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Optimizing drug inventory application development in pharmacies through agile methodology implementation

Denny Jean Cross Sihombing
Faculty of Engineering, Atma Jaya Catholic University of Indonesia

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ABSTRACT
This research investigates the application of Agile methods in developing drug inventory applications in pharmacies. The problems identified were the complexity of drug stock management, challenges in fulfilling drug requests and dispensing, and the risk of delay and loss of drugs that could compromise the efficiency and accuracy of inventory management. The research method involved comprehensive data collection, application development using the Agile approach, and user acceptance evaluation. The evaluation results showed a user satisfaction rate of 80%, with the application successfully meeting user needs and expectations and functioning key features such as drug stock management, ordering and procurement, and drug expiration tracking. The contribution of this research is to prove that the application of Agile methods can improve the efficiency and effectiveness of drug stock management in pharmacies and provide guidance for developing applications responsive to user needs in the healthcare industry.

Corresponding Author:
Denny Jean Cross Sihombing
Atma Jaya Catholic University of Indonesia
Jakarta, Indonesia
denny.jean@atmajaya.ac.id

INTRODUCTION

Drug stock management in pharmacies is a complex task involving various factors that must be carefully considered. This is due to the variety of drugs available in terms of type, dosage, and expiration date. In addition, changes in drug demand from patients, as well as government policies regarding drug use and distribution, are also factors that complicate stock management(Mospan & Gillette, n.d.; Rushton et al., 2023). In this situation, pharmacies must monitor and manage drug inventory efficiently to meet patient needs on time while avoiding unnecessary overstocking. One of the critical challenges in fulfilling drug demand and dispensing in dispensaries is ensuring adequate drug availability to meet patient needs. Drug demand can vary significantly, especially in dispensaries that cater to diverse types of patients with various health conditions. Therefore, dispensaries need to have an efficient system to predict drug demand and maintain sufficient stock to meet the demand. In addition, dispensing of drugs must also be done carefully and on time to ensure that patients get the drugs according to their doctor's prescription.

Drug delays or losses are serious risks that can compromise quality healthcare. Delays in drug procurement can lead to patients not getting the drugs they need in time,

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which in turn can worsen their health conditions. In addition, drug loss can result in significant financial losses for the dispensary and generate distrust from authorities and the general public. Therefore, dispensaries need to have a robust system in place to properly manage drug stocks and reduce the risk of drug delays and losses as much as possible. Drug inventory apps play a crucial role in improving the efficiency and accuracy of inventory management in dispensaries. Using the right app, dispensaries can automatically monitor drug inventory, perform alerts when drug stock is approaching the minimum limit, and manage the drug procurement and dispensing process more efficiently. In addition, the app can also help track drug expiration dates, facilitate stock updates, and provide detailed reports on drug inventory performance. Thus, using a drug inventory app helps optimize the stock management process and improves the accuracy and reliability of managing drug inventory in pharmacies(Alghamdi et al., 2023; Andia et al., 2022).

The trend of using technology applications in the healthcare industry continues to increase along with the development of information technology. Technology applications such as electronic medical record management systems (EMR), hospital information systems (HIS), and medication inventory applications have become standard in many health practices and healthcare facilities. Using such applications increases efficiency in medical and administrative data management, improves coordination among medical personnel, reduces human errors, and improves the overall quality of patient care. Therefore, this trend shows that technology applications have great potential to change how the healthcare industry operates and provide significant benefits to patients and healthcare providers.(Aljaber et al., 2023; Chen et al., 2023; Coic et al., 2020; Hohmeier et al., 2023)

In the context of medication management in pharmacies, the need for sustainable and adaptive applications is critical. Along with changes in government regulations, patient needs, and market trends, such applications must be able to adapt and continuously evolve to stay relevant. This includes the ability to adjust to policy changes related to drug distribution and sales and integration with new technologies to improve efficiency and reliability. A sustainable and adaptive app will ensure that dispensaries can continue to provide quality services to patients while remaining compliant with regulatory and industry standards(Abeyaratne & Galbraith, n.d.; Fahim et al., 2024; Tupas et al., n.d.; Yong et al., 2023).

