and business rules. The Bill of Materials (BOM) method was proposed to link dental treatments with the necessary materials and quantities, while the First-In, First-Out (FIFO) method was proposed to determine stock issuance based on the receipt date of each inventory batch. Each inventory receipt record included the receipt date, expiration date, and quantity, with the expiration date serving the purpose of monitoring shelf life. The system design stage subsequently translated these requirements into a system architecture, UML models, database

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structure, and interface design. The resulting design was reviewed during the requirements verification stage prior to its implementation as a web-based system. Finally, the implemented system was evaluated through black-box testing, simulations of inventory recording efficiency, and User Acceptance Testing (UAT).

2.1. System Modeling and Architecture

The proposed system was modeled based on the identified requirements and business rules using Unified Modeling Language (UML) [24] and Entity Relationship Diagrams (ERD) [25]. UML is used to represent system functionality, user interactions, and business processes, while ERDs are used to design the database structure and define relationships between system entities. The use case diagram depicts interactions among three primary actors: the Administrator, Clinic Staff, and Medical Staff. The Administrator is responsible for managing master data, user access, procurement activities, and overall inventory monitoring. Clinic Staff and Medical Staff carry out operational tasks such as stock adjustments, medical procedure registration, and inventory monitoring specific to their respective clinic locations.

Activity diagrams were developed to model the workflows of key business processes, including user authentication, procurement management, goods receipt processing, and medical procedure registration. These diagrams illustrate the sequence of activities performed by users and the system during inventory-related operations. The database structure was designed using an Entity-Relationship Diagram (ERD) comprising three main components: master data, inventory management data, and operational transaction data. Master data stores information regarding users, clinic locations, suppliers, categories, and inventory items. Inventory management data tracks stock availability and inventory movements, while operational transaction data manages procurement activities, goods receipt processes, medical procedure records, and material usage. The relationship between medical procedures and required materials is represented through a Bill of Materials (BOM) structure, enabling automatic inventory reduction based on the specific medical procedure activities performed.

2.2. Core Algorithms and Calculations

To support inventory automation and monitoring, the proposed system integrates four key mechanisms: First-In-First-Out (FIFO), Bill of Materials (BOM), inventory depletion alerts using the Moving Average method, and monitoring of expired inventory.

2.2.1 First-In-First-Out (FIFO) Mechanism

The FIFO method is used to determine the stock issuance sequence, in which older inventory batches are prioritized before newer batches [26][27]. In the proposed system, the sequence is determined based on the recorded receipt date for each inventory batch. As inventory is utilized, stock is drawn down sequentially, starting with the oldest available batch,until the required quantity is met. This mechanism aims to maintain stock rotation and prevent older batches from remaining in storage while newer ones are consumed first.

The FIFO method is selected to maintain stock rotation based on the date of receipt. Although expiration dates are recorded for each inventory batch, expiration-related risks are monitored separately through an inventory expiration alert mechanism. Thus, FIFO determines the stock issuance sequence based on the receipt date, while expiration monitoring identifies batches of goods that are approaching or have passed their expiration dates. The stock deduction process is calculated as in the following Formula 1.

$$i{=}1kQi{=}Qtotal \qquad \sum_{i=1}^{k} Q_i = Q_{total} \tag{1}$$

where (Q_i) represents the quantity deducted from batch (i), and (Q_{total}) denotes the total quantity required for a specific treatment or transaction.

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2.2.2. Bill of Materials (BOM) Integration

The Bill of Materials (BOM) mechanism defines the materials and quantities required for a specific dental treatment [28], [29]. In the proposed system, each action is linked to a pre-defined BOM configuration. When an action is recorded, the system automatically calculates the required quantity of each material based on the relevant BOM. These calculated quantities are then processed using a FIFO mechanism to automatically deduct the corresponding inventory stock.

$$Q_{BOM} = Q_{pivot} \times N_{treatment} \quad (2)$$

where $\left(Q_{\{pivot\}}\right)$ represents the standard quantity of a material defined in the BOM, and $(N_{\{treatment\}})$ denotes the number of treatments performed.

