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Research Article

Design and Implementation of Health Supplies Inventory Monitoring System Using First Expired First Out Method

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Abstract:

The manual management of health supplies inventory by pharmacists at UPTD Puskesmas Toari, Southeast Sulawesi, poses a challenge in monitoring the stock of health supplies due to the manual recording, resulting in less effective monitoring of the inventory. This study aims to design a monitoring system for health supplies inventory using the First Expired First Out (FEFO) method. The FEFO method is suitable for managing the dispensing of health supplies that are closest to their expiration date by utilizing them first to avoid any expired supplies being consumed. The development of this health supplies inventory monitoring system will utilize the waterfall method, consisting of five stages: Requirement Analysis, Design, Implementation, Testing, and Maintenance. The system will be web-based, providing efficient management of health supplies inventory, including medications, disposable medical materials (BMHP), and medical equipment, while also providing timely and accurate information. The research findings indicate that the system can effectively monitor the health supplies inventory at the UPTD Puskesmas Toari Pharmacy Warehouse, utilizing the FEFO method to prioritize the dispensing of health supplies with the nearest expiration date. The system also includes a notification feature to inform the need for immediate dispensing of health supplies. Questionnaire results showed that respondents agreed with the implementation of the monitoring system at the UPTD Puskesmas Toari Pharmacy Warehouse.

Keywords: Sistem Monitoring, *Persediaan*, First Expired First Out (FEFO), *Pengelolaan Persediaan*.
Dataset link*:*

1. Introduction

In today's Information and Communication Technology (ICT) era, knowledge grows and develops rapidly. The globalization era becomes tangible when digital accessibility is readily available worldwide. Given the current development of digital services, technology offers numerous advantages that simplify complex tasks. One of the implementations of technology is monitoring systems [1]-[5]. A monitoring system enables real-time remote monitoring. It can also be utilized to monitor the inventory of health supplies at institutions such as Puskesmas.

Puskesmas serves as a health service facility, acting as a healthcare center for communities in specific areas. UPTD Puskesmas Toari, located in Ranojaya Village, Toari District, Kolaka Regency, Southeast Sulawesi Province, plays a crucial role in providing healthcare services to the residents in the Toari area. One of its responsibilities is to provide health supplies, including medications, disposable medical materials (BMHP), and medical equipment, to the Toari community seeking medical treatment.

Currently, the management of health supplies inventory is done manually by the pharmacist. The data recording for the incoming and outgoing medications and BMHP is recorded in a ledger, while the inventory data of medical equipment is recorded in Microsoft Word. Although this process may seem straightforward, the management of health supplies inventory in the warehouse becomes suboptimal. It can lead to errors in

recording incoming and outgoing health supplies in the warehouse. To address this issue, a computer-based monitoring system is required. The appropriate method based on the above issue is the First Expired First Out (FEFO) method.

The First Expired First Out (FEFO) method is suitable for managing the dispensing of health supplies with the nearest expiration date in the warehouse. It utilizes the health supplies that are closest to expiration before others [6], [7], [8]. By using the FEFO method, the inventory of health supplies can be controlled based on their approaching expiration dates, while medical equipment calibration can be done directly through notifications from the system. This approach increases the efficiency of pharmacists in managing health supplies inventory at the UPTD Puskesmas Toari Pharmacy Warehouse.

Previous research, such as the "Design of Drug Inventory System Using the FEFO Method," found that the system can request assets, process drugs, and generate reports on drug inventory [9]. Another study, "Design of Health Equipment Inventory Information System Using the FEFO Method," resulted in a system that facilitates effective inputting of incoming and outgoing equipment based on their expiration dates and minimizes input errors [8].

Based on the aforementioned issues, the author conducted a research with the title "Design and Implementation of Health Supplies Inventory Monitoring System Using First Expired First Out Method." This application is web-based, implementing the FEFO method to assist pharmacists in controlling health supplies inventory in the warehouse. Additionally, the head of the Puskesmas can coordinate real-time health management to achieve health development goals. The system incorporates a notification feature for pharmacists to remind them of the need for equipment calibration.