Traditional development often faces several constraints that can hinder project success, such as the inability to respond quickly to changing user needs, lack of transparency in the development process, and high risk of delivering products that do not meet user expectations(Al-Saqqa et al., 2020; Dingsøyr et al., 2012; Kaur et al., 2023; Santos et al., n.d.; Serrador & Pinto, 2015). On the other hand, the Agile approach offers a solution to overcome some of these constraints by allowing developers to work iteratively, collaborate actively with stakeholders, and provide regular feedback. This approach also allows greater flexibility in adjusting project priorities and scope based on changing needs and market conditions(Akhtar et al., n.d.; Alami et al., 2022, 2023; Estrada-Esponda et al., 2024; Hasan et al., 2013; Meiliana et al., 2023; Michalides et al., 2023).

The inability to develop an efficient drug inventory application can have severe implications for pharmacy drug management. These include an increased risk of delays in

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procuring and dispensing drugs, lack of visibility into available drug stocks, as well as difficulties in monitoring and tracking important information such as drug expiration dates. As a result, medication management in dispensaries can be disorganized and prone to errors and inaccuracies, negatively impacting the healthcare services provided to patients. Therefore, it is essential to implement an efficient and adaptive development approach to ensure that the drug inventory application can adequately meet the needs of drug management in dispensaries.

This research investigates the effectiveness of Agile methods in developing dispensary drug inventory applications. We sought to analyze the benefits derived from the use of Agile approaches in improving the efficiency and accuracy of drug stock management in dispensaries and assess its influence on the ability of dispensaries to respond to changing market needs and government regulations related to drug management. In addition, we seek to identify challenges and barriers that may be encountered in applying Agile methods in developing drug inventory applications and provide solutions or recommendations to overcome them. Through this research, we hope to provide a better understanding of how the application of Agile methods can improve the quality of health services provided by pharmacies to patients. The results of this study are expected to significantly contribute to the scientific literature on health management and information technology, as well as be a guideline for dispensaries in choosing the right development approach for their drug stock management system. In addition, the practical implications of this research are expected to help improve the operational efficiency of dispensaries and, in turn, improve the health services provided to the community, as well as being a foundation for further research on the development of health applications with an Agile approach.

METHODS

In this research, the initial stages consisted of data collection involving literature review, interviews with stakeholders, and analysis of historical data to understand the needs and challenges in drug stock management in dispensaries. Next, application development was conducted using Agile methods, from prototype design and development to iterative evaluation based on stakeholder feedback. The final stage is user acceptance evaluation, where the developed application is presented to stakeholders to obtain usability, performance, and user satisfaction feedback. The results of this evaluation are then used to adapt the app to meet user needs and expectations better. Through these stages, this research can provide a better understanding of the benefits of applying Agile methods in the development of drug inventory applications in pharmacies, as well as contribute to the practice of software development in the context of the healthcare industry.

Figure 1. Research Stages

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Data Collection

During the data collection phase of this research, various activities were undertaken to gain a comprehensive understanding of the challenges encountered in drug inventory management within pharmacies. The initial step involved identifying the existing problems, including the complexities inherent in drug stock management, difficulties in fulfilling medication requests, and the risks associated with delays and losses of pharmaceuticals. Subsequently, surveys and direct observations were conducted within pharmacies to examine the processes involved in drug inventory management, the prevailing practices, and the obstacles faced by pharmacy personnel. Interviews were also conducted with pharmacy staff, managers, and potential customers to solicit their perspectives on the existing challenges and the need for novel solutions. Document analysis, encompassing stock reports and order records, was performed further to elucidate patterns and trends in drug inventory management. A literature review was also conducted to explore studies related to applying Agile methodology in software development within the pharmaceutical industry. Finally, consultations with software development and inventory management experts facilitated the acquisition of additional insights and recommendations regarding more effective data collection strategies.

