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MediStock: Medical Stock Website Development Using Design Thinking

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Abstract
Pharmacies play a vital role in public health by ensuring the availability of essential medications. However, inefficient inventory management systems, particularly in Malang, lead to operational inefficiencies, stock discrepancies, and regulatory compliance challenges. This study aims to develop a web-based inventory management system, MediStock, using the Design Thinking methodology to address these issues effectively. The research employs a human-centered approach, focusing on user needs and experiences through the stages of empathize, define, ideate, prototype, and testing. The system integrates real-time stock monitoring, predictive analytics, and compliance with electronic medical records, enhancing operational efficiency and regulatory adherence. Results indicate that MediStock significantly improves inventory management by minimizing stock discrepancies, optimizing procurement processes, and ensuring real-time visibility of medicine stocks. The heuristic evaluation revealed high usability and adaptability among different user groups, confirming the system's effectiveness and the user-centered design. These findings highlight the potential of Design Thinking to bridge the gap between complex technological solutions and user needs in healthcare inventory management. This study contributes to the field by providing an innovative, user-friendly inventory management solution that enhances operational efficiency and regulatory compliance. Future research should explore the scalability of the system and its integration with broader healthcare management systems to maximize its impact on the healthcare sector.

1. Introduction

Pharmacies play a crucial role in public health by supplying essential medications to the population, ensuring accessibility and safety in medicine distribution [1]. Efficient medicine inventory management is fundamental to maintaining this role, as it prevents shortages, reduces waste, and ensures that medications are readily available when needed. Despite its importance, many pharmacies continue to rely on traditional, non-computerized inventory systems, leading to inefficiencies, increased operational costs, and higher risks of stock outs or overstock situations [2]. In Malang, Indonesia, pharmacies still use manual recording methods, including paper-based logs and books for stock management, procurement, and reporting. This traditional approach is prone to human error, time-consuming, and unable to provide real-time inventory visibility, hindering effective decision-making and operational efficiency [3] .

National regulations further underscore the significance of inventory management in pharmacies. According to Indonesia's Minister of Health Regulation Number 24 of 2022, health service facilities, including pharmacies, must implement electronic systems for medical record management, including medicine inventory tracking. This regulatory requirement is intended to enhance accuracy, standardization, and compliance across health service operations. However, most pharmacies are unprepared to transition to electronic inventory systems due to the lack of integrated and efficient technological solutions tailored to their needs [4] . Consequently, there is an urgent need for innovative, user-centric inventory management solutions that not only comply with regulatory standards but also enhance operational efficiency.

Inventory management challenges in pharmacies do not only occur in Indonesia. Globally, inefficient inventory systems in pharmacies result in significant financial losses and impact service quality [5] . Studies show that manual stock recording is highly susceptible to errors, leading to inaccurate inventory counts, discrepancies of stock, and delays in procurement [6] . These inefficiencies contribute to stock shortages, which impact the availability of essential medicines and compromise patient care. Moreover, the absence of real-time inventory tracking hinders pharmacies from optimizing stock levels, leading to either excess stock—causing expiration and wastage—or shortages that disrupt the supply chain and affect customer satisfaction [7] .

To address these issues, various technological solutions have been proposed. General approaches to improving inventory management include the use of computerized systems, inventory management software, and cloud-based platforms that facilitate real-time stock monitoring and data analytics [8]. These solutions enable pharmacies to automate stock recording, streamline procurement processes, and enhance decision-making through accurate data insights. However, despite their advantages, many of these systems are either too complex or too costly to be implemented effectively by small to medium-sized pharmacies.

Design Thinking has emerged as a promising approach for developing user-centric technological solutions tailored to specific needs. Design Thinking is a human-centered method that emphasizes empathy, ideation, prototyping, and

testing to solve complex problems creatively and effectively [9]. By focusing on user needs and experiences, Design Thinking facilitates the development of intuitive and accessible systems, ensuring high user adoption and satisfaction. Recent studies have demonstrated the effectiveness of Design Thinking in developing inventory management systems, customer relationship management (CRM) tools, and user interfaces for various applications [10]. These studies highlight the potential of Design Thinking to bridge the gap between complex technological solutions and user needs by creating practical, easy-to-use applications.

