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Evaluation of Hospital Pharmacy Information System Using the PIECES Framework at Dr. Adhyatma General Hospital

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Abstract

Background: *Information systems played a crucial role in improving efficiency and service quality in hospital pharmacy management. Effective medication management was essential to prevent medication errors and ensure medication availability. However, comprehensive, multidimensional evaluations remained limited. The PIECES framework was selected for its comprehensive assessment of system Performance, Information, Economy, Control, Efficiency, and Service.* ***Objective:*** *This study evaluated the implementation of the Hospital Management Information System (SIMRS) at the Dr. Adhyatma General Hospital pharmacy using the PIECES framework and analyzed its correlation with user satisfaction.* ***Methods:*** *A non-experimental mixed-methods study was conducted using direct observations and expert-validated questionnaires. Using a total sampling method, 12 pharmacy staff members actively involved in medication management were included. Descriptive statistics were used to compute the PIECES dimension mean scores, and Spearman's rank correlation was used to analyze their association with user satisfaction ($p < 0.05$).* ***Results:*** *The evaluated system demonstrated satisfactory capabilities across all PIECES dimensions, with an overall mean score of 4.19. The Information dimension scored highest (4.32), while Efficiency scored lowest (4.07), indicating a specific need to optimize workflow and usability. All dimensions were significantly and positively correlated with user satisfaction. Performance showed the strongest correlation ($\rho = 0.82$; $p = 0.001$), whereas Service showed the weakest, yet significant, association ($\rho = 0.58$; $p = 0.041$).* ***Conclusion:*** *The implementation of SIMRS effectively optimized pharmaceutical service management, operational efficiency, and clinical data accuracy. Due to limitations, including the small sample size and single-center design, the study recommended subsequent multicenter research with larger cohorts to validate these findings.*

Keywords: *Hospital Information Systems; Medication System; Personal Satisfaction; Pharmacy Service; Program Evaluation*

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INTRODUCTION

The Indonesian government has accelerated digital health transformation through Law No. 17 of 2023 and Government Regulation No. 28 of 2024, which emphasize implementing integrated health information systems to improve healthcare quality, patient safety, and service efficiency [1,2]. This national strategic step aligns fully with the Global Strategy on Digital Health 2020–2025, which encourages the comprehensive adoption of digital health technologies to address 21st-century health system challenges [3]. In hospitals, pharmaceutical information systems play a crucial role in medication management, ensuring medicine availability, reducing medication errors, and improving operational efficiency.

Medication availability is an essential indicator of pharmaceutical service quality and patient safety. Inadequate inventory management can lead to drug shortages, delayed therapy, inappropriate drug substitution, and increased medication errors [4,5]. From a governance perspective, digital transformation in healthcare today is actively assessing the role of digital technologies in supporting managerial processes, such as optimizing inventory control, preventing stockouts, and ensuring more rational resource allocation [6,7]. To address these challenges, hospital pharmacy information systems must support accurate inventory control, expiration date monitoring, and traceability of high-risk medicines, including narcotics, high-alert medications, look-alike sound-alike (LASA) drugs, cytotoxic agents, and emergency medicines. Precise tracking of these medications is critical, as recommended by the ISMP list of high-alert medications in acute care settings [8,9]. Furthermore, innovations such as automated dispensing cabinets, barcode medication administration, and closed-loop electronic medication management systems have been shown to improve workflows and the safety of controlled medications significantly [4]. Meta-analyses also confirm the effectiveness of electronic medication systems in reducing medication error rates and associated harm among hospital inpatients [5].

