Journal of Information Systems and Informatics
Vol. 7, No. 2, June 2025 e-ISSN: 2656-4882 p-ISSN: 2656-5935
DOI: 10.51519/journalisi.v7i2.1139 Published By DRPM-UBD

Development and Capability Evaluation of a Firebase-Based Pharmacy Inventory System Using COBIT 2019

Alif Noorachmad Muttaqin[1], Muharman Lubis[2], Muhammad Dwi Hary Sandy[3]

[1,2]Master of Information Systems, Telkom University, Bandung, Indonesia
[3]Informatics Management, STMIK Cilegon, Cilegon, Indonesia
Email: [1]weaboo@student.telkomuniversity.ac.id, [2]muharmanlubis@telkomuniversity.ac.id, [3]muhammaddwiharrysandy@gmail.com

Abstract

Pharmacy inventory control systems require proper and timely data management to be able to supply medicines and function as such. The study conceptualized and tested a Firebase-based system of pharmacy inventory control. The system was conceptualized in the web and Android platforms with the key objectives of enabling real-time synchronization, tracking, and reporting functionalities. Capability measurement from utilizing the COBIT 2019 method was utilized in evaluating system governance and operational performance. Four key processes are BAI03 (Identification and Build of Managed Solutions), DSS01 (Managed Operations), DSS02 (Managed Service Requests and Managed Incidents), and MEA01 (Managed Performance Monitoring) were chosen shortlisted and mapped to system indicators. Seven pharmacy employees were subjected to the assessment with a Likert-scale questionnaire. The results showed that three processes attained Capability Level 4 (Predictable) and one attained Capability Level 5 (Optimizing), i.e., the system performs predictably and allows continuous improvement. Weakness points despite deployment of the system with proof of handling data with ease and responsiveness were the fact that the sample size of respondents was small and one pharmacy only had it deployed. Much more must be done to experiment with the system in different environments and explore integration with third-party platforms for further scalability and adherence to governance.

Keywords: pharmacy system; Firebase; COBIT 2019; capability level; inventory management

1. INTRODUCTION

Effective management of pharmacy stock is not just a matter of operational efficiency it's a critical component in ensuring uninterrupted healthcare services, particularly in developing countries. In today's healthcare settings, especially in countries like Indonesia, pharmacies face growing pressure to maintain consistent drug availability, reduce service delays, and improve the precision of pharmaceutical transactions [1], [2]. Unfortunately, most pharmacies still rely on

outdated manual or semi-digital stock management methods. These outdated systems frequently lead to numerous issues such as data inconsistencies, human error, and inefficiencies in restocking procedures [3]. The consequences are tangible: patients often face medicine shortages, staff waste time on repetitive manual tasks, and the system as a whole becomes more vulnerable to error and inefficiency.

This ongoing dependency on manual operations underlines a crucial need for integrated and real-time digital systems that can modernize pharmaceutical stock handling. Such systems must be capable of synchronizing data across departments, ensuring traceability of every stock movement, and maintaining compliance with healthcare regulations [4], [5]. Prior research has advocated for the adoption of various computer-based solutions in pharmacy management. For instance, Raut et al. [6] introduced a cloud-based e-pharmacy platform designed for real-time stock updates and improved customer service. Likewise, Syafariani et al. [7] highlighted the potential of a web-based drug transaction system to eliminate manual errors and reduce input inefficiencies. These contributions showcase promising directions, but they often fall short in evaluating how such systems align with broader governance and data management standards.

Moreover, technical innovations like Firebase-based platforms and digital dashboards have been tested with encouraging outcomes in other healthcare contexts. Ghanem et al. [8] implemented Firebase within a hospital information system, enabling synchronized and secure clinical data exchange. However, its application remained largely confined to patient records rather than stock-related operations. Dhina et al. [9] demonstrated the use of digital dashboards in monitoring pharmaceutical education labs, proving real-time monitoring benefits. Additional studies have introduced features like location-based pharmacy apps and teleconsultation capabilities [10], yet these innovations often prioritize user-facing functionality over backend governance and performance evaluation frameworks.

What is notably missing in these prior approaches is a comprehensive, governance-centered analysis that evaluates the effectiveness and maturity of these systems. It's one thing to implement a functional digital tool, and quite another to determine whether that tool meets long-term operational, regulatory, and strategic goals. COBIT 2019, a globally recognized framework for IT governance, offers a robust mechanism for such an evaluation. It assesses processes from Level 0 (Incomplete) to Level 5 (Optimizing), helping organizations identify how well-defined and controlled their IT systems truly are. With this lens, it becomes possible to understand not just whether a pharmacy stock management system works—but how mature, efficient, and reliable it is according to internationally accepted standards [11], [12], [13].