2. Method

Metode Waterfall

Waterfall Method is a technique used in software development to provide stages in an orderly manner according to the conditions in the UPTD Puskesmas Toari warehouse [1], [10]. The stages of the waterfall method are as follows **Figure 1**:

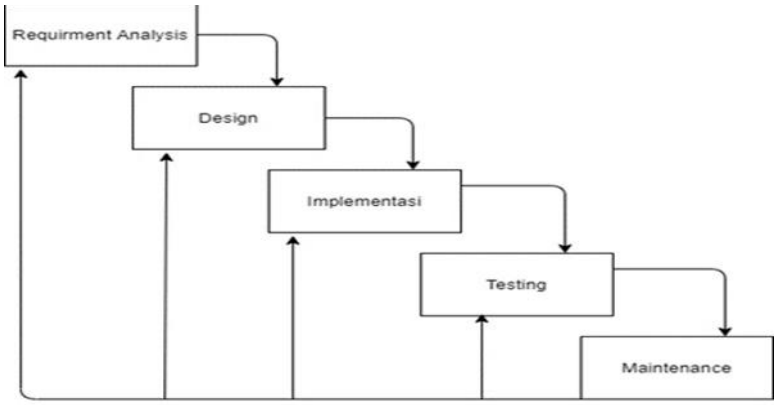

Figure 1. Software Development Using the Waterfall Method

1. Requirement Analysis:

   In this stage, the author conducted interviews with pharmacists and analyzed the problems faced by them in managing health supplies data.

2. Design:

   In this stage, the author designed the system based on the information obtained from the interviews with pharmacists. The system design utilized use case diagrams, activity diagrams, and class diagrams to illustrate the interaction between users and the designed system. The user interface and user experience design were created using Adobe Illustrator to provide users with an understanding of the system before proceeding to the source code development.

3. Implementation:
   In this stage, coding was done using PHP (Hypertext Preprocessor) and JavaScript programming languages, along with CodeIgniter Framework version 3. This resulted in a system equivalent to the previously designed system in the design stage [11].

4. Testing:
   In this stage, the system underwent black box testing [12] to determine the quality of the system being tested.

5. Maintenance:
   In this stage, maintenance activities were carried out to address any issues encountered during the operation of the monitoring system [13].

First Expired First Out (FEFO) Method

First Expired First Out (FEFO) method is a technique used to prioritize the dispensing of health supplies, specifically medications and disposable medical materials (BMHP), that are nearing their expiration dates in the UPTD Puskesmas Toari Warehouse. This approach minimizes health supplies nearing expiration and enhances the system's efficiency in real-world applications. The implementation of the First Expired First Out method for dispensing health supplies can be seen in **Figure 2** below:

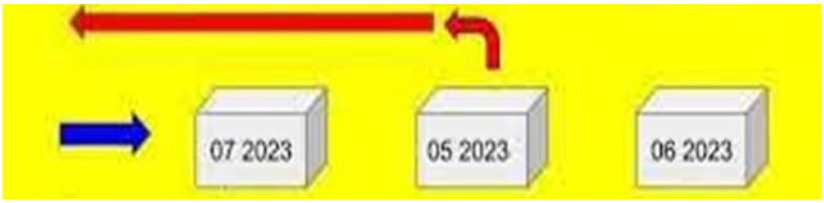

Figure 2. Implementation of Outbound Goods Using the First Expired First Out (FEFO) Method

Figure 2. The FEFO method prioritizes health supplies that are nearing expiration, and those items will be used or taken out first.

System Design

1) *Use Case Diagram*

The Use Case Diagram is a system representation that outlines the interactions between actors and the monitoring system [14]. The form of the use case diagram in describing the actors with the monitoring system can be seen in **Figure 3**:

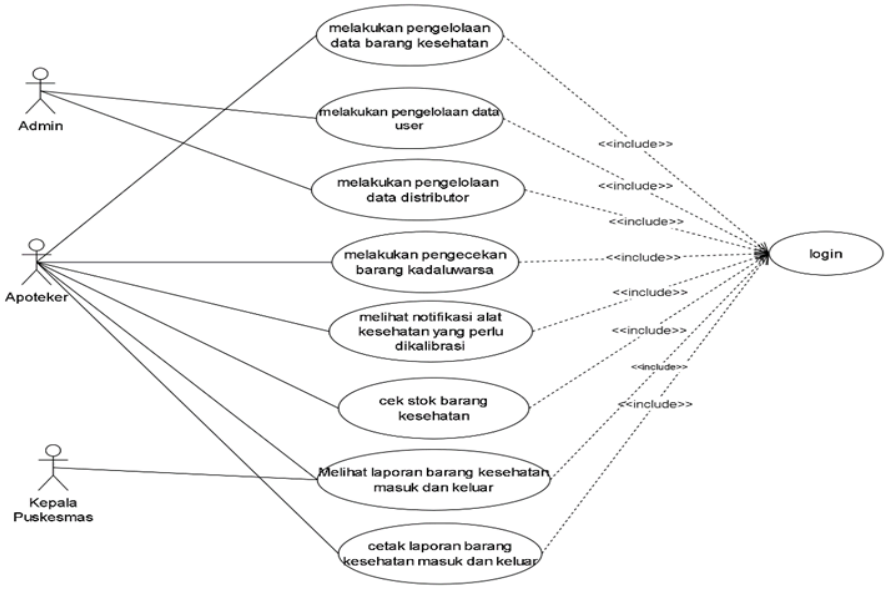

Figure 3. Proposed System Use Case Diagram

In **Figure 3**, the Use Case Diagram of the Proposed System describes the monitoring system with 3 actors: Admin, Pharmacist, and Head of Puskesmas. The Admin acts to manage user data and

distributor data. The Pharmacist, after logging in, is responsible for managing health supplies data, checking for expired items, viewing notifications for equipment calibration, checking health supplies inventory, viewing incoming and outgoing health supplies reports, and generating health supplies reports. The Head of Puskesmas acts to view the incoming and outgoing health supplies reports within the system.