2.2.3. Inventory Depletion Alert Using Moving Average

To support inventory planning and prevent stock shortages, the system estimates inventory depletion duration using a 7-day Moving Average method [22]. The Average Daily Usage (ADU) is calculated as in Formula 3.

$$ADU = \frac{\sum_{t=1}^{7} D_t}{7} \quad (3)$$

where (Dt) represents the actual quantity consumed on day (t). The estimated remaining inventory duration is calculated using Formula 4.

$$Days\ Remaining = \frac{Current\ Stock}{ADU} \quad (4)$$

where $Current\ Stock$ represents the current inventory quantity and ADU represents the Average Daily Usage. The calculation is applied only when the ADU value is greater than zero. Based on the estimated remaining inventory duration, inventory status is classified into three categories. Items with a remaining inventory duration of two days or less are categorized as Critical. Items with a remaining inventory duration of more than two days up to five days are categorized as Warning, while items with a remaining inventory duration of more than five days are categorized as Normal [30].

2.2.4 Expired and Slow-Moving Alert

To identify inventory items with low turnover rates and a potential risk of expiration, the system calculates the inventory turnover percentage over a 90-day observation period using the following Formula 5.

$$Turnover = \frac{Total\ Outflow\ (90\ Days)}{Current\ Stock} \times 100\% \quad (5)$$

Where $Total\ Outflow\ (90\ days)$ represents the total quantity of inventory issued during the previous 90 days, and *Current Stock* represents the available inventory quantity at the time of calculation. An item is classified as a slow-moving item if its turnover value is less than or equal to 20% after being stored for more than 30 days. Additionally, the remaining shelf life of each inventory batch is calculated as in Formula 6.

$$Days\ to\ Expiry\ =\ Expiration\ Date\ -\ Current\ Date \quad (6)$$

where $Expiration\ Date$ represents the product expiration date and $Current\ Date$ represents the date on which the calculation is performed. Based on the calculated $Days\ to\ Expiry$ value, inventory expiration status is classified into four categories. Items whose remaining shelf life is less than or equal to zero days are categorized as Expired. Items with a remaining shelf life of up to seven days are categorized as Critical, while items with a remaining shelf life between eight and thirty days are categorized as Warning. All other items are categorized as Normal.

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3. RESULTS AND DISCUSSION

3.1. System Implementation

The proposed system was successfully implemented as a web-based application using Laravel as the backend framework, Next.js as the frontend framework, and MariaDB as the database management system. The system integrates inventory management, procurement, procedure registration, low-stock alerts, expiration date monitoring, and automated notification features into a single unified platform. Figure 1 illustrates the system architecture and the decoupled communication flow between the frontend and backend via a RESTful API.