The reliability of these pharmacy management information systems is directly proportional to global efforts to establish a patient safety culture. This includes the Global Patient Safety Action Plan 2021–2030, which sets ambitious targets to eliminate avoidable harm in healthcare practices [7], and the World Health Organization (WHO) "Medication Without Harm" initiative, which makes preventing injury from medication management errors an urgent priority [8]. Previous studies have reported that digital pharmacy information systems improve inventory control, reduce medication errors, and enhance service quality. The substantial impact of electronic health records and their subsystems on healthcare quality has also been demonstrated through various systematic reviews and meta-analyses [10]. However, most studies have focused on system implementation or user satisfaction, while comprehensive evaluations of medication management information systems across multiple performance dimensions remain limited. Furthermore, studies applying the PIECES framework in Indonesian regional public hospitals are still scarce.

The PIECES framework was selected because it provides a comprehensive assessment of information systems across six dimensions—Performance, Information, Economy, Control, Efficiency, and Service—enabling the identification of strengths and weaknesses that may affect user satisfaction and system effectiveness. Accordingly, this study aimed to evaluate the implementation of the medication management information system in the Pharmacy Department of Dr. Adhyatma General Hospital using the PIECES framework. The novelty of this study lies in applying the PIECES framework to assess a hospital pharmacy medication management system and in identifying, through correlation analysis, the dimensions most strongly associated with user satisfaction.

MATERIALS AND METHODS

Study Design and Ethical Considerations

This research was designed as a non-experimental mixed-methods study using a prospective observational approach and a structured questionnaire to evaluate the implementation of the Hospital Management Information System (SIMRS) within Indonesia's digital health transformation framework, as mandated by Law No. 17 of 2023 and Government Regulation No. 28 of 2024 [1,2]. Ethical clearance was formally obtained from the Health Research Ethics Committee of Dr. Adhyatma General Hospital, Central Java Province, under No. 015/KEPK.EC/III/2024, ensuring the protection of human subjects. All participants provided written informed consent before their involvement, and researchers maintained strict data confidentiality throughout the study [3,4].

Research Setting and Participant Selection

The investigation was conducted at the Pharmacy Installation of Dr. Adhyatma General Hospital, which has used SIMRS since 2003 to support integrated pharmaceutical services [12]. A census sampling method was used to include the entire eligible population of pharmacy staff actively engaged with the system. This approach yielded a sample of 12 respondents, distributed across five functional units: the pharmaceutical warehouse (n = 2), outpatient pharmacy (n = 3), inpatient pharmacy (n = 2), emergency department (n = 2), and cytotoxic preparation unit (n = 1) [13,14]. The participant profile reflected significant professional diversity, with 66.7% holding professional pharmacist degrees and 83.3% having more than three years of work experience, ensuring highly reliable evaluations of the system [7,8].

Research Instrument and the PIECES Framework

The primary research instrument was a structured questionnaire developed using the PIECES framework. The questionnaire consisted of 30 indicators, with each of the six dimensions—Performance, Information, Economy, Control, Efficiency, and Service—represented by five specific items [9,10]. The indicators were designed as follows. First, Performance indicators focused on system responsiveness, response time, and integrated distribution workflows [9]. Second, Information items assessed data accuracy, real-time monitoring, and the integration of information to support clinical decisions. Third, Economy evaluated cost-effectiveness in procurement and storage optimization, while Control focused on audit trail regularity, access control, and regulatory compliance for high-risk medications. Finally, Efficiency measured workflow optimization and resource utilization, while Service assessed system responsiveness and overall usability [11].

Responses were captured using a five-point Likert scale. To ensure academic rigor, the instrument underwent content validation by a panel of experts. Reliability was statistically confirmed using Cronbach's alpha coefficient, with a threshold of ≥ 0.70 established to guarantee internal consistency [12].

Data Collection and Statistical Procedures

Primary data were collected through direct observation and by administering a validated questionnaire to hospital pharmacy personnel who met the study eligibility criteria. The questionnaire was distributed after participants provided informed consent, and all completed questionnaires were checked for completeness before data analysis. The overall research process, including participant recruitment, data collection, and statistical analysis, is illustrated in Figure 1.