Application Development

After comprehensive data collection, we moved to the drug inventory app development phase. We designed and crafted the app based on the findings from the data collection, prioritizing user needs and preferences. We adopted an Agile approach to development by setting sprints and creating a clear product backlog. We developed app prototypes iteratively, conducted regular progress evaluations, and integrated stakeholder feedback into the development process.

User Acceptance Evaluation

The last stage of this research is the user acceptance evaluation of the developed application. We conducted demo sessions and presentations to stakeholders to demonstrate the functionality and features of the developed app. We collected user feedback regarding the app's usability, performance, and satisfaction. Based on the results of this evaluation, we analyzed and evaluated the areas that needed to be fixed or improved in the app. We then adapt the app based on the user feedback to ensure that the app meets the needs and expectations of the users to the best of our ability.

RESULTS AND DISCUSSION

Data Collection

The results of the data collection stage show the efforts made to gain an in-depth understanding of drug stock management in pharmacies. The literature review provided insights into the principles of Agile methods in software application development, particularly in the context of the healthcare industry, which will serve as a foundation for further development. In-person interviews with pharmacists, dispensary staff, and potential users of the application provided important information about the day-to-day challenges faced in drug stock management and the needs to be met in the development of the

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application. In addition, historical data on drug stock management performance, including drug procurement delays, accurate inventory levels, and user satisfaction levels with dispensary services, provided a comprehensive picture of the existing situation and areas for improvement or enhancement in drug stock management at the dispensary.

Table 1. Data Collection Results

No	Data Source	Findings
1	Literature Review	An in-depth literature review was conducted to understand the principles of Agile methods in software application development, especially in the healthcare industry.
2	Interview	Interviews were conducted with pharmacists, dispensary staff, and potential app users to gain insights into the day-to-day challenges of medication stock management and app development needs.
3	Historical Data	Historical data on drug stock management performance at the dispensary was collected, including information on delays in drug procurement, accurate inventory levels, and user satisfaction levels with dispensary services.

Table 1 In collecting data for this research, a focused and comprehensive method was used to gain an in-depth understanding of drug stock management in a dispensary environment. An in-depth literature review regarding the principles of Agile methods in software application development and recent research regarding best practices in medication stock management provided a solid foundation for the subsequent research. Interviews with pharmacists, dispensary staff, and potential users of the application highlighted the real challenges faced in day-to-day medication stock management and the needs to be met by the application to be developed. Meanwhile, analysis of historical data on stock management performance provided a clear picture of existing conditions and trends, enabling the identification of areas where stock management could be improved. By combining information from these various sources, this research can produce evidence-based and user needs-oriented solutions in developing an effective and targeted medicine inventory application.

Aplication Development

The outcome of the drug inventory app development phase included a series of steps focused on meeting the needs and preferences of users, as revealed in the previous data collection. In this stage, we undertook the design and customization of the app design based on the findings from the data analysis, ensuring that the app could effectively address the challenges faced in drug stock management in pharmacies. An Agile approach was applied by defining sprints and creating a clear product backlog, enabling iterative development of the app that considers feedback and changing needs during the development process. Application prototypes were developed incrementally with user

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priorities, and periodic evaluations were conducted to ensure consistent progress and quality. Integration of stakeholder feedback is an integral part of the development process, ensuring that the resulting app best meets their expectations and needs. As such, this stage of development became a strong foundation in our efforts to create a compelling solution for stock management in pharmacies.

Table 2. Application Features

Features	Function
Medicine Stock Management	This feature allows pharmacies to monitor and manage their medication stock efficiently in real-time. With automatic notifications of stock approaching the minimum limit, pharmacists can take proactive measures to ensure sufficient availability of medicines for patients.
Ordering and Procurement	This feature facilitates automatic ordering based on inventory levels and recorded drug demand. By monitoring the status of drug orders from suppliers, pharmacies can ensure that drug inventory is always maintained and that there are no significant stock shortages.
Expiration Tracking	This feature allows pharmacies to track drug expiration dates and provide automatic alerts for drugs that are about to expire. By grouping drugs by expiry date, pharmacies can optimize stock rotation and prevent wastage of expired drugs.
Medicine Category Management	This feature allows pharmacies to group drugs based on specific categories or types, such as over-the-counter drugs, prescriptions, or supplements. Thus, searching and managing drug stocks becomes more organized and efficient.
Reports and Analysis	This feature allows pharmacies to generate reports on drug inventory performance, including stock turnover, drug utilization rates, and demand trends. The data analysis helps the pharmacy identify patterns for strategic decision-making and better stock planning.