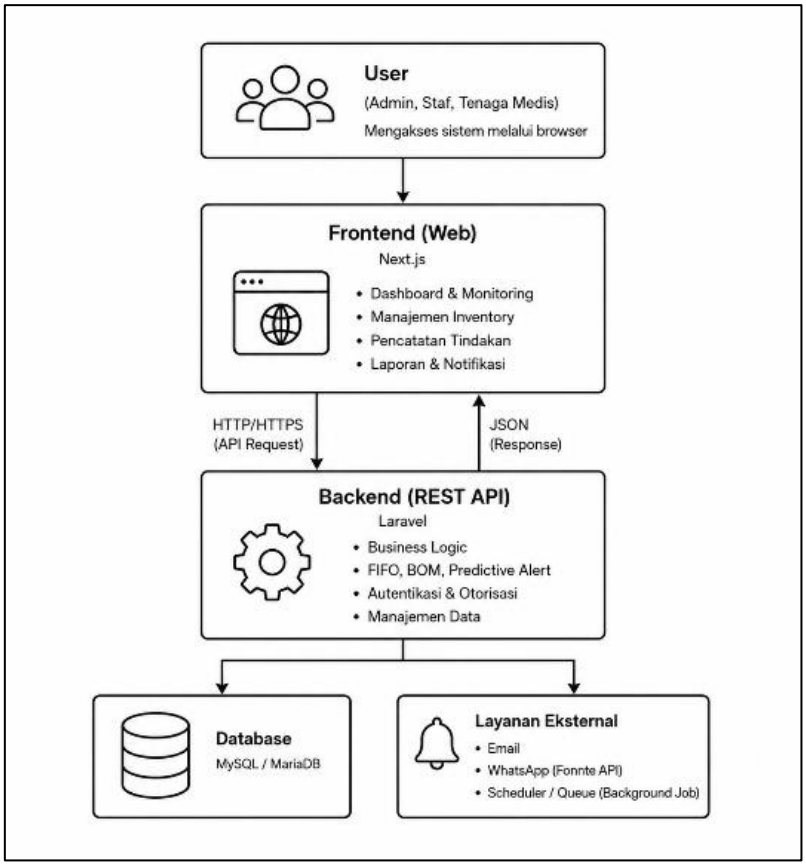


Figure 1. System architecture and decoupled API communication workflow.

This system adopts a decoupled architecture, where the frontend and backend communicate via RESTful APIs. This architecture enhances scalability and maintainability while allowing each component to be developed independently. Its implementation also supports role-based access control and multi-location inventory management to meet the operational needs of multiple clinic branches.

3.2. Inventory Management and Treatment Automation

The inventory management module enables users to monitor stock availability, product categories, inventory batches, expiration dates, and inventory movements in real-time. Inventory levels are automatically updated whenever procurement, usage (treatment), or stock adjustment transactions occur. To support multi-branch operations, the system implements location-based access control, ensuring that users can only access inventory data relevant to the clinic location where they are assigned. This mechanism prevents data overlap between branches and enhances inventory tracking capabilities across the organization. Figure 2 illustrates the inventory management module, including stock availability, inventory batches, expiration dates, and inventory movements.

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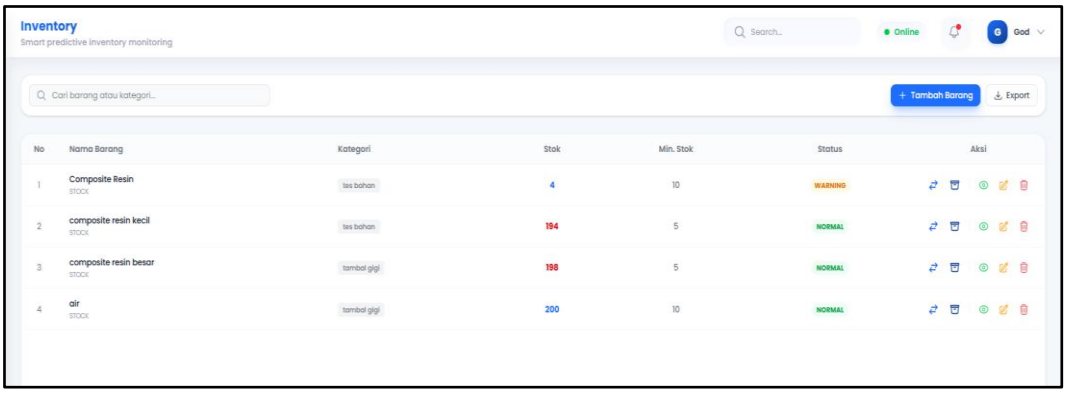


Figure 2. Inventory management module.

This system integrates a Bill of Materials (BOM) mechanism to automate inventory deduction based on dental treatment activities. When a treatment is recorded, material requirements are calculated and automatically deducted from inventory according to the predefined BOM configuration. Inventory usage is processed using a FIFO mechanism to ensure that older stock is utilized before newer stock. This automation eliminates manual stock deduction tasks, reduces inventory recording errors, and ensures that inventory usage accurately reflects the actual treatment activities performed at the clinic. Figure 3 illustrates the treatment automation module, where the predefined BOM is used to determine the materials required for each treatment and the FIFO mechanism is applied for inventory deduction.