2) *Activity Diagram*

The Activity Diagram is a model diagram that describes the procedures occurring in the health supplies inventory monitoring system at the UPTD Puskesmas Toari Warehouse.

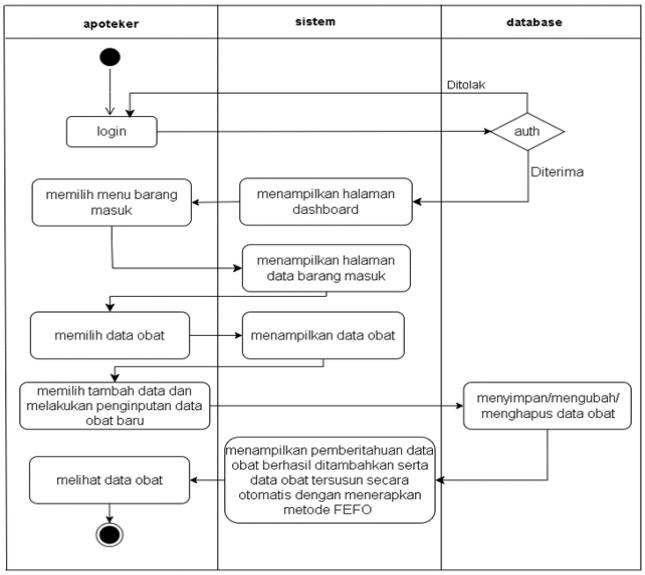

Figure 4. Activity Diagram for Managing Incoming Medicine in the Warehouse

In Figure 4, it describes the procedure for managing incoming medications in the warehouse. The Pharmacist enters data for newly arrived medications into the system. Then, the medication arrangement process follows the First Expired First Out method, where the system automatically prioritizes medications based on their nearest expiration date.

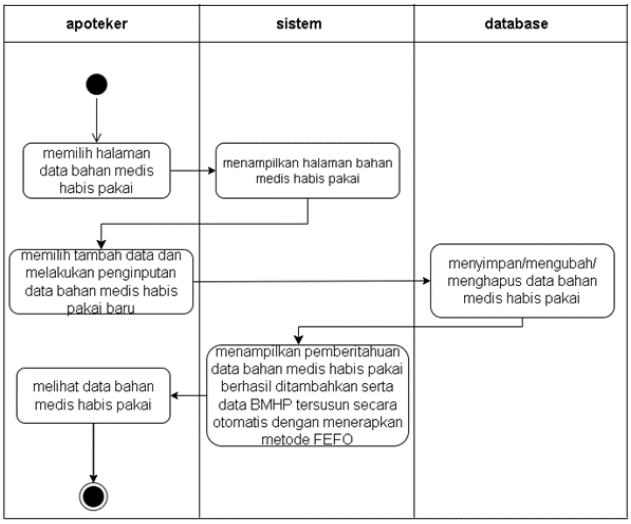

Figure 5. Activity Diagram for Managing Incoming Medical Consumables (BMHP) in the Warehouse

In Figure 5, it represents an activity diagram describing the procedure for managing incoming disposable medical materials (BMHP) in the warehouse. The Pharmacist enters data for newly arrived BMHP into the system. The BMHP arrangement process follows the First Expired First Out method, where the system automatically prioritizes BMHP based on their closest expiration date.