Prior research has successfully applied Design Thinking to inventory management and related fields. For example, Design Thinking has been used to develop inventory systems for small and medium enterprises (SMEs), enhancing operational efficiency and reducing stock discrepancies [11]. Another study applied Design Thinking to create a CRM system with an intuitive user interface, significantly improving user engagement and decision-making processes [12]. These applications demonstrate the versatility and effectiveness of Design Thinking in creating systems that are not only functional but also user-friendly and adaptable to various operational contexts.

Despite these advancements, there remains a gap in the application of Design Thinking for pharmacy inventory management, particularly in integrating regulatory compliance with operational efficiency. Although previous studies has explored Design Thinking for inventory systems, they often focus on general inventory management without addressing the specific needs and challenges of pharmacies, such as integration with electronic medical records and compliance with health regulations [13]. Moreover, existing solutions lack features that provide real-time stock visibility, predictive analytics, and seamless integration with supply chain systems, limiting their effectiveness in dynamic and highly regulated healthcare environments.

This study aims to address these gaps by developing a web-based inventory management system for pharmacies using the Design Thinking methodology. The system, named MediStock, is designed to provide real-time stock monitoring, predictive analytics, and integration with electronic medical records to ensure compliance with PMK Number 24 of 2022. The novelty of this study lies in its user-centric approach, using Design Thinking to create an intuitive and efficient system tailored specifically for pharmacies. By focusing on regulatory compliance, operational efficiency, and user experience, this study contributes to the advancement of inventory management systems in the healthcare sector. The scope of this study includes system design, prototyping, and heuristic evaluation to assess usability and effectiveness, ensuring that the developed solution meets the needs of diverse pharmacy stakeholders.

2. Research Method

The steps in Design Thinking serve as the foundation for the research method employed in this study. One concept from a human-centered, human-based approach is design thinking. This strategy can implement technology, meet user needs, and make things simple for users [11]. Existing issues, like improving user experience and making it simpler for consumers to use developed prototypes, can be resolved with Design Thinking [12]. The advantage of design thinking is the people-oriented approach, so that collaboration arises between stakeholders as users and designers [14]. Because Design Thinking is a solution-based approach to problem-solving that solely considers the user's recurring experience, it was selected.

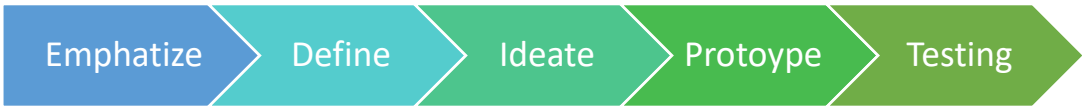

Figure 1. Research Framework based on Design Thinking [15]

Figure 1 show the phases of Design Thinking. This method itself has 5 stages, namely: empathize is the stage where we understand the emotions and feelings of the user. Through this stage, we can feel how someone's emotions and feelings are from various aspect. Define is the stage where we get the view of the user. in order for us to comprehend consumer demands through personas [13]. One example of this stage is the creation of personas as the foundation for apps. The ideate stage is where we come up with concepts that will serve as the foundation for prototypes. The prototype phase uses the minimum viable product (MVP), which focuses on creating the key characteristics of the persona [16].

Creating user flows is one example of this step. Prototyping is the process of incorporating ideas from the previous step into a finished product or prototype that is prepared for the final step. Testing is where we test our product or prototype on users with predefined scenarios to determine whether the created product is feasible [17]. The researchers chose heuristic evaluation as the test method because it can identify design issues early on and can be used in parallel with other evaluation models [18].

3. Results and Discussion

3.1 Emphathize

One technique for examining the requirements at the empathy stage is observation. Observation results show that many pharmacies face various challenges in managing drug stock. One of the main problems is the use of manual processes that are inefficient and prone to recording errors, making it difficult for pharmacies to monitor medicine stock in real time. Lack of visibility in the supply chain causes delays in drug procurement, increases the risk of stock shortages when demand is high, or even excess stock that has the potential to cause damage and expiration.

In addition, pharmacies experience increased operational costs due to these inefficiencies, especially in terms of stock management and medicine storage. The lack of application of modern technology worsens the situation because many pharmacies still use traditional methods. Another challenge is the need for system integration with electronic medical records as regulated in PMK Number 24 of 2022, which further emphasizes the urgency of implementing technology-based solutions to support efficient and regulatory medicine stock management.