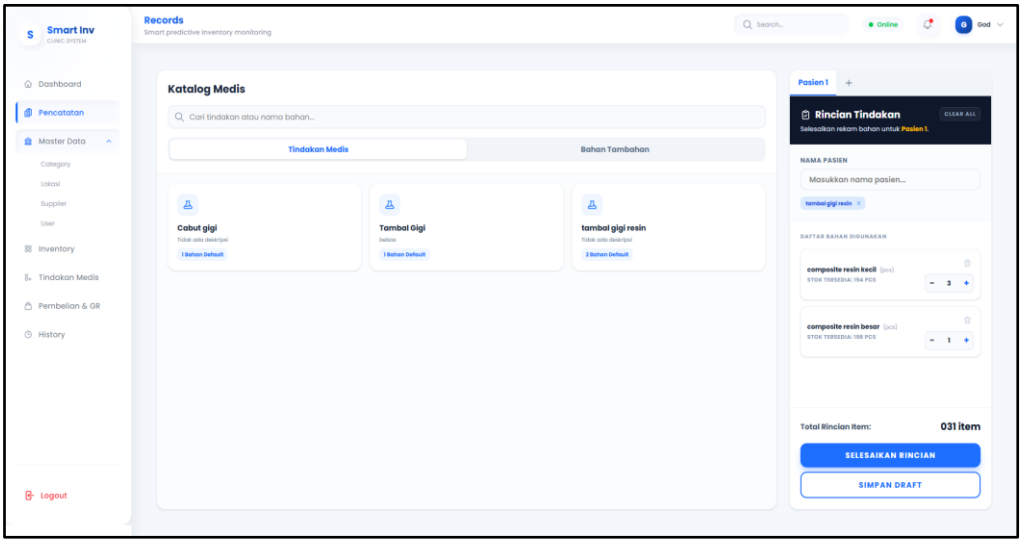


Figure 3. Treatment automation module.

Table 1 presents an example of the BOM configuration for a scaling treatment, including the materials and quantities required for the treatment.

Table 1. Example of BOM configuration for scaling treatment.

Treatment	Material	Qty
Scaling	Gloves	1
Scaling	Mask	1
Scaling	Saliva Ejector	1

Once the scaling procedure is complete, the system automatically deducts one pair of gloves, one mask, and one saliva ejector from the available inventory, in accordance with the established Bill of Materials (BOM)

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configuration. The integration between the BOM and the FIFO method enables the automatic recording of inventory usage, eliminating the need for manual stock adjustments.

3.3. Inventory Depletion Alert

The system monitors inventory usage patterns to estimate the time until stock depletion and identify potential stock shortages. Inventory consumption data is processed using a 7-day Moving Average method to calculate the Average Daily Usage (ADU), which is then used to estimate the remaining duration of inventory availability. Based on the calculated remaining days, inventory status is classified into Critical, Warning, and Normal categories. Products with a remaining inventory duration of two days or less are categorized as Critical, while products with a remaining duration of more than two days but less than or equal to five days are categorized as Warning. Table 2 presents an example of stock depletion alert calculations based on current stock, Average Daily Usage (ADU), estimated remaining days, and the resulting inventory status.

Table 2. Example calculation for inventory depletion alerts.

Product	Current Stock	ADU	Days Remaining	Status
Gloves	10	5	2	Critical
Mask	20	4	5	Warning

The implemented inventory depletion warning mechanism successfully identifies products at high risk of running out of stock and provides early warnings before shortages occur. This enables clinic staff to proactively replenish supplies and reduces the risk of operational disruptions caused by the unavailability of medical equipment.