This study, therefore, proposes the development of a Firebase-powered pharmacy stock system evaluated through four specific COBIT 2019 processes: IBM03 (Managed Solution Identification and Build), DSS01 (Managed Operations), DSS02 (Managed Service Requests and Incidents), and MEA01 (Managed Performance Monitoring). By integrating these COBIT components, the research shifts focus from basic functionality to strategic governance alignment. The goal is to examine whether the system can not only manage inventory in real-time but also support robust data integrity, streamline operations, and ensure regulatory compliance. Such an approach empowers decision-makers to pinpoint which process areas align with governance best practices—and which areas demand further optimization and oversight [14].

2. METHODS

This research employs a case study method focused on the design and evaluation of an electronic inventory management system for pharmacy inventory. This research was conducted at Sumber Sehat Pharmacy in Ujungbatu, which used to be manually keeping track of its drugs' inventories through written records and spreadsheet programs. This study uses a design and evaluation methodology, which combines system development and governance-based evaluation through the COBIT 2019 capability level model. The research work is conducted in five stages: (1) requirement analysis and process modeling, (2) Android and Firebase-based system implementation, (3) application in pharmacy, (4) functional testing and user evaluation, and (5) IT process capability assessment through COBIT 2019. The research design workflow is shown in Figure 1.

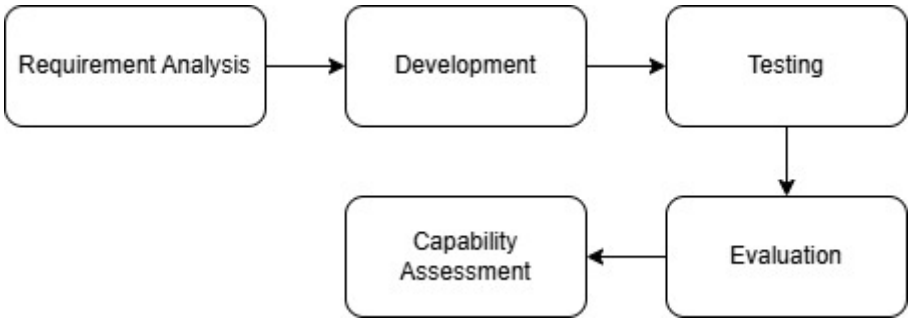

Figure 1. Research Design

2.1. System Development

The inventory management system was developed using Android Studio for the mobile application and Firebase for the backend [15], [16]. Firebase entities used were Realtime Database to synchronize data, Authentication to manage user

p-ISSN: **2656-5935** http://journal-isi.org/index.php/isi e-ISSN: **2656-4882**

access, and Hosting for deployment. UML diagrams such as use case and activity diagrams were utilized for system modeling to model requirements and define user flows [17].

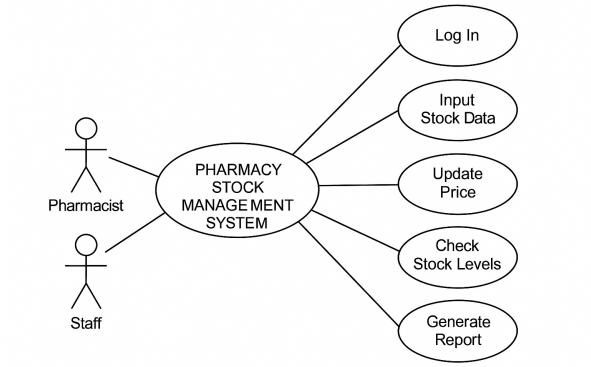

Figure 2. Use Case Diagram of the Pharmacy Stock Management System

The main features developed are account login, reading/writing of stocks of medicines, displaying lists of stocks, and generating stock movement reports. The system's interface was designed easy to use for pharmacy staff with minimal technical experience.