3.2 Define

The researchers examine and comprehends the issues gathered in the preceding step during this phase. From the needs in the empathy step, the define stage generates "how might we" in order for the researchers to ascertain the essential requirements for designing the application. Pharmacies experience major problems in managing drug stock, namely the inability to monitor stock in real time, minimal visibility into the supply chain, and high risk of recording errors. This has an impact on procurement delays, stock shortages, excess stock, and increased operational costs. Another challenge faced is the lack of integration with the electronic medical record system, which is an urgent need according to PMK Number 24 of 2022. For this reason, efficient technology-based solutions that can be integrated with other systems are needed to overcome this problem.

3.3 Ideate

Several key characteristics that are well-thought-out are part of the suggested solution to the issues with controlling medicine supplies in pharmacies. First, visualization of stock data and prediction of medicine need are the goals of implementing the Analytical Dashboard. This feature serves as a tool to help make more strategic and accurate data-based decisions. The second is the creation of a Real-Time Stock Management System, which uses a web-based platform, enables immediate drug stock monitoring. To increase stock management efficiency, this system has tools for medicine histories and automatic recording. Third, the purpose of the Stock Notifications and Alerts is to provide pharmacies with up-to-date information on expired drugs, supplies that are running low, and procurement needs so they can manage the availability of medicines better. Last but not least, the creation of the Supply Chain Tracking System contributes to improving the supply chain's efficiency and transparency by keeping an eye on suppliers' medicine availability and guaranteeing prompt delivery procedures.

3.4 Prototype

A number of key elements are combined into the prototype, which was created to solve the issue of managing medicine inventories in pharmacies. Illustrations are included with every component to give a better understanding of how it is used.

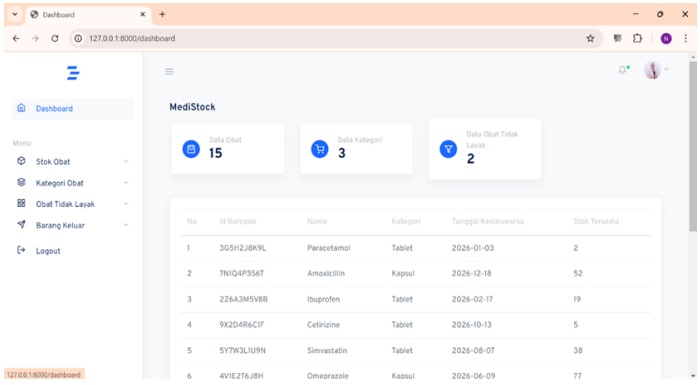

Figure 2. Main interface

As the primary display for tracking medicine data, medicine categories, and medications that are unsafe for ingestion, the Dashboard is the first component of this prototype. Users can easily obtain information about medicine stocks, categories, and eligibility status directly from this dashboard's overview. Figure 2 shows how this component is implemented.

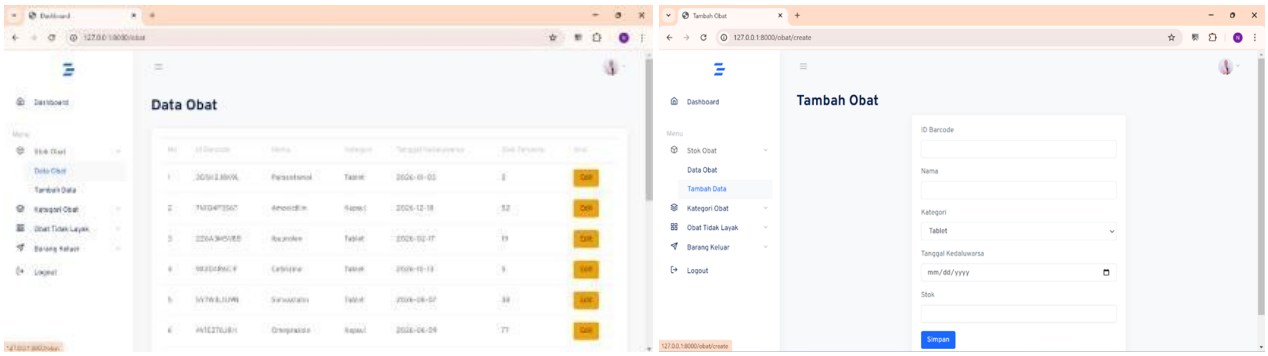

Figure 3. Management drug stock

Furthermore, this prototype provides the ability to Manage Medicine Stock, which allows users to monitor and manage stock in real-time to ensure medicine availability, minimize recording errors, and avoid shortages or excess stock. The implementation of this component can be seen in Figure 3.