3.4. Expired and Slow-Moving Monitoring

The system continuously monitors inventory turnover and product expiration dates to identify slow-moving and expired inventory items. Inventory turnover is calculated over a 90-day observation period to identify products with low movement rates, while expiration monitoring evaluates the remaining shelf life of each inventory item. Products with a turnover value of 20% or less after being in storage for more than 30 days are classified as slow-moving, enabling users to identify inventory that is not being effectively utilized. Table 3 presents sample expiration monitoring results based on the remaining shelf life of inventory batches and their expiration status.

Table 3. Example calculation for expiry monitoring.

Product	Days to Expiry	Status
Dental Cement	5	Critical
Composite Resin	-2	Expired

The remaining shelf life of inventory items is evaluated to determine the risk level regarding expiration. Products nearing their expiration date are automatically categorized as "Warning" or "Critical" based on their remaining shelf life, while expired products are immediately flagged for corrective action. Through continuous monitoring of stock turnover and expiration status, the system helps users identify inventory risks early and supports more effective decision-making for inventory planning.

3.5. Notification System

Inventory alerts are automatically transmitted via various communication channels, including web notifications, email notifications, and WhatsApp messages. This notification mechanism operates through a scheduled background process that periodically evaluates inventory conditions, such as low stock levels, slow-

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moving inventory, and product expiration status. When predefined alert conditions are met, notifications are automatically sent to authorized users based on their assigned clinic locations. Figure 4 illustrates the multi-channel notification workflow, encompassing web, email, and WhatsApp notifications.

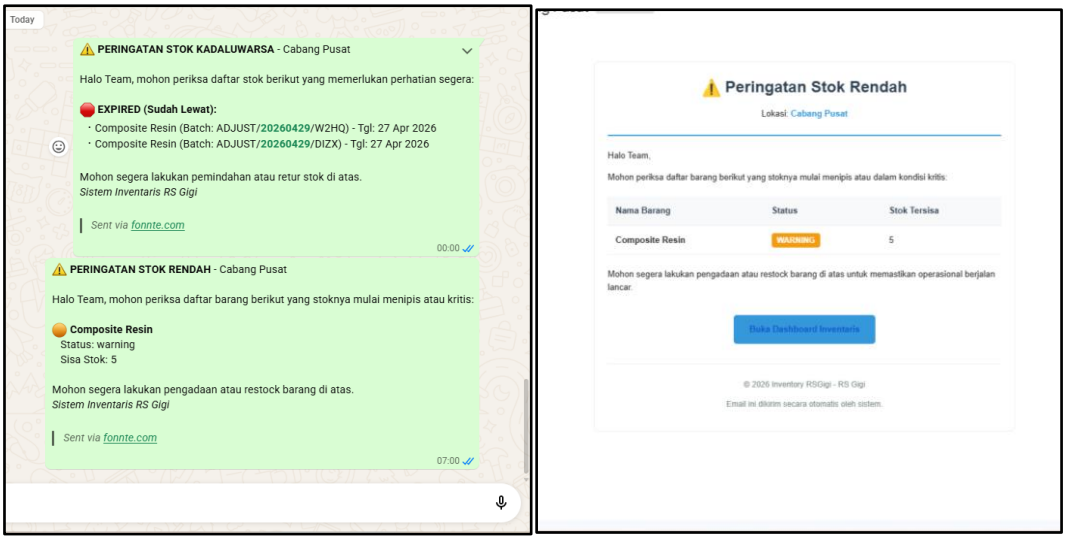


Figure 4. Multi-channel notification system.

The notification workflow operates asynchronously to ensure that monitoring activities do not impact overall system performance. Test results indicate that WhatsApp notifications are successfully sent approximately 19 seconds after the monitoring process is initiated. These results demonstrate the system's capability to provide timely inventory alerts and support rapid responses to critical inventory conditions.