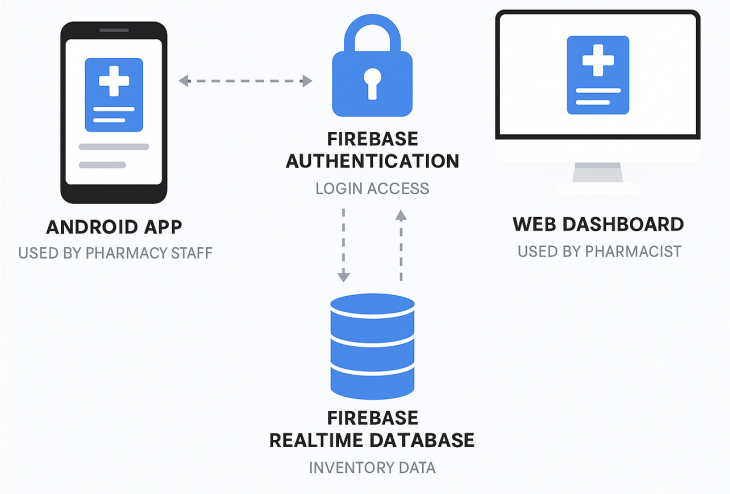

Figure 3. Firebase Architecture

2.2. Functional Testing

For verification that the features implemented were working as needed, black-box testing was carried out. Test cases for every important function, such as login, stock

changes, and reporting, were defined. Every function was tested against predicted outcomes for normal and edge-case inputs [18], [19].

2.3. Capability Evaluation Using COBIT 2019

The system was evaluated based on COBIT 2019, which provides Capability Levels ranging from 0 (Incomplete) to 5 (Optimizing) for all processes. This study selected four processes within three domains that are relevant to system operation and user perception:

Table 1. Capability Evaluating

COBIT Domain	Process Code	Indicator	Process Name
BAI	BAI03	Data Management	Managed Solution Identification and Build
DSS	DSS01	Ease of Use	Managed Operation
	DSS02	Performance	Managed Service Requests and Incidents
MEA	MEA01	Monitoring	Managed Performance Monitoring

Each activity was associated with a survey item: BAI03 for handling data; DSS01 for ease of use; DSS02 for performance; and MEA01 for monitoring [20], [21]. The questionnaire for the users used a 4-point Likert scale (1 = Don't Agree, 4 = Strongly Agree), with three to four statements for each measure [22], [23]. To evaluate the system's capability level, a structured questionnaire was developed based on COBIT 2019 domains and relevant user experience indicators. Table 2 outlines the full list of questions mapped to each evaluated process.

Table 2. Questionnaire

Indicator	Process	Survey Question
Ease of Use	DSS01	The system interface is easy to understand and navigate
		I can complete task with minimal guidance
		System functions behave as expected during daily use
Data Management	BAI03	I can add, edit, and remove inventory data without confusion
		The data saved reflects real conditions in the pharmacy accurately
		Stock data is consistently updated across devices
Monitoring	MEA01	I can easily view inventory stock and movement history

p-ISSN: **2656-5935** http://journal-isi.org/index.php/isi e-ISSN: **2656-4882**

Indicator	Process	Survey Question
Performance	DSS02	The system provides useful feedback when changes are made Reports or dashboards are clear and support daily decisions The system responds quickly when I input or retrieve data Features load consistently without crashes or delays I can complete stock transactions (input/output) without technical issues

Responses were grouped by indicator, and the average of three questions per process was used to determine the capability level score. These scores were then translated into percentages and mapped to COBIT 2019 capability levels.

2.4. Respondents and Data Collection

Seven pharmacy personnel participated in the evaluation, consisting of six employees and a registered pharmacist. They were selected purposively based on their function in inventory activities. Respondents completed the questionnaire following a two-week pilot test on the system, and responses were averaged per process.

Table 3. Respondent

Code	Respondent
R1	Pharmacist
R2	Staff 1
R3	Staff 2
R4	Staff 3
R5	Staff 4
R6	Staff 5
R7	Staff 6

2.5. Capability Scoring and Conversion

The capability measure in this study is derived from the COBIT 2019 framework by ISACA, which offers six capability levels of process capability between 0 and 5 [24], [25]. The level should reflect the degree of accomplishment with respect to process performance and governance. Evaluation was conducted by converting mean Likert-scale values to percentages and equivalent capability level based on the criteria in Table 4. Each mean score was then multiplied by the number of

testers (7) and divided by the top scorer (28) to obtain a percentage value, which was converted to a capability level with the following scale:

Table 4. Capability Scoring and Conversion

Level	Name	Range	Definition
0	Incomplete	0-16%	The process is not implemented or fails to achieve its intended purpose
1	Performed	17–33%	The process achieves its purpose but lacks structure and documentation
2	Managed	34–50%	The process is planned and executed in accordance with policy and tracked
3	Established	51–66%	The process is well-defined, standardized, and integrated with other processes
4	Predictable	67–83%	The process operates within defined limits to achieve consistent outcomes
5	Optimizing	>84%	The process is continuously improved to meet relevant current and future needs

This is a perception-based evaluation, not a formal audit. It provides a sense of how users evaluate the capability of system processes in real use, which is useful in early-stage system deployment and iteration.