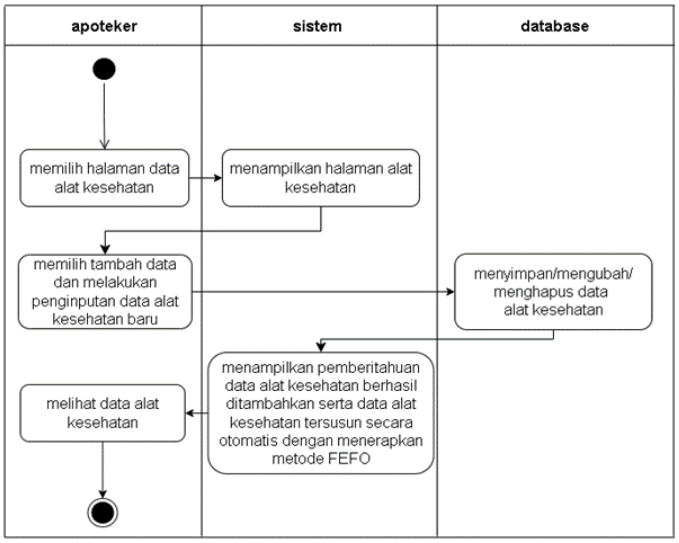

Figure 6. Activity Diagram for Managing Incoming Health Equipment in the Room

In Figure 6, it illustrates an activity diagram describing the procedure for managing incoming medical equipment in each room. The Pharmacist enters data for newly arrived medical equipment into the system. The medical equipment arrangement process follows the First Expired First Out method, where the system automatically prioritizes medical equipment based on their calibration schedule that is closer.

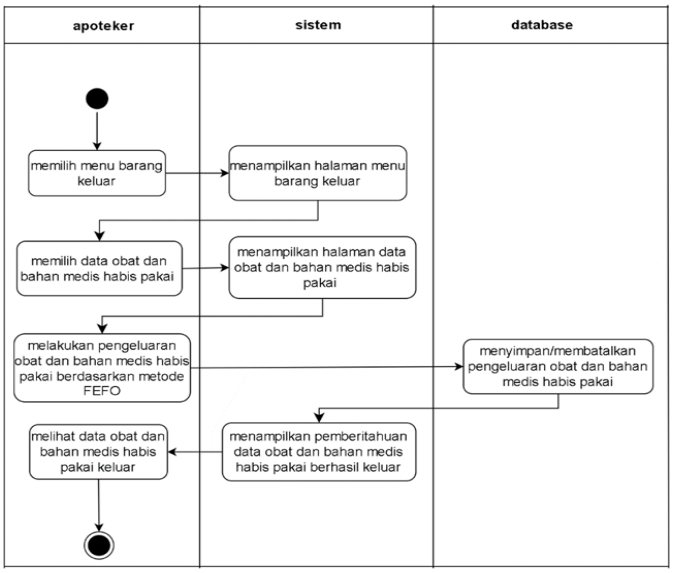

Figure 7. Activity Diagram for Outbound Medicine and Medical Consumables (BMHP) Using the FEFO Method

In Figure 7, it illustrates an activity diagram describing the procedure for dispensing health supplies, including medications and BMHP, from the warehouse using the First Expired First Out (FEFO) method.

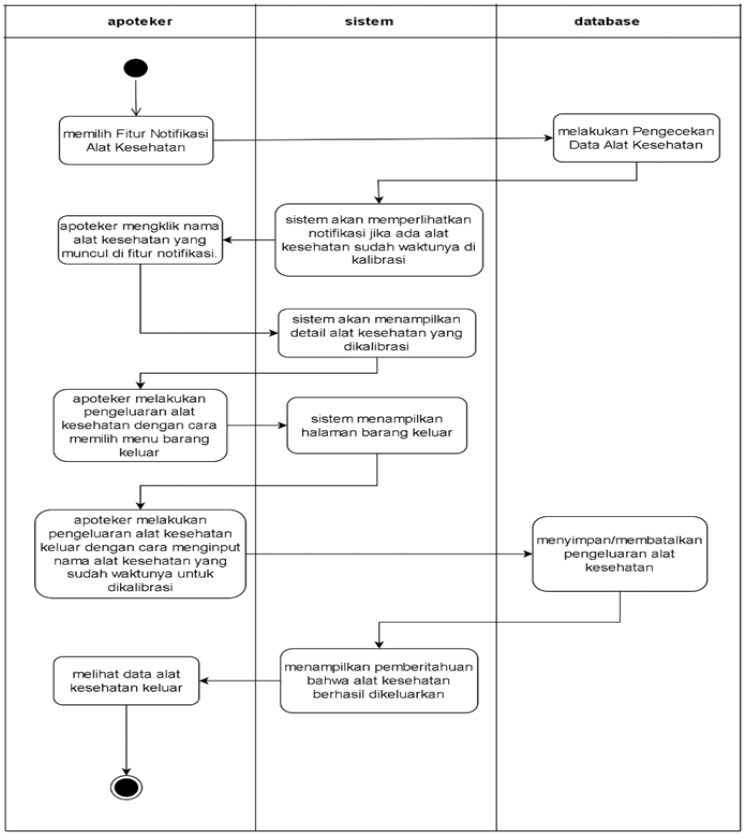

Figure 8. Activity Diagram for Outbound Health Equipment

In Figure 8, it represents an activity diagram describing the procedure for dispensing medical equipment based on the appearance of notifications for equipment calibration to the Health Department.

3) *Class Diagram*

The Class Diagram is a type of diagram that describes the structure of each object with its attributes.