3.6. System Testing

3.6.1 Black-box Testing

Functional validation was conducted using the black-box testing method. The testing process evaluated the system's core functionalities, including authentication, treatment registration, inventory reduction, low-stock alerts, expiration monitoring, and notification delivery. Table 4 presents the functional validation results, including the functions tested, expected outputs, and corresponding test results. The results indicate that all tested functionalities operated in accordance with the established requirements and produced the expected outputs.

Table 4. Functional validation results via black-box testing.

Function	Expected Result	Result
Login	User authenticated	Valid
Create Treatment	Treatment recorded	Valid
Inventory Deduction	Stock reduced automatically	Valid
Inventory Depletion Alerts	Alert generated correctly	Valid
Expired Alert	Alert generated correctly	Valid
Notification Delivery	Notification successfully sent	Valid

3.6.2. Inventory Recording Efficiency Simulation

To compare the efficiency of the action-based inventory automation mechanism, a simulation was conducted comparing the manual inventory recording process with the proposed automation approach based on the Bill

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of Materials (BOM). The simulation focused on the number of operational steps and the time required to record inventory usage resulting from dental care activities. Identical treatment scenarios were executed using both approaches. In the manual procedure, the user recorded the necessary stock reductions individually in Excel, whereas in the automated approach, the user selected the treatment type, and the system automatically determined the required materials and deducted the relevant stock based on a pre-established Bill of Materials (BOM). The number of operational steps was calculated based on the user actions required to complete the recording process. Recording time was measured using a stopwatch, spanning from the start of the process until the transaction was completed. The simulation was conducted by the author with the knowledge of the clinic director, and each procedure was repeated five times to determine the average recording time. Table 5 presents the comparison between the manual Excel-based inventory recording procedure and the proposed BOM-based automation in terms of operational steps and recording time.

Table 5. Inventory recording simulation result.

Method	Recording Process	Steps	Estimated Time
Manual	Stock recorded individually	5–25 steps	1–3 minutes
BOM Automation System	Stock reduced automatically based on treatment	1–3 steps	5–15 seconds

Simulation results indicate that the proposed system requires fewer operational steps and less recording time compared to manual, Excel-based procedures. Action-based BOM automation entails approximately 1–3 operational steps, whereas the manual Excel-based procedure involves 5–25 steps. Recording time ranges from 5–15 seconds for the automated process, compared to 1–3 minutes for the manual procedure. These findings suggest that the developed automation mechanism facilitates more efficient inventory recording by reducing the number of user actions and the time required to record stock reductions associated with specific actions.

3.6.3 User Acceptance Testing (UAT)

User Acceptance Testing (UAT) was conducted involving seven respondents selected based on their roles as users of the application developed for the dental clinic. These respondents, comprising the Director, front office staff, nurses, cleaning/driving staff, technicians, and administrators, represented the various users involved in the clinic's operations. The evaluation consisted of twenty assessment statements measured using a five-point Likert scale. The questionnaire covered six dimensions: utility and ease of use; inventory recording and procurement; inventory monitoring and tracking; treatment-based material usage and automatic stock deduction; inventory alerts and notifications; and overall operational effectiveness and system acceptance. The questionnaire was designed by the authors based on system requirements, business rules, and operational workflows identified during the requirements engineering process. Table 6 presents the overall UAT results, including the number of respondents, number of assessment items, actual score, ideal score, percentage, and acceptance category.

Table 6. User acceptance testing (UAT) result.

Evaluation Aspect	Score
Total Respondents	7
Total Questions	20
Actual Score	620
Ideal Score	700
UAT Percentage	88.57%
Category	Very Good

The obtained UAT score of 88.57% indicates a high level of user acceptance and suggests that the system is suitable for supporting daily inventory management activities at Dental Clinic.