3. RESULTS AND DISCUSSION

3.1. System Implementation Results

The development and deployment of the pharmacy inventory management system using Android and Firebase technologies yielded highly encouraging outcomes. Designed to simplify and digitize core inventory operations, the system offered key functionalities including secure user authentication, real-time stock input and output, seamless report generation, and a user-friendly dashboard. From the outset, the interface was designed with simplicity in mind, ensuring that even personnel with limited technical expertise could navigate and operate the system efficiently.

Over a trial period of two weeks, the system was implemented and tested in a real-world pharmacy environment by actual staff. The pharmacy personnel engaged with the application daily to input drug stocks, monitor inventory levels, update records, and generate reports. The test environment was not simulated—staff worked under actual operational conditions, which provided a realistic and robust setting to evaluate the system's performance and usability. During this phase, users registered accounts (Figure 4), managed stock entries (Figure 5), and accessed real-time reporting tools (Figure 6). The intuitive structure of the application helped

reduce the training curve significantly, and users quickly adapted to the new digital workflow.

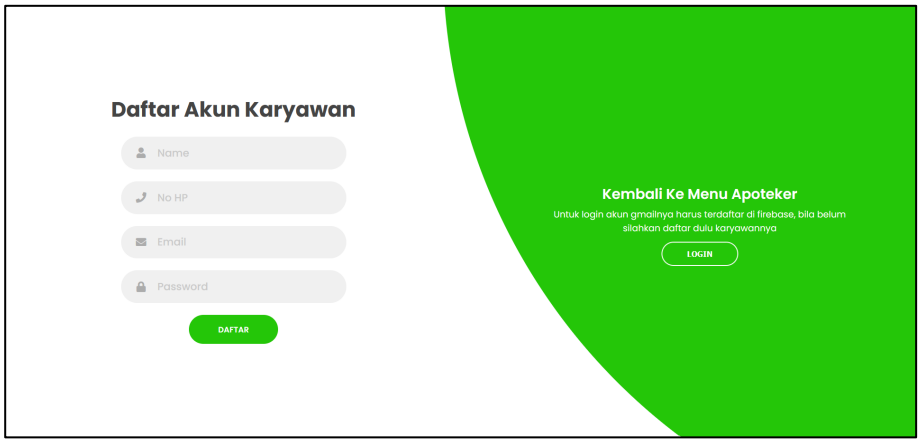

Figure 4. Pharmacy Employees Account Registration

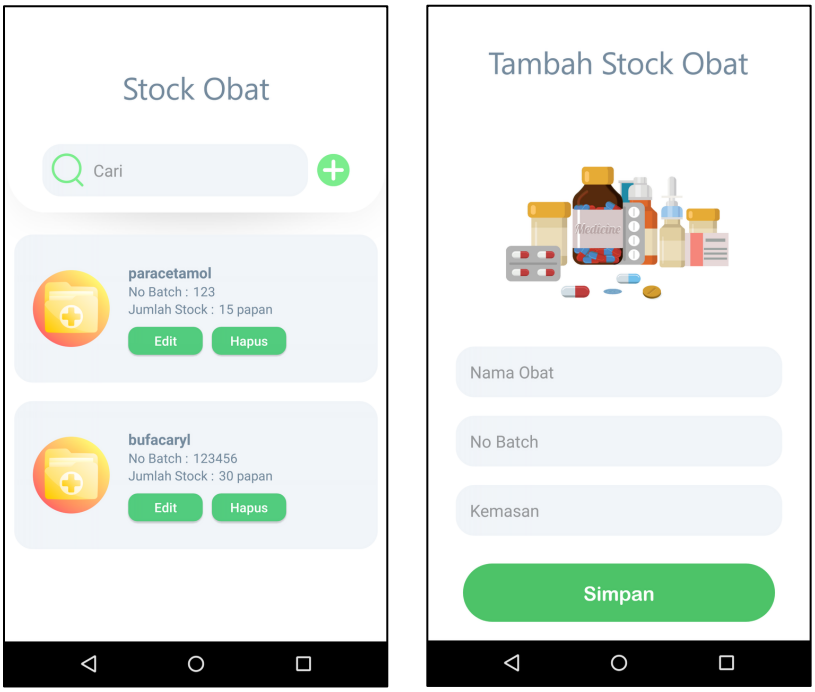

Figure 5. Drug Stock Pharmacy Employee

p-ISSN: **2656-5935** http://journal-isi.org/index.php/isi e-ISSN: **2656-4882**

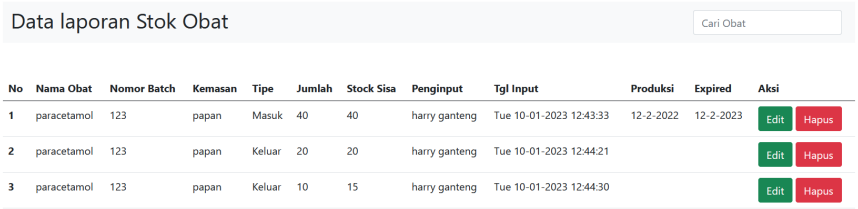

Figure 6. Drug Stock Report

Functional reliability of the system was confirmed using black-box testing methods, which focused on evaluating the system based on inputs and expected outputs without knowledge of internal code structures. This form of testing ensured a user-centric evaluation, as it mimicked how real users interact with the application. As shown in Table 5, each core functionality of the system was thoroughly tested—including login procedures, stock entry, real-time monitoring, data editing, and report generation. The system performed optimally under normal and boundary conditions. No critical failures or performance bottlenecks were recorded during the testing phase, and all inputs produced the correct, expected outputs within seconds.

Table 5. Black-Box Testing on the Pharmacy Inventory Management System

Feature Tested	Input Description	Expected Output	Actual Output	Response Time	Tester	Status
User Login	Valid username and password	Redirect to appropriate user dashboard	Redirected correctly	< 2 seconds	Pharmacist	Passed
Stock Input (Android)	Drug name, quantity, and price	Data saved and synced in Firebase	Data saved and visible in web view	< 3 seconds	Staff Member 1	Passed
Stock Monitoring (Web)	Firebase-connected dashboard	Real-time display of updated stock	Displayed correctly and promptly	< 2 seconds	Pharmacist	Passed
Edit Stock Data	Modify quantity via web	Changes updated and reflected live	Reflected immediately on both platforms	< 2 seconds	Staff Member 2	Passed