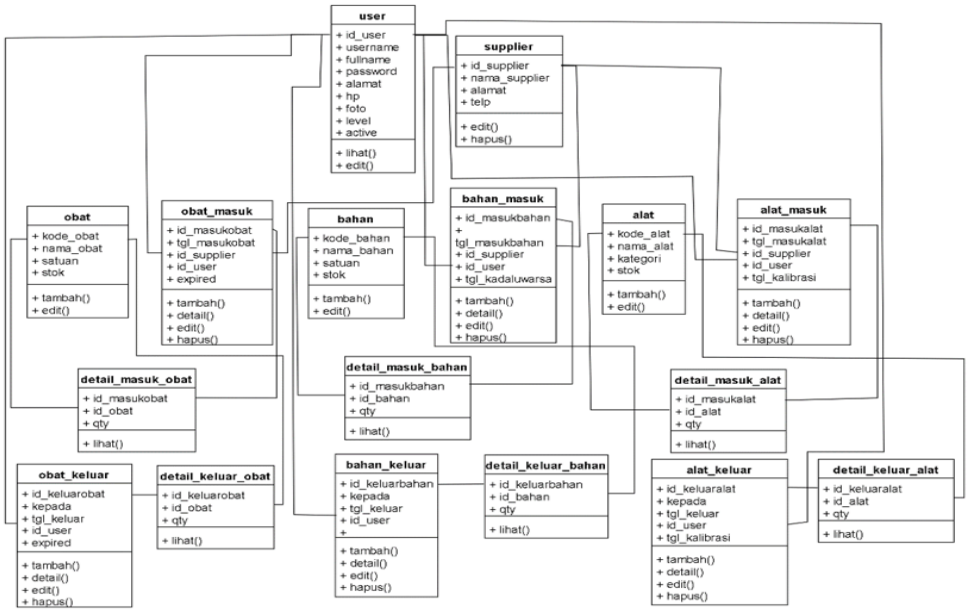

Figure 9. Class Diagram for Health Supplies Monitoring System

In Figure 9, it represents the class diagram of the health supplies inventory monitoring system, which is used for structural modeling [15]. Therefore, the design of this monitoring system employs the First Expired First Out method to prioritize the expiration of each health supply in the warehouse, starting from those nearing expiration to those with a longer expiration period. The health supplies

referred to here include medications and disposable medical materials (BMHP) available at the UPTD Puskesmas Toari Warehouse.

3. Results and Disscusion

Research Findings

The following are the results of the conducted research after the implementation of the health supplies inventory monitoring system at UPTD Puskesmas Toari:

1) Halaman Login Sistem Mnonitoring

Figure 10. Login Page

In Figure 10, it shows the first page for accessing the health supplies inventory monitoring system. This page can be accessed by administrators, pharmacists, and head of the Puskesmas.

2) Tampilan Notifikasi Alat Kesehatan di Kalibrasi

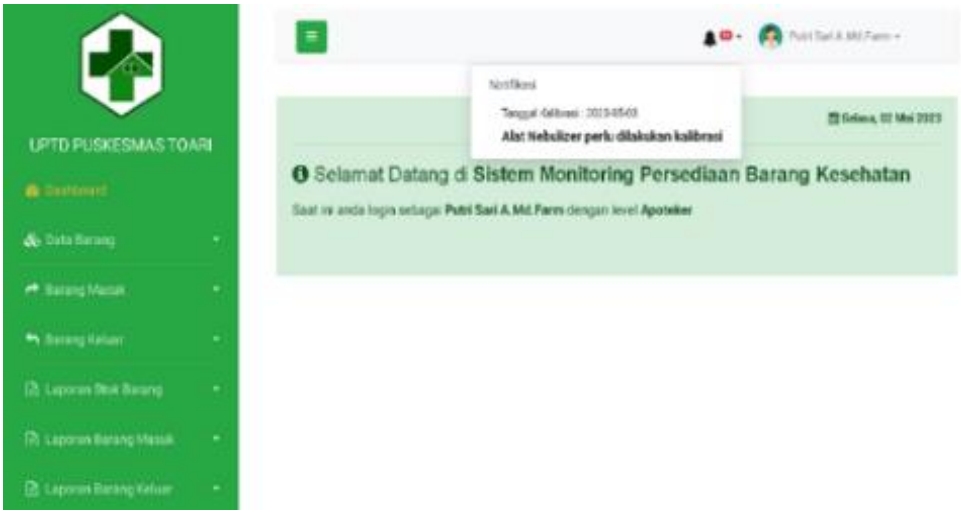

Figure 11. Notification Display for Health Equipment Calibration

Figure 11 represents a notification regarding the need for calibration of a health equipment named Nebulizer to the Health Department. This notification appears one day (H-1) before the scheduled calibration of the health equipment. This page can be accessed by pharmacist.