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3.7. Discussion

The proposed system integrates several inventory management mechanisms within a single workflow for dental clinic operations. Previous studies have demonstrated the use of web-based inventory systems for data centralization, transaction management, and inventory monitoring [7][8][9]. Other studies have applied FIFO for inventory rotation and traceability [10][11][12][13][14], while BOM has been used to define material requirements and automate material consumption [17], [18]. In the proposed system, these mechanisms are linked to maintenance activities: the established Bill of Materials (BOM) determines the materials and quantities required for maintenance, while the FIFO method determines which inventory batch is drawn down based on the receipt date. Each inventory batch also records an expiration date, which is monitored separately via an expiration alert mechanism. Thus, FIFO is used to maintain stock rotation based on receipt dates, whereas expiration monitoring identifies batches nearing or past their expiration dates. The system also integrates stock depletion alerts based on a 7-day moving average, monitoring for expired and slow-moving inventory, and notifications across multiple channels. This integration links maintenance logging, material usage, batch-level inventory tracking, and inventory monitoring within a single workflow.

The evaluation results demonstrate the operation and practical application of the proposed system from both functional and user perspectives. Black-box testing confirmed that the implemented functions operate in accordance with system requirement specifications. Inventory recording simulations showed that action-based automation requires approximately 1–3 operational steps and a recording time of 5–15 seconds, compared to 5–25 steps and 1–3 minutes for manual, Excel-based procedures. These results indicate that linking action logging with the automatic recording of material usage can streamline the inventory recording process. The User Acceptance Testing (UAT) yielded a score of 88.57%, indicating a high level of user acceptance among the seven application users involved in clinic operations. However, this simulation and UAT results must be interpreted within the scope of the evaluation conducted and cannot be generalized to other dental clinics. Furthermore, the Moving Average mechanism serves as a method for estimating inventory depletion rather than a validated forecasting model, as forecasting performance was not formally evaluated due to limited historical usage data.

The primary contribution of this research lies in integrating maintenance-based inventory automation, batch-level stock rotation, low-stock alerts, monitoring of expiration dates and slow-moving items, and multi-channel notifications into a single web-based workflow tailored to dental clinic operations. In contrast, previous studies reviewed in this research address web-based inventory management, FIFO, BOM, demand forecasting, and notification mechanisms as separate functions [7]–[23], The proposed system directly links these functions to dental care activities. Specifically, the integration of BOM and FIFO associates treatment registration with stock reduction at the batch level, while alerts regarding stock depletion and expiration provide complementary monitoring for potential stockouts and expiration risks. Therefore, the primary contribution of this research lies in integrating these mechanisms into a unified dental inventory workflow, rather than in introducing new FIFO, BOM, or Moving Average algorithms.

4. CONCLUSIONS

This study successfully designed and developed a web-based inventory management and treatment automation system for Dental Clinic using the Waterfall Software Development Life Cycle (SDLC) model. The developed system integrates inventory management, procurement, treatment registration, inventory depletion alerts, expired inventory monitoring, and multi-channel notification services within a single platform.

Implementing a Bill of Materials (BOM) mechanism enables automated inventory reduction based on handling activities, while the First-In-First-Out (FIFO) method supports the systematic use of inventory batches and enhances traceability. Furthermore, inventory reduction alerts based on a 7-day moving average, alongside features for monitoring expiration dates and slow-moving items, facilitate proactive inventory management by providing early warnings regarding potential stockouts and inventory-related risks.

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Evaluation results indicate that the proposed system supports the automation of inventory management processes. Simulations of inventory recording demonstrate that the treatment-based automation mechanism reduces operational procedures from approximately 5–25 steps to just 1–3 steps and shortens recording time from 1–3 minutes to around 5–15 seconds. Furthermore, Black Box testing confirms that all system functionalities operate according to established requirements, while User Acceptance Testing (UAT) involving seven respondents yielded a score of 88.57%, indicating a high level of user acceptance and the system's suitability for daily operational use.

Future research could focus on integrating financial management features, evaluating inventory reduction estimates using more extensive historical consumption data, implementing advanced forecasting techniques, and evolving the platform into a comprehensive clinic management system or an Enterprise Resource Planning (ERP) system to support broader healthcare operational processes.

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