Report Generation	Request daily PDF export	Report downloadable as PDF	PDF generated successfully	< 5 seconds	Pharmacist	Passed

The real-world implementation demonstrated that the system is not only technically sound but also highly adaptable to the daily workflows of pharmacy personnel. Every core feature worked as intended, and response times remained consistently low contributing to a seamless user experience. Staff members reported an observable improvement in accuracy and efficiency, citing that the

system reduced the number of manual steps required to manage inventory and decreased the likelihood of errors. Additionally, the successful integration of Firebase ensured that data synchronization across platforms (mobile and web) was immediate and reliable.

The results affirm that the Firebase-based pharmacy inventory system is both operationally viable and well-received by end users. Its performance under practical conditions showcases the system's readiness for broader implementation across similar healthcare environments. The system's smooth functioning, stability, and user acceptance position it as a scalable solution for modernizing pharmacy stock management in resource-constrained settings.

3.2. Capability Evaluation

To assess the system's governance alignment and functional maturity, a capability evaluation was conducted based on four critical processes from the COBIT 2019 framework. These were: DSS01 (Managed Operations), BAI03 (Managed Solution Identification and Build), MEA01 (Managed Performance Monitoring), and DSS02 (Managed Service Requests and Incidents). Each of these processes was mapped to a key performance indicator: ease of use, data management, monitoring, and performance, respectively. This mapping allowed for a structured evaluation that connects technical usability with governance-level expectations.

The evaluation was carried out after a two-week pilot where pharmacy staff engaged daily with the system. A structured questionnaire containing Likert-scale items was used to capture users' perceptions across the four indicators. Each pharmacy personnel answered three Likert-style questions for each indicator, resulting in a cumulative evaluation dataset. Seven pharmacy employees (R1–R7) participated, and the individual scores across all indicators are presented in Table 6. The scoring followed a four-point Likert scale (1 = Poor, 4 = Excellent), and each respondent's answers were averaged per indicator.

Table 6. Maturity Level Scoring Based on Likert Evaluation

Respondent	Ease of Use	Data Management	Monitoring	Performance
R1	3	3	4	4
R2	3	3	3	3
R3	3	3	3	3
R4	2	3	4	3
R5	3	3	3	4
R6	3	3	3	3
R7	3	3	3	4

Each score represents the average of 3 Likert questions per indicator.

Following this, total scores for each indicator were computed (maximum possible score = 28) and converted into percentages. These percentages were then mapped against COBIT 2019's capability level chart, which defines maturity levels from 0 (Incomplete) to 5 (Optimizing). The conversion and corresponding capability levels are outlined in Table 7, providing a clear visual representation of the system's performance within each governance area.