The features presented in table 2 the drug inventory application in pharmacies are crucial elements that support efficiency and effectiveness in drug stock management. Real-time stock management allows pharmacies to anticipate needs and avoid critical shortages. Automated ordering and procurement features help maintain drug availability by promptly identifying and ordering the required drugs. Drug expiry tracking with automated alerts helps pharmacies minimize expired drug waste and ensure safe and quality drugs are

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available. Drug category management helps organize drug stocks efficiently, while reports and data analysis provide valuable insights for better decision-making. By combining these features, the app can be a powerful tool in improving pharmacy operations, ensuring quality service to patients, and meeting stringent compliance standards in the healthcare industry.

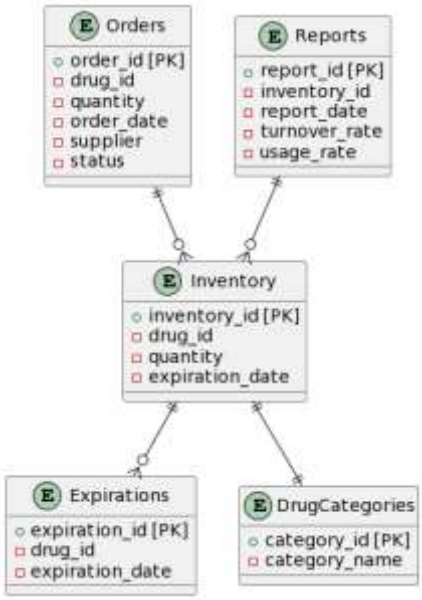

Figure 2. ER Diagram

The data model as shown in Figure 2, consisting of tables such as Inventory, Orders, Expirations, Categories, and Reports, provides a comprehensive structure for drug inventory management in a dispensary. The Inventory table allows monitoring of drug stocks and expiry dates while Orders record drug orders to suppliers. Expirations help in avoiding the use of expired drugs, while DrugCategories facilitate the grouping of drugs by category. The Reports table provides reports on drug inventory performance, enabling better analysis to improve efficiency and service quality. Overall, this data model supports effective and organized drug management in dispensaries, integrating the various aspects required to ensure the availability of safe and quality drugs to patients.

User Acceptance Evaluation

After evaluating the app's user satisfaction and functional testing results, we received positive feedback from users. The majority of users, as much as 80%, expressed high satisfaction with the app's ease of use, functionality, and added value. Key features such as real-time drug stock monitoring and drug expiration date tracking were well appreciated by users. Meanwhile, functional testing showed that the app can function as expected without significant bugs or issues. Key features such as drug stock management, ordering and procurement, and drug expiration tracking have been well-tested and can handle high user loads. Nevertheless, suggestions for improvements and additional features from users will be considered for future updates to improve the app's user experience and overall functionality continuously.

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CONCLUSION

This research highlights the successful development of a drug inventory application by applying Agile methods in the context of the healthcare industry. User acceptance evaluations showed that the application was well received, with most respondents expressing high satisfaction with the ease of use, helpful functionality, and added value provided. Functional testing also validated the application's performance, confirming that key features functioned well and could handle the user load without significant issues. Nevertheless, feedback from users provided opportunities for further improvements and continued development. Taking into account the suggestions for improvements and enhancements, the app has the potential to be a valuable tool in improving the efficiency and effectiveness of drug stock management in dispensaries. Therefore, the conclusion of this study underscores the importance of being responsive to user needs in the development of health applications, with the hope of making a significant contribution to improving service standards and overall health management.

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