Data analysis was performed using statistical software and consisted of descriptive and inferential analyses. Descriptive analyses were used to summarize respondents' characteristics and their perceptions of the hospital pharmacy information system. Categorical variables were presented as frequencies and percentages, whereas continuous variables were summarized using means and standard deviations, as appropriate. Mean scores for each dimension of the PIECES framework (Performance, Information, Economy, Control, Efficiency, and Service) were calculated to describe respondents' evaluations of the system.

Inferential Analysis was conducted to examine the relationship between each PIECES framework dimension and overall user satisfaction. Because the questionnaire responses were measured using ordinal (Likert-scale) data and the sample size was relatively small (n = 12), Spearman's rank correlation coefficient (ρ) was employed as the appropriate nonparametric statistical test. The strength of the correlations was interpreted based on the magnitude of the correlation coefficient. At the same time, statistical significance was determined using a two-tailed test with a significance level of $p < 0.05$.

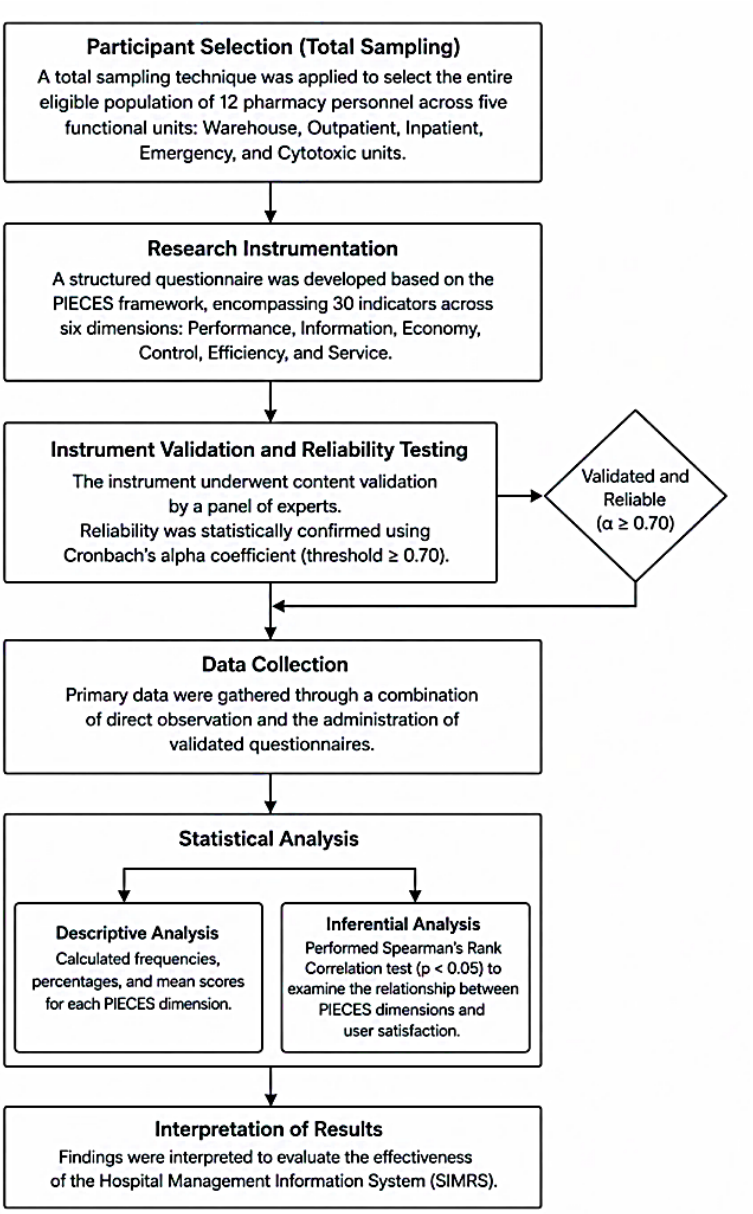

Figure 1. The research methodological flowchart used to evaluate the medication management information system based on the PIECES framework, including participant selection, instrument validation, data collection, and statistical analysis.