Table 7. Capability Evaluation Based on COBIT 2019

Process	Indicator	Total Score	% Score	Capability Level
DSS01	Ease of Use	20	71,4%	4 – Predictable
DSS02	Performance	24	85,7%	5 – Optimizing
BAI03	Data Management	21	75%	4 – Predictable
MEA01	Monitoring	23	82,1%	4 – Predictable

As demonstrated in Table 7, the system achieved particularly high marks for performance (DSS02), reaching Capability Level 5 – Optimizing, which indicates that this aspect of the system is functioning at the highest governance standard. This means that system responses were not only timely and consistent but are likely to improve further due to built-in feedback and monitoring mechanisms. Pharmacy personnel experienced smooth, real-time processing without notable delays or errors, validating the system's readiness for mission-critical deployments.

The remaining areas ease of use (DSS01), data management (BAI03), and monitoring (MEA01) all achieved Capability Level 4 – Predictable. This level suggests that these processes are well-documented, repeatable, and reliable, with minimal deviation in output. Users found the interface straightforward, data handling consistent, and system monitoring intuitive and reliable. These aspects create a stable foundation for digital pharmacy operations, even in resource-limited environments.

The COBIT 2019-based evaluation reaffirms the maturity, reliability, and scalability of the developed system. The performance optimization evident in DSS02, alongside the predictability in other domains, illustrates a strong governance backbone. This positions the Firebase-based system not just as a functional tool but as a strategically mature solution fit for expansion across broader healthcare ecosystems.

3.3. Discussion and Analysis

The test results provide strong evidence that the pharmacy stock management system has reached a mature capability level across all four key process domains defined by COBIT 2019. These findings indicate that the system is not only functionally sound but also strategically aligned with IT governance principles,

which is a significant achievement for digital transformation efforts in healthcare. However, while the performance metrics are promising on the surface, a deeper analysis reveals several important dimensions that need to be considered before drawing comprehensive conclusions.

To begin with, the high performance in BAI03 (Data Management) and DSS02 (Service Requests and Incidents) reflects the technical strength of the system, especially in terms of its ability to handle data uniformly and synchronize stock information in real-time. This capability is largely attributed to the solid architecture of Firebase, which enables real-time updates and concurrent data handling with minimal lag. These results affirm the system's readiness to support dynamic pharmacy operations where timing and accuracy are critical.

Similarly, results from DSS01 (Managed Operations) and MEA01 (Performance Monitoring) demonstrate that users were able to interact with the system in a stable and consistent manner. The interface design, workflows, and overall usability appear to align well with the existing pharmacy processes. This indicates a good degree of design fit the system was built not just for functionality but with real operational workflows in mind. When a digital system integrates seamlessly into the existing routines of its users, adoption becomes smoother, and efficiency naturally improves.

That said, the evaluation methodology itself has limitations that must be acknowledged. The assessment was based solely on user perception, using Likert-scale ratings, which are inherently subjective. Although the study involved seven pharmacy staff members, this sample size is quite limited and represents just one operational context. It may not adequately capture the diversity of experiences and user behaviors present in different pharmacies, particularly in rural or infrastructure-poor settings. Furthermore, participants' previous exposure to technology or lack thereof can influence their ratings, either positively due to novelty or negatively due to confusion. These factors may skew the results and limit the generalizability of the capability scores.

In practice, several operational challenges emerged during system deployment. One of the key issues was the varying levels of digital literacy among staff. While some users quickly adapted to the interface, others needed additional guidance, especially when navigating multi-step functions like stock reporting or performing data synchronization tasks. This highlighted a clear need for more structured user onboarding and hands-on support during early system adoption. Furthermore, internet connectivity issues occasionally disrupted synchronization between the mobile application and Firebase's cloud database. Though these interruptions were temporary, they could compromise the system's promise of real-time data accuracy—especially in remote locations where connectivity is inconsistent.

To improve the system's adoption and perceived capability moving forward, several enhancements should be prioritized. First, incorporating offline capabilities or cached synchronization would make the system more resilient in low-bandwidth environments. Second, simplifying user flows—especially in multi-step tasks—can enhance usability and reduce friction. Lastly, implementing a robust training and onboarding program, tailored to varying digital literacy levels, would help ensure smoother adoption across diverse pharmacy settings.

In summary, while the system demonstrates strong technical foundations and aligns well with COBIT 2019 capability levels, it is not without limitations. Addressing these usability, training, and infrastructure-related challenges will be key to ensuring broader scalability and long-term impact. Once these barriers are addressed, the system will not only maintain its high capability levels but also deliver more consistent results across varied healthcare environments—transforming pharmacy inventory management with minimal added burden on infrastructure or personnel.