3) Tampilan Data Barang Kesehatan Masuk

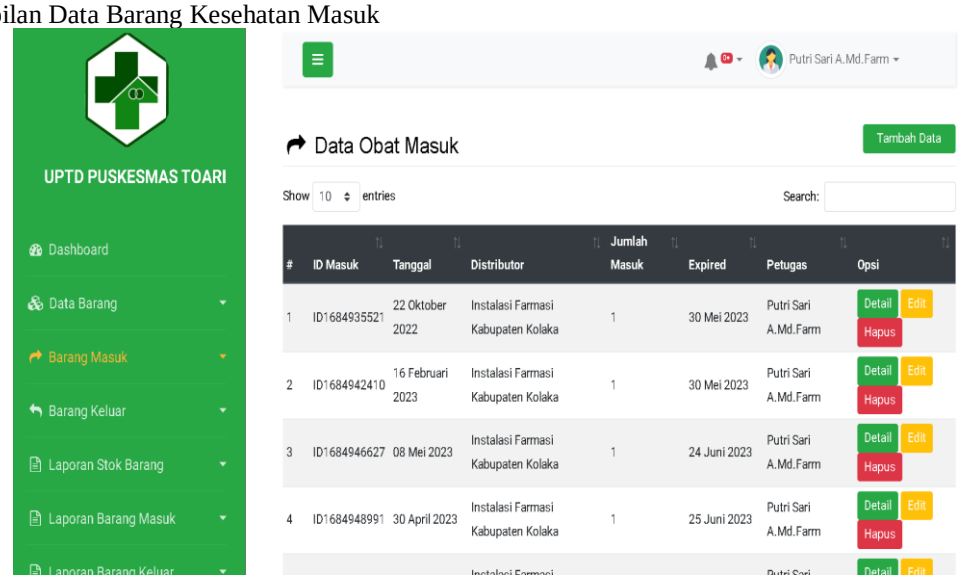

Figure 12. Display of Incoming Medicine in the Warehouse

Figure 12 displays the data of medications received in the warehouse. It also includes menus for the arrival of disposable medical materials (BMHP) and health equipment, which follows the First Expired First Out (FEFO) method. The pharmacist inputs data of newly received medications and BMHP from the District Pharmacy Installation, while health equipment is obtained from the Health Department. The details of the received health supplies can be viewed in the detail menu to get comprehensive information. This page can be accessed by pharmacists.

4) Tampilan Data Barang Kesehatan Keluar

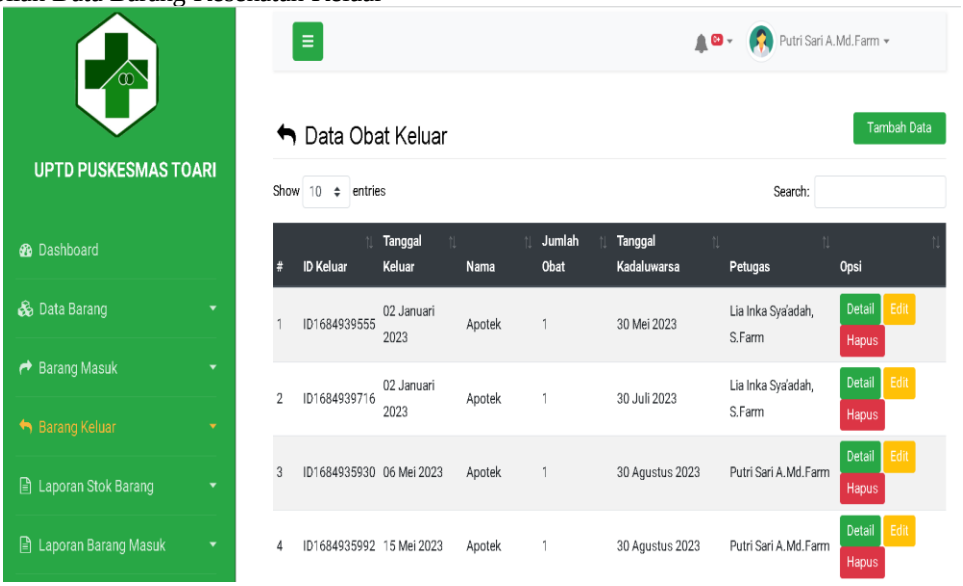

Figure 13. Display of Outgoing Medicine Data in the Warehouse

Figure 13 presents the data of medications taken out from the warehouse. It also includes menus for the removal of disposable medical materials (BMHP) and health equipment, following the First Expired First Out (FEFO) method. The pharmacist enters the names of the medications and BMHP that are taken out from the warehouse, while health equipment is removed based on the H-1 notification in the monitoring system. This notification is intended for the pharmacist to prepare the health equipment for calibration to the Health Department. This page can be accessed by pharmacists.