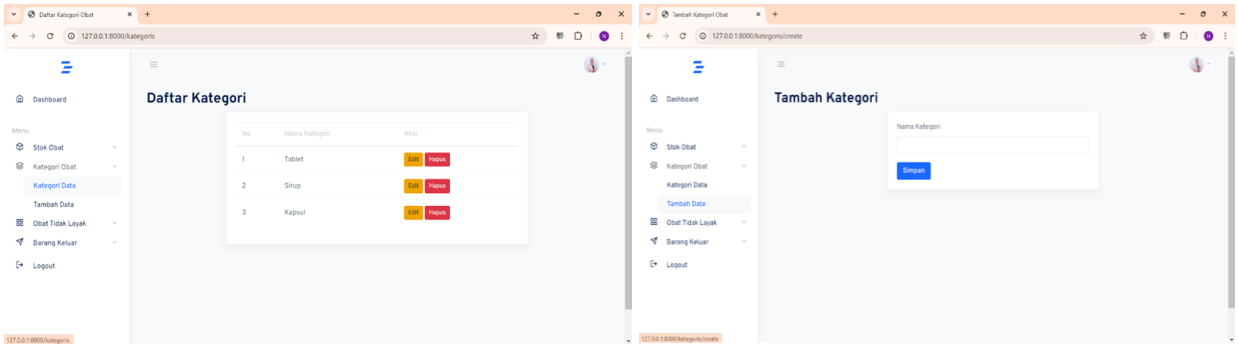

Figure 4. Management drug categories

Additionally, this prototype has a Medicine Category Management component that enables the management of pharmaceuticals by category, such as tablets, syrups, or capsules, making it easier to easily and systematically classify, search, and manage medicine supplies. Figure 4 provides a summary of this element.

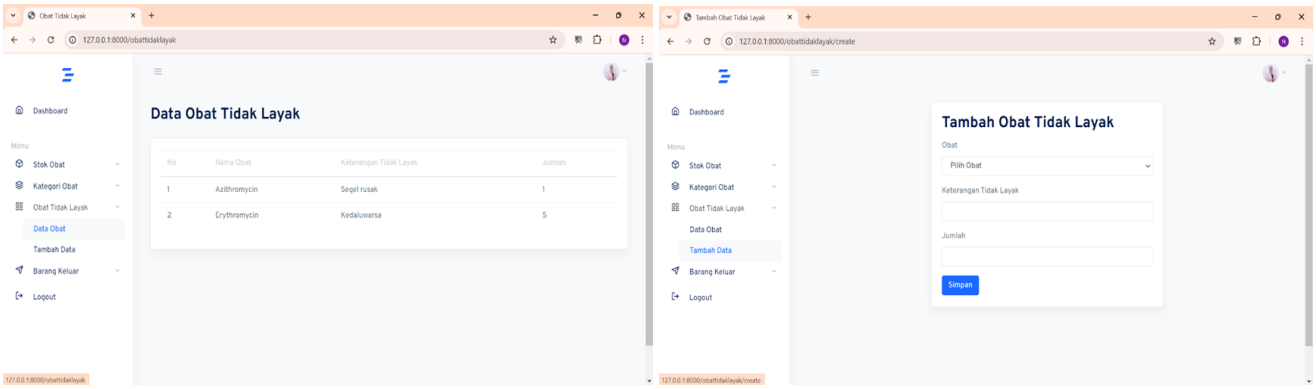

Figure 5. Unusable medicines

To preserve the quality of the medicine stock by methodically documenting and updating status, the Unusable Medication Management component is made to handle medications that are no longer suitable for use, such as damaged or expired medications. Figure 5 illustrates how this component is visualised.