4. CONCLUSION

This study finds that the development and deployment of an Android-based, web-enabled, and Firebase-integrated stock management system significantly reduced inefficiencies commonly found in manual pharmacy inventory practices. Through user and functional testing, the system proved to be highly usable, responsive, and capable of maintaining structured and governed data processes. Its maturity was validated with capability levels reaching Level 4 (Predictable) and Level 5 (Optimizing), based on COBIT 2019 criteria. The system enhances precision, traceability, and operational efficiency, making it a practical and scalable solution for other pharmacies facing similar challenges. Its lightweight and cloud-based architecture supports broader applicability, aligning well with national digital health initiatives. Future developments may focus on integrating third-party services and expanding the system for multi-branch management, further strengthening its role in modernizing pharmaceutical operations.

REFERENCES

[1] M. Elarbi, O. Ayadi, M. Masmoudi, and F. Masmoudi, "Drug-inventory-management-model for a multi-echelon pharmaceutical supply-chain: case study of the Tunisian pharmaceutical supply-chain," *Supply Chain Forum: An International Journal*, vol. 22, no. 1, pp. 44–56, Jan. 2021, doi: 10.1080/16258312.2020.1824532.

[2] M. A. Raza *et al.*, "Artificial Intelligence (AI) in Pharmacy: An Overview of Innovations," *Innov Pharm*, vol. 13, no. 2, p. 13, Jul. 2022, doi: 10.24926/iip.v13i2.4839.

[3] M. Lubis, D. O. Handayani, A. Rostiawan, Q. J. Adrian, R. Fauzi, and I. F. Zamzami, "Design Approach in Electronic Health Consultation Application: User Empowerment for Internet Addiction," in *2021 International Conference Advancement in Data Science, E-learning and Information Systems (ICADEIS)*, IEEE, Oct. 2021, pp. 1–6. doi: 10.1109/ICADEIS52521.2021.9702064.

[4] F. Atika and D. Irwan, "Pharmacy Inventory System Design Using Agile Methods," *Al'adzkiya International of Computer Science and Information Technology (AIoCSIT) Journal*, vol. 1, no. 2, pp. 62–68, Nov. 2020, doi: 10.55311/aiocsit.v1i2.91.

[5] S. Suhirman, A. T. Hidayat, W. A. Saputra, and S. Saifullah, "Website-Based E-Pharmacy Application Development to Improve Sales Services Using Waterfall Method," *International Journal of Advances in Data and Information Systems*, vol. 2, no. 2, pp. 114–129, Oct. 2021, doi: 10.25008/ijadis.v2i2.1226.

[6] S. Raut, S. Moharana, S. Sahoo, R. Jena, and P. Patra, "Design and Usage of a Digital E-Pharmacy Application Framework," in *Predictive Analytics in Cloud, Fog, and Edge Computing*, Cham: Springer International Publishing, 2023, pp. 91–105. doi: 10.1007/978-3-031-18034-7_6.

[7] R. F. Syafariani, D. Ginanjar, and E. N. Hayati, "Website-Based Information System on Drug Purchases and Sales at Pharmacy," *Jurnal Teknologi Informasi dan Pendidikan*, vol. 14, no. 2, pp. 172–177, Feb. 2022, doi: 10.24036/jtip.v14i2.448.

[8] S. I. Ghanem, E. Hamshary, L. Matar, and A. Morsy, "Enhancing Healthcare Service with Firebase Integration and Intelligent Chatbot Deployment," in *2024 Intelligent Methods, Systems, and Applications (IMSA)*, IEEE, Jul. 2024, pp. 550–555. doi: 10.1109/IMSA61967.2024.10652750.

[9] M. A. Dhina, G. Hadisoebroto, S. R. Mubaroq, and I. Gustiana, "Implementation of digital performance assessment to measure pharmacy physics laboratory skills," *Momentum: Physics Education Journal*, pp. 65–72, Jan. 2021, doi: 10.21067/mpej.v5i1.5146.

[10] N. N. B. Hamid and T. Anwar, "The MedMaps apps: Mobile application for finding, managing and commercialize pharmacy," in *2017 6th ICT International Student Project Conference (ICT-ISPC)*, IEEE, May 2017, pp. 1–5. doi: 10.1109/ICT-ISPC.2017.8075306.

[11] T. Dharmada, J. Wiratama, and A. Faza, "Leveraging COBIT 2019 Framework for Recommending ERP System Module Development at Cardboard Manufacturing Industry," *Journal of Information Systems and Informatics*, vol. 6, no. 2, pp. 1195–1214, Jun. 2024, doi: 10.51519/journalisi.v6i2.764.