5) Tampilan Laporan Stok Barang Bulanan

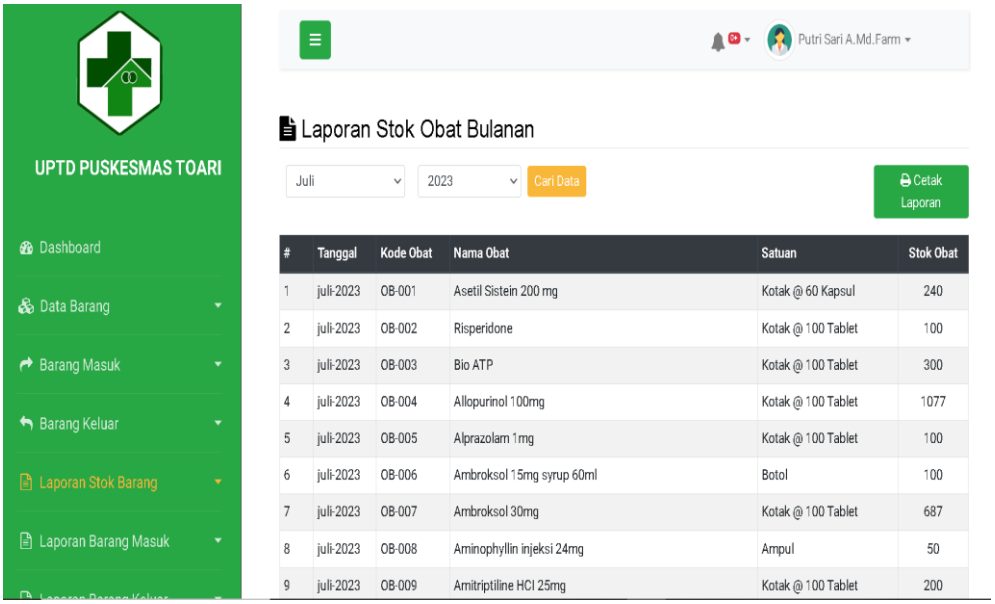

Figure 14. Monthly Stock Report Display for Medicines

Figure 14 shows the monthly drug stock report for July 2023. It also includes menus for BMHP stock and monthly health equipment stock. There is a print report menu if the pharmacist wishes to print the report for July 2023. This page can be viewed by pharmacists.

6) Tampilan Laporan Bulanan Barang Kesehatan Masuk

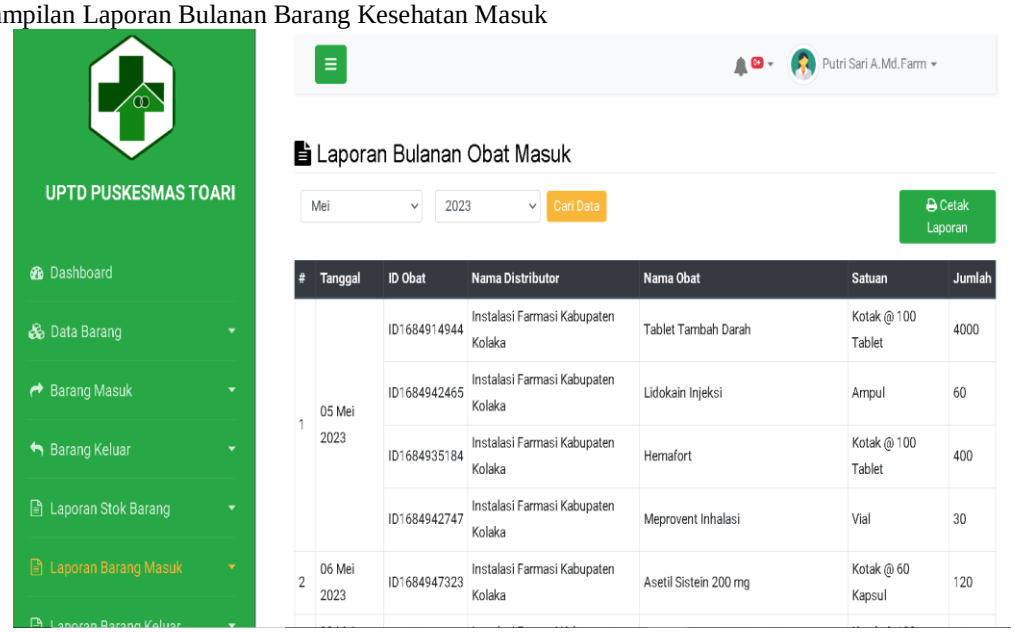

Figure 15. Monthly Report Display for Incoming Medicines

Figure 15 displays the monthly report of medications received in May 2023. It also includes menus for monthly BMHP report and health equipment report. There is a print report menu if the pharmacist or head of the Puskesmas wishes to print the report for May 2023. This page can be accessed by pharmacists and the head of the Puskesmas.