RESULTS AND DISCUSSION

Respondent Profiles and Professional Readiness

The study evaluated a sample of 12 pharmacy personnel actively engaged with the Hospital Management Information System. Most participants were in the 40–44 age group (41.7%), and females constituted the majority (58.3%). The respondents demonstrated a high level of professional readiness, with 83.3% having more than three years of clinical experience and 66.7% holding professional pharmacist degrees. Furthermore, all participants (100%) reported prior experience with information systems, which effectively minimized technological resistance during the evaluation.

Table 1. Respondent characteristics

Respondent Characteristics	Frequency (n)	Percentage (%)
Age (years)		
35–39	4	33.3
40–44	5	41.7
50–54	3	25.0
Total	12	100
Gender		
Male	5	41.7
Female	7	58.3
Total	12	100
Educational Background		
Diploma in Pharmacy (D-III)	3	25.0
Bachelor of Pharmacy (S1)	1	8.3
Pharmacist (Professional Degree)	8	66.7
Total	12	100
Work Experience		16.7
1–3 years	2	
>3 years	10	83.3
Total	12	100
Experience Using Information Systems		
Yes	12	100
Total	12	100
Information System Unit		
Pharmacy Warehouse	2	16.7
Outpatient Pharmacy	3	25.0
Inpatient Pharmacy	3	25.0
Emergency Department Pharmacy	2	16.7
Cytotoxic Unit	2	16.7
Total	**12**	**100**

This extensive professional background and digital literacy were essential, as experienced users with advanced clinical degrees are better positioned to critically evaluate whether a health information technology meets routine operational requirements and national standards. The participants were strategically distributed across five critical functional units, including the pharmacy warehouse, outpatient and inpatient pharmacies, emergency department, and cytotoxic unit, ensuring a comprehensive and holistic assessment of the entire medication supply chain [4,5].

Multi-dimensional Evaluation of SIMRS via the PIECES Framework

The evaluation of SIMRS using the PIECES framework yielded an overall satisfactory mean score of 4.19 out of 5.00, indicating consistent fulfillment of both technical and administrative expectations. The Information dimension received the highest rating (mean = 4.32), reflecting users' high value for the system's ability to provide accurate data, real-time monitoring, and integrated information to support clinical decision-making [5-7].

This finding strongly aligned with the World Health Organization's "Medication Without Harm" initiative, which emphasizes accurate health data as a fundamental requirement for preventing medication errors and ensuring patient safety [6,8]. The Performance dimension also received a remarkably high evaluation (mean = 4.27), driven primarily by fast system response times, systematic procurement, and integrated distribution workflows [5,6]. High system performance is a critical enabler of clinical safety; as previous literature indicates, integrated electronic systems operating without technical lag enable the real-time application of evidence-based protocols and significantly reduce inpatient medication error rates [9].

Table 2. Respondents' evaluation of the system based on the PIECES framework

PIECES dimension	SA, n (%)	A, n (%)	N, n (%)	Mean	Interpretation
Performance	21 (35.0)	34 (56.7)	5 (8.3)	4.27	Satisfied
Information	22 (36.7)	35 (58.3)	3 (5.0)	4.32	Satisfied
Economy	20 (33.3)	30 (50.0)	10 (16.7)	4.17	Satisfied
Control	15 (25.0)	40 (66.7)	5 (8.3)	4.17	Satisfied
Efficiency	10 (16.7)	44 (73.3)	6 (10.0)	4.07	Satisfied
Service	13 (21.7)	43 (71.7)	4 (6.6)	4.15	Satisfied
Overall				**4.19**	**Satisfied**

Note. SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree. Each of the six PIECES dimensions comprised five distinct questionnaire items. Because all 12 respondents evaluated every item, this evaluation yielded a total of 60 individual responses per dimension (12 respondents × 5 items). Additionally, the columns for Disagree (D) and Strongly Disagree (SD) were excluded from the table as these categories received zero (0) responses across all dimensions. The maximum achievable mean score was 5.00.