[12] B. Y. Fitriyani and A. H. Muhammad, "COBIT 2019 for Enhanced ICT Governance: A Case Study at a Higher Education Institution," *Journal of Information Systems and Informatics*, vol. 7, no. 1, pp. 45–62, Mar. 2025, doi: 10.51519/journalisi.v7i1.972.

[13] M. A. Lanure, F. Maulana, and M. Lubis, "Assessment of IT Maturity Level and Roadmap Preparation for Improving Governance Based on COBIT 5 (Case Study: XYZ Company)," in *2022 1st International Conference on Information System & Information Technology (ICISIT)*, IEEE, Jul. 2022, pp. 31–36. doi: 10.1109/ICISIT54091.2022.9872860.

[14] Y. Guo and Y. Zeng, "The impact of government support on port industry competitiveness: A qualitative exploration," *Journal of Infrastructure, Policy and Development*, vol. 8, no. 5, p. 5552, May 2024, doi: 10.24294/jipd.v8i5.5552.

[15] A. Susanto, A. R. Arjuni, W. Ikram, and R. Rismayani, "Android-Based Introduction to Agricultural Crops and Pests," *Journal of Information Systems and Informatics*, vol. 4, no. 2, pp. 385–397, Jun. 2022, doi: 10.51519/journalisi.v4i2.263.

[16] U. A. Madaminov and M. R. Allaberganova, "Firebase Database Usage and Application Technology in Modern Mobile Applications," in *2023 IEEE XVI International Scientific and Technical Conference Actual Problems of Electronic Instrument Engineering (APEIE)*, IEEE, Nov. 2023, pp. 1690–1694. doi: 10.1109/APEIE59731.2023.10347828.

[17] B. M. Esiefarienrhe and T. J. Moemi, "UML Design of Business Intelligence System for Small-Scale Enterprises," *Journal of Information Systems and Informatics*, vol. 6, no. 1, pp. 495–513, Mar. 2024, doi: 10.51519/journalisi.v6i1.672.

[18] P. K. Ayuningtyas, D. Atmodjo WP, and P. Rachmadi, "Performance And Functional Testing With The Black Box Testing Method," *International Journal of Progressive Sciences and Technologies*, vol. 39, no. 2, p. 212, Jul. 2023, doi: 10.52155/ijpsat.v39.2.5471.

[19] A. Maspupah, "Literature Review: Advantages and Disadvantages of Black Box and White Box Testing Methods," *Jurnal Techno Nusa Mandiri*, vol. 21, no. 2, pp. 151–162, Sep. 2024, doi: 10.33480/techno.v21i2.5776.

[20] P. Germanakos, Z. Lekkas, C. Amyrotos, and P. Andreou, "Proposing a Perceived Expertise Tool in Business Data Analytics," in *Adjunct Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization*, New York, NY, USA: ACM, Jun. 2021, pp. 142–149. doi: 10.1145/3450614.3462236.

[21] S. Abbasnasab Sardareh, G. T. L. Brown, and P. Denny, "Comparing four contemporary statistical software tools for introductory data science and statistics in the social sciences," *Teach Stat*, vol. 43, no. S1, Jul. 2021, doi: 10.1111/test.12274.

[22] R. Tezza and G. L. Vargas, "Scale to measure usability in Mobile Crowd Sensing (MCS) applications," *Journal of Statistics and Management Systems*, vol. 25, no. 3, pp. 501–520, Apr. 2022, doi: 10.1080/09720510.2021.1878631.

[23] L. M. Tonetto, C. L. P. Copetti, P. Brust-Renck, C. de Lima Amorim, L. P. Kowalski, and G. B. de Carvalho, "Assessing user experience with services: measuring subjective well-being in oncology hospitals," *BMC Health Serv Res*, vol. 25, no. 1, p. 796, Jun. 2025, doi: 10.1186/s12913-025-12965-6.

[24] B. V. Tulus and A. R. Tanaamah, "Design of Information Technology Governance in Educational Institutions Using COBIT 2019 Framework," *Journal of Information Systems and Informatics*, vol. 5, no. 1, pp. 31–43, Feb. 2023, doi: 10.51519/journalisi.v5i1.408.

[25] K. Leonardo and R. Latuperissa, "Information Technology Governance Design in Trading Companies Using the COBIT 2019 Framework," *Journal of Information Systems and Informatics*, vol. 6, no. 3, pp. 1466–1483, Sep. 2024, doi: 10.51519/journalisi.v6i3.798.