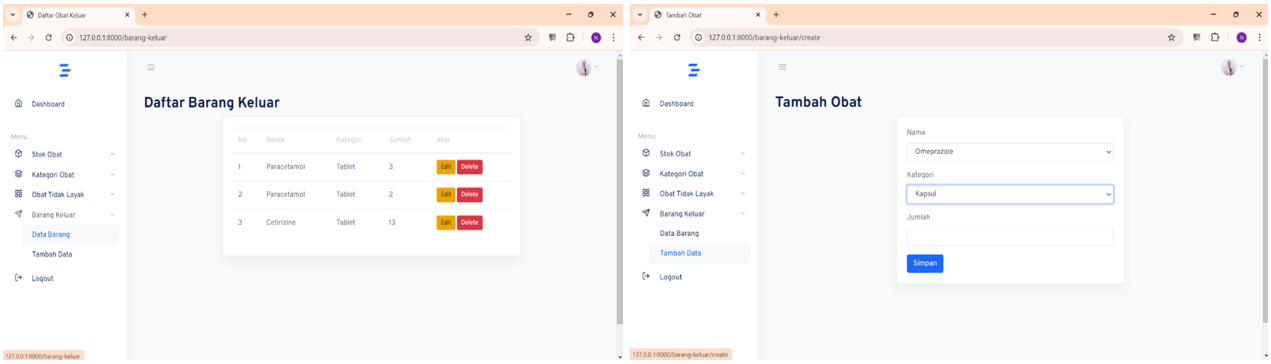

Figure 6. Outgoing Medication Management

Additionally, the Outgoing Medication Management component of the prototype enables the analysis of medication usage patterns for better planning and facilitates recording and tracking of medication distribution for orderly procedures. Figure 6 provides an illustration of this component.

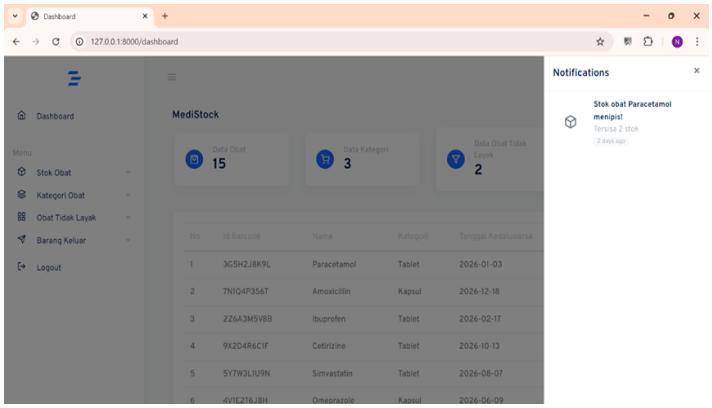

Figure 7. Notification of low medicine stock

In order to avoid stock shortages and guarantee that medications are available when needed, this prototype also has a Minimal Stock Notification component that automatically sounds a warning when the stock falls below the minimal limit. Figure 7 provides more details on this component. This prototype is designed as a comprehensive solution that aims to improve the efficiency, accuracy and quality of medicine stock management in pharmacies.

3.5 Testing

The researchers employ the heuristic evaluation approach throughout the testing process to test an application's appearance or user interface. By measuring a system's degree of use, this evaluation method can identify functional issues with the system's interface design. Based on the evaluation procedure that has been completed, developers can use this evaluation to focus on issues that require attention [19][20]. To ensure that our application has been thoroughly tested and is user-friendly for both pharmacists and the public, who are even less tech-savvy, the researchers recruited testers from a variety of social backgrounds for this test, including IT students, pharmacists, and members of the general public. This is supported by the data in the attached table and graph, which display the percentage data of each value overall and the % data of each inquiry scenario that served as the foundation for evaluating the heuristic evaluation testing method. Table 1 shows that our application received many positive evaluations from the testers, including a score of 5 in which the percentage was 60.01%, a score of 4 in which the percentage was 33.07%, a score of 3 in which the percentage was 7.44%, a score of 2 in which the percentage was 2.32%, and a score of 1 in which the percentage was 1.03%.