Additionally, the Economy and Control dimensions both had a mean score of 4.17. The system demonstrated cost-effective procurement and automated reporting, reducing operational costs [7-12]. At the same time, robust digital control mechanisms, such as real-time stock monitoring and audit trails, provided the transparency and regulatory compliance needed to manage high-alert medications, narcotics, and look-alike sound-alike (LASA) drugs [12,13]. These capabilities supported Indonesia's digital health transformation mandates for integrated systems under Law No. 17 of 2023 and Government Regulation No. 28 of 2024. Conversely, the Efficiency dimension recorded the lowest score (mean = 4.07), though it remained within the satisfactory category [14]. While the system facilitated faster workflows, it had limited ability to automate documentation, indicating an urgent need to minimize repetitive manual tasks to maximize productivity [7,15].

Qualitative Impact of System Dimensions on Pharmaceutical Services

The qualitative analysis detailed in Table 3 showed that although the system improved general workflows, the Efficiency dimension had limitations in automated documentation. These remaining usability barriers and complex interfaces often posed significant hurdles to the full adoption of electronic health records. Addressing these interface challenges was essential to prevent the emergence of a digital divide in advanced use among hospital personnel [1,2].

Table 3. Summary of PIECES dimension analysis for the management information system

PIECES Dimension	Key Findings	Interpretation
Performance	Fast response time, integrated distribution, systematic procurement	Improves workflow efficiency and reduces medication errors
Information	Accurate data, real-time monitoring, integrated information	Supports clinical decision-making and patient safety
Economy	Cost-effective procurement, optimized storage, automated reporting	Reduces operational and administrative costs
Control	Real-time stock monitoring, audit trail, regulatory compliance	Enhances transparency, safety, and accountability
Efficiency	Faster workflows, automated documentation, optimized resources	Increases productivity and minimizes manual errors
Service	Timely drug distribution, responsive system, automated reporting	Supports service delivery but usability still requires improvement

Furthermore, evaluating these qualitative aspects proved critical, as continuous performance and information quality assessments were primary determinants of public hospital information system success [3,16]. Within the Performance dimension, integrated distribution and systematic procurement workflows operated effectively; prior systemic evaluations confirmed that computerized provider order entry systems significantly reduced preventable adverse drug events and medication errors in hospital settings [4,17].

Additionally, the system's automated dispensing capabilities directly contributed to clinical safety by reducing the rate of omitted and delayed medication doses. The high-quality data and real-time monitoring generated by the Information and Control dimensions also provided a necessary technological foundation for integrating artificial intelligence to proactively improve patient safety in future operations [5,18, 19].

Correlation Between PIECES Dimensions and User Satisfaction

The inferential analysis in Table 4 indicated that all PIECES dimensions were significantly correlated with overall user satisfaction, although the Service and Efficiency dimensions showed the weakest relative correlations. This finding was consistent with earlier reports in which healthcare professionals and nurse informaticians expressed lower satisfaction when faced with persistent usability challenges and inadequate secondary support features [7,20]. Comprehensive systematic reviews of health information systems have previously established that assessing user satisfaction across these multiple dimensions is crucial for accurately evaluating clinical system implementations [8]. The exceptionally strong correlations observed in the Performance and Information dimensions emphasized the critical role of health information technology and digital innovation in building national learning health and care systems [9].