7) Halaman Laporan Bulanan Barang Kesehatan Keluar

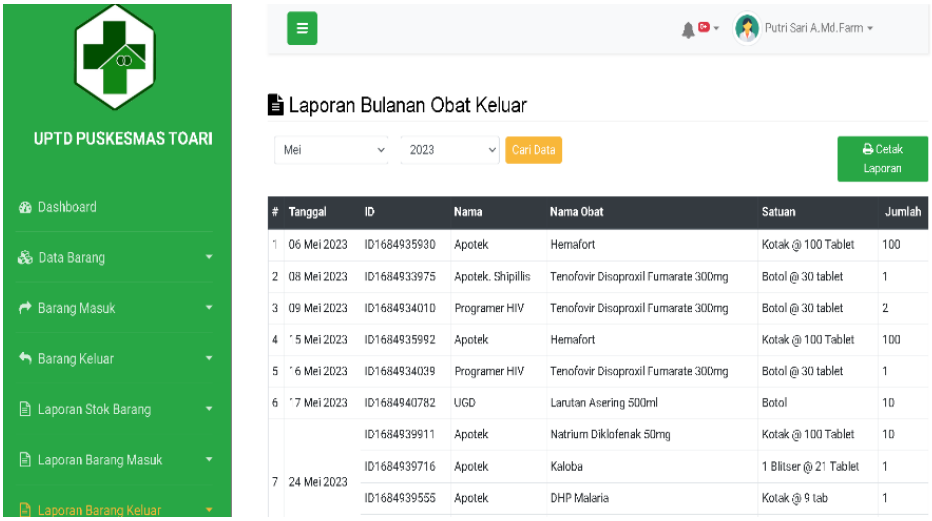

Figure 16. Monthly Report Page for Outgoing Medicines

Figure 16 presents the list of names of disposable medical materials taken out in May 2023. It also includes menus for the monthly BMHP report and health equipment report. There is a print report menu if the pharmacist or head of the Puskesmas wishes to print the report for May 2023. This page can be accessed by pharmacists and the head of the Puskesmas

Discussion

There are three discussions: the system, the method, and the notifications. Firstly, the system discussion describes the advantages of this created system. Secondly, the method discussion focuses on the used method for managing health supplies inventory, which is the First Expired First Out (FEFO) method. This method prioritizes the retrieval of health supplies nearing expiration, with them being the first ones to be taken out. Thirdly, the notifications in the system aim to remind pharmacists about the need for equipment calibration.

1. Discussion on Monitoring System
   This system is intended to assist pharmacists at UPTD Puskesmas Toari in addressing the issue of the lack of a system capable of managing health supplies inventory. The system underwent blackbox testing during its development.
2. Discussion on the Used Method
   Based on the author's knowledge and literature review, the First Expired First Out (FEFO) method is suitable for monitoring health supplies inventory at the warehouse of UPTD Puskesmas Toari. The implementation of FEFO in the system prioritizes items nearing their expiration date. Additionally, the inbound and outbound processes of health supplies also adhere to the FEFO method. Thus, when pharmacists need to retrieve health supplies from the pharmacy warehouse, they can take out those items that are nearing expiration, including medicines and BMHP, to enhance their work efficiency. Furthermore, for the development of the health supplies monitoring system, the waterfall method is employed. The waterfall method encompasses five stages: Requirement Analysis, Design, Implementation, Testing, and Maintenance. In this study, two methods were used for the health supplies monitoring system at UPTD Puskesmas Toari.
3. Discussion on Notifications
   Notifications are implemented for health equipment at UPTD Puskesmas Toari. The purpose of these notifications is to assist pharmacists in providing information that certain health equipment in the room at UPTD Puskesmas Toari requires calibration at the Health Department.

4. Conclusion

Based on the discussions presented above, the author concludes that the implementation of the health supplies inventory monitoring system at Gudang Farmasi UPTD Puskesmas Toari, with its prioritization of health supplies nearing expiration using the FEFO method, has proven beneficial for the pharmacists. This system helps in managing health supplies inventory efficiently. The system incorporates notifications for health equipment as reminders about the need for calibration to the Health Department. The web-based monitoring

system, developed using the waterfall method, minimizes potential errors during its operation. With this system in place, pharmacists at Gudang Farmasi UPTD Puskesmas Toari can access real-time information about health supplies stock in the warehouse, view the calibration schedule for health equipment through the notifications, and track all incoming and outgoing health supplies at the warehouse, thus enhancing the efficiency of pharmacists' work at UPTD Puskesmas Toari.

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