Table 1. Heuristic evaluation result

Question	Percentage				
	5	4	3	2	1
Each page has a title that explains the contents of the page	53,3%	40%	6,7%		
Menu and page names already exist according to their contents	60%	33,3%	6,7%		
The icons and schema design on each page are consistent	40%	46,7%	6,7%	6,7%	
The icons used are generally used icons	46,7%	20%	33,3%		
Menu names have been written logically and understood by users	46,7%	40%	6,7%	6,7%	
Matching logo of the application	66,7%	20%	6,7%	6,7%	
Users can access features according to their role	46,7%	53,3%			
If the system has cascading menus/pages, users can easily return to the previous menu/page.	46,7%	40%		6,7%	6,7%
Each page has a title	53,3%	26,7%	13,3%		6,7%
The standard of writing and language on each page is consistent	60%	26,7%	13,3%		
The appearance of the application on each page has the same form and content, and is consistent	60%	33,3%		6,7%	
The text on the instructions is clear and does not cause double meaning (ambiguous)	66,7%	33,3%			
There is an error notification when a system failure occurs	60%	20%	13,3%	6,7%	
Profile is according to role	46,7%	33,3%	20%		
There is a difference between button and text highlight color	53,3%	33,3%	6,7%	6,7%	
Menus and information are well displayed	80%	20%			
Menu groupings and information can be easily rememberes	66,7%	26,7%	6,7%		
There is a helpful navigation on each page	60%	33,3%		6,7%	
Responsive display adapts to smartphone resolution	60%	13,3%	13,3%	6,7%	6,7%
List and table designs are neatly arranged	53,3%	40%	6,7%		
The menu layout is easily accessed by users	60%	40%			
Information is displayed on each page allowing users to make decisions	66,7%	33,3%			
Clear error messages when an error occured	60%	40%			
Makes it easier for users to recognize, diagnose and get out of errors	60%	40%			
There is a clear menu according to the role	66,7%	20%	6,7%		6,7%
There is a logout option	66,7%	20%	13,3%		
When the profile icon is clicked it will display a related menu (such as logout to leave the role)	53,3%	33,3%	13,3%		
Total	**60,01%**	**33,07%**	**7,44%**	**2,32%**	**1,03%**

Referring to Figure 8, the percentage distribution of test results employing heuristic testing on five categories, numbered 1 through 5, is shown in the figure as a pie chart. With a proportion of 58%, category 1 represents the largest portion, followed by category 2 with 32%, which overall covers 90% of the entire data. The percentages for the other three, four, and five categories are significantly lower, at 7%, 2%, and 1%, respectively. The dominance of category 1 and category 2 implies that most of the data in this test is concentrated in these two primary categories, indicating the possibility of substantial difficulties in the areas covered by these categories. Meanwhile, the low percentages in categories 3, 4, and 5 show that more specific or small problems are less common. According to inductive reasoning, this test finds important problems centered on two broad categories that that may have a major impact on overall system performance or user experience.

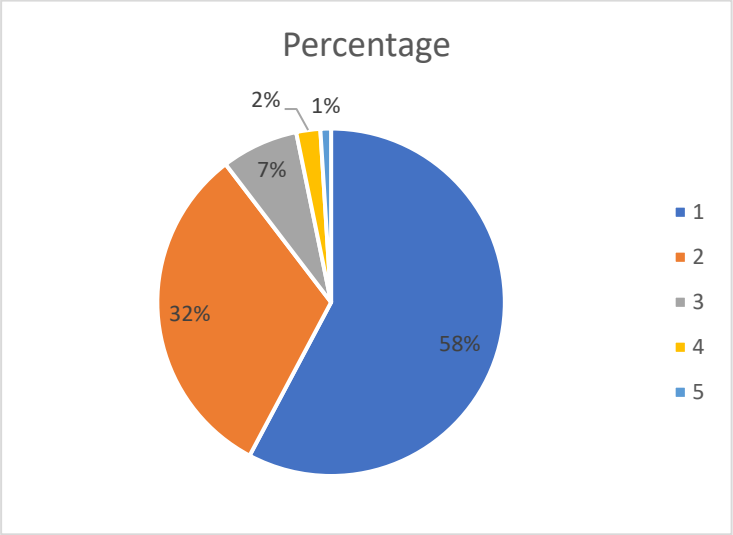

Figure 8. Percentage value graph

4. Conclusion

This study demonstrates the effectiveness of using Design Thinking to develop a web-based inventory management system, MediStock, specifically designed for pharmacies. By integrating real-time stock monitoring, predictive analytics, and electronic medical record compliance, MediStock addresses the operational inefficiencies and regulatory challenges faced by pharmacies, particularly those in Malang. The system enhances decision-making, reduces the risk of stock shortages and overstock situations, and ensures adherence to national health regulations.

The key findings indicate that a user-centric approach, facilitated by Design Thinking, significantly improves usability and operational efficiency in drug inventory management. The heuristic evaluation results showed positive user experiences and high adaptability among diverse user groups, highlighting the system's practicality and effectiveness. These results contribute to the development of knowledge on inventory management systems in healthcare by demonstrating the potential of Design Thinking in creating innovative and easy-to-use solutions.

This study not only advances the field of healthcare technology but also provides a strategic framework for implementing a regulatory-compliant inventory system. Future research should explore the scalability of MediStock in larger healthcare settings and investigate additional features, such as advanced data analytics and integration with broader healthcare management systems.

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