Table 4. PIECES dimensions and user satisfaction correlation

PIECES Dimension	Spearman's rho (ρ)	p-value	Correlation Strength	Interpretation
Performance	0.82	0.001	Very Strong	Significant positive correlation
Information	0.76	0.004	Strong	Significant positive correlation
Economy	0.69	0.012	Moderate–Strong	Significant positive correlation
Control	0.67	0.018	Moderate–Strong	Significant positive correlation
Efficiency	0.71	0.009	Strong	Significant positive correlation
Service	0.58	0.041	Moderate	Significant positive correlation

Furthermore, the robust results of this study validated the need for comprehensive evaluation frameworks to investigate the multifaceted impacts of health information systems. The very strong positive correlation between system performance and user acceptance aligned with the Technology Acceptance Model, which posited that perceived usefulness and technical reliability heavily dictated user adoption in healthcare settings [9,10,20]. The overall satisfactory evaluation of the pharmacy information system reaffirmed that comprehensive eHealth implementations significantly enhanced the quality and safety of clinical care [11,12,19]. Ultimately, these findings corroborated the broader literature, demonstrating that the effective adoption of health information technology yielded predominantly positive results in optimizing hospital management and pharmaceutical services.

Advanced Technologies, Usability, and Evaluation Needs

Future development efforts included proposals for advanced monitoring features for high-alert medications and LASA drugs. The high-quality data generated by the system provided a foundational technological architecture for eventually incorporating artificial intelligence to proactively reduce medication errors and mitigate clinical harm [20]. To sustain these technological prospects, strategic initiatives prioritized optimizing system usability and responsiveness, specifically addressing the relatively lower-rated Service and Efficiency dimensions. Resolving these interface challenges was essential, as previous studies demonstrated that healthcare professionals frequently reported low satisfaction when confronted with persistent usability barriers in electronic health records [21]. Despite these promising developments, the limitations of the single-center design highlighted the fundamental need for future multicenter research. Expanding the evaluation scope remained critical, as comprehensive systematic reviews previously established that robust assessments were crucial for accurately interpreting clinical system implementations [22].

Furthermore, the successful digitalization of medication supply chains underscored the critical role of electronic health innovations in establishing robust national learning health and care systems [23]. Therefore, rigorous, multidimensional evaluation frameworks in subsequent studies were strongly recommended to ensure the generalizability of these findings across diverse healthcare environments [24].

Technology Acceptance and Clinical Safety Optimization

Addressing operational obstacles aligned with the Technology Acceptance Model, which posited that perceived technical reliability and ease of use strongly determined long-term user adoption in healthcare

settings [25]. Consequently, continuous technical support and targeted training were deemed necessary to enhance personnel's digital competencies, ensure sustained system engagement, and strengthen interoperability among hospital units. By enabling real-time monitoring and systematic workflows, this comprehensive eHealth implementation significantly improved the overall quality and safety of clinical care within the institution [26].

The effective integration of the Hospital Management Information System (SIMRS) into the pharmacy department supported national digital health mandates and served as a strategic asset for evidence-based decision-making. These operational successes corroborated the broader literature, which indicates that health information technology implementations consistently yield predominantly positive results in optimizing hospital operations [27].

CONCLUSION AND SUGGESTION

The study concluded that pharmacy personnel perceived the implementation of the Hospital Management Information System (SIMRS) at Dr. Adhyatma General Hospital positively, with all PIECES dimensions receiving satisfactory ratings. The Information dimension was the highest-rated component, reflecting the system's effectiveness in delivering accurate data and enabling real-time monitoring. Furthermore, all PIECES dimensions showed significant positive correlations with user satisfaction, with the Performance dimension showing the strongest association. This underscores the critical importance of system responsiveness, reliability, and integrated workflows in driving user acceptance and supporting medication management within the framework of national digital health mandates.

To optimize system utilization, future initiatives should prioritize system improvements by enhancing usability and automating workflows to address identified gaps in the Efficiency dimension. Recommendations included developing advanced monitoring features for high-alert and high-risk medications to strengthen patient safety and proactively mitigate medication errors. Additionally, the study suggested that providing regular technical training and strengthening interoperability between hospital units are essential for facilitating coordinated clinical decision-making. Given the single-center design, future multicenter research with larger participant groups and objective performance indicators is necessary to provide a more comprehensive and generalizable assessment of SIMRS effectiveness across diverse healthcare